Cruise Report for 'Deep-Sea Coral Gardens' Expedition 2019: R/V *Shearwater* SW-19-06

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Objectives

This 2019 expedition was a continuation of the 'Patterns in Deep-Sea Corals' expeditions from 2015-2017 (Caldow et al., 2015; Etnoyer et al., 2016). The research team embarked from Santa Barbara, CA in June of 2019 aboard NOAA Research Vessel (R/V) *Shearwater* with the remotely operated vehicle (ROV) *Beagle*. The objectives of this expedition were a continuation of work to explore newly mapped deep-water habitat (>40-50 m) around the Channel Islands National Marine Sanctuary (CINMS) in order to ground-truth these maps and to evaluate the distribution of mesophotic and deep-sea corals and fishes in relation to surficial geology. Specifically, this expedition sought to:

(1) Survey mesophotic and deep-sea coral ecosystems in priority areas identified by partners;
(2) Explore newly mapped deep-water habitat around CINMS from previous cruises aboard the NOAA ships *Bell M. Shimada*, *Reuben Lasker*, and *Rainier*;
(3) Evaluate the abundance and distribution of deep corals and fishes in relation to geology;
(4) Collect live biological specimens of deep-sea corals for live display and husbandry;
(5) Deploy temperature sensors for synoptic monitoring of temperature from 20 to 182 m.

Methodology

This expedition used the ROV *Beagle* to conduct video surveys aboard the R/V *Shearwater*, OMAO cruise number SW-19-06 from June 4-15, 2019. The sample types collected included still images, HD video, ROV transects, and coral specimens. The science team anticipated 2-4 ROV dives per day, of 1-3 hours duration. Biological samples of corals were collected using the 5 function HydroLek manipulator with a grabber and cutter on the ROV. Location of ROV dive targets were determined daily based on a variety of factors including weather, sea state, current location of the vessel, and proximity to areas surveyed with multibeam during previous missions. ROV dives were planned in advance using multibeam bathymetry and backscatter maps to pick areas of hard bottom with high relief and areas of soft bottom with low relief. Dive summaries were prepared by the lead scientist (Etnoyer), to document dive activities, seafloor habitat, species observed, and relative abundance qualitatively (as high, medium, or low) when notable.

ROV seafloor surveys

Seafloor surveys were conducted using the ROV *Beagle*. The ROV was equipped with the following equipment that collected continuous data throughout each dive: (1) a Sony high-definition, forward-looking video camera, (2) a Kongsberg forward-looking digital still camera with strobes that was used to manually collect still images approximately every 5 seconds, (3) two 15mW red lasers projecting parallel lights 10 cm apart, which were used to scale images collected by the video and still cameras, (4) an ORE Offshore Trackpoint III® ultra-short baseline (USBL) acoustic navigation system with ORE Offshore Motion Reference Unit (MRU) pitch and roll sensor to reference the ROV position relative to the ship's Global Positioning System, which was used to calculate the ROV's real-time position, and (5) a Seabird SBE-19 plus V2 CTD + Seabird SBE-43 DO_2 environmental sensor which was used to collect salinity, temperature, dissolved oxygen, and depth.

ROV transects
Each dive consisted of a series of pre-planned transects that surveyed presumed hard and soft bottom habitats observed in mapping data. Transects were intended to be of 5 - 15 minutes duration but could be longer in duration (20 minutes or more). Several transects would take place over the course of a single dive. The purpose of conducting the video transects is to traverse different substrate types during the dive, and to assess the abundance of benthic megafauna in units of organisms (or colonies) per 100 m^2, in accordance with OSPAR definitions (OSPAR, 2010). These transects corresponded to a survey distance of ~54 - 915 m. During each transect, the ROV attempted to maintain a constant course, altitude (< 1 m) and speed (est. 0.5 knots) off the bottom. The video and still cameras maintained a wide and fixed frame during this time, with lasers in view (10 cm apart). The transects are later subdivided during post-cruise video analyses in the lab into smaller video segments between 25-100 m distance over one substrate class (hard, soft, mixed). If large deviations from the transect protocol occurred (*e.g.* a prolonged change of altitude or course), then that particular video segment will be excluded from analyses.

Specimen collections
Biological specimens were collected during seafloor surveys using the manipulator arm of the ROV and a scoop. For each collected specimen, the date, time, latitude, longitude, depth, and temperature was recorded at the time of collection. Once specimens were retrieved on the deck of the ship, they were placed in a 120 L cooler, and maintained alive with chilled surface water kept at the *in situ* temperature of 8 °C by an AquaEuro USA 1 HP Max-Chill Titanium chiller for live husbandry by Monterey Bay Aquarium.

Temperature logger deployment
Four sets of two HOBO® TidbiT MX® temperature loggers were deployed during Leg 2 and Leg 3. Each set had one logger with activated Bluetooth communication and one logger that was set to log-only mode to ensure the maximum battery life of 10 years. The manufacturer provided no estimation of battery life with activated Bluetooth communication. Both loggers were set to record temperatures every 30 minutes. These tandem logger sets were deployed at 20, 50, 106, and 182 m around Anacapa Island by the ROV on a line with a bottom weight and a float wrapped in reflective tape to assist in recovery (Caldow et al., 2015).

Permits

The expedition was conducted under scientific research permit CINMS-2019-003 issued to Dr. Peter Etnoyer of NCCOS by the Channel Islands National Marine Sanctuary. Samples were collected under the MULTI-2019-002 permit issued to the Monterey Bay Aquarium.

Funding

The expedition SW-19-06 was made possible by NOAA's Deep Sea Coral Research and Technology Program through the West Coast Deep-Sea Coral Initiative (WCDSCI; 2018-2021). Additional support for this effort was contributed by the National Centers of Coastal Ocean Science, the Monterey Bay Aquarium, Marine Applied Research and Exploration, and the Office of National Marine Sanctuaries. The WCDSCI is a 4-year research initiative to discover, map, characterize, explore, and conduct research on deep-sea coral and sponge habitats off California, Oregon, and Washington. As identified in the Science Plan, the expedition described below directly addresses one of the three main research themes of the WCDSCI: "Explore and assess DSCS resources within NOAA

National Marine Sanctuaries with emphasis on areas of sanctuary resource protection and management concerns." With direct consultation from CINMS resource protection and research teams, this cruise was designed to address critical sanctuary research needs and subsequently provide information that will inform management and conservation decisions. Additionally, SW-19-06 will provide useful information on a region-wide scale as it contributes to a broader understanding of the role National Marine Sanctuaries play in the protection of deep-sea habitats.

Summary of Events

The SW-19-06 expedition had some setbacks at the onset but ultimately was a successful expedition. On June 4, 2019, the vessel departed Santa Barbara Harbor in the early morning with 3 ship crew, 4 ROV crew, and 3 scientists aboard. The cruise itinerary is shown in Table 1 and list of participants is shown in Table 2. The vessel reached San Miguel Island that morning, but as soon as the vessel was on site the crew responded to an alarm and went below deck to discover that the vessel was taking on water through the seals of the propeller shaft. Multiple engine mounts had sheared and were causing the engine to pull away from the mounting point, created a gap in the seals while the engine was operating. The team returned using one engine to Ventura Harbor for repairs, and set sail again for the Channel Islands the morning of June 6.

The expedition commenced work in Anacapa Passage on June 6, diving sites mapped by the NOAA ship *Bell M. Shimada*. The site was called 'The Rings', in reference to the pattern of concentric, circular ridges evident in multibeam bathymetry data. The team moved the next day to survey Santa Cruz Canyon, Gull Island Reserve, and a part of Santa Rosa Island recently mapped by a combination of the NOAA ships *Bell M. Shimada, Reuben Lasker,* and *Rainier*. The ship returned to Santa Barbara on June 8 to disembark two researchers from Leg 1 - Andrew Shuler from NOAA/CSS Inc. and Diana Watters from National Marine Fisheries Service (NMFS) Southwest Fisheries Science Center.

Two new researchers came aboard for Leg 2 - Elizabeth Gugliotti from NOAA/CSS Inc. and Matt Wandell from the Monterey Bay Aquarium. Leg 2 surveyed sites west of San Miguel Island recently mapped by NOAA ships *Rainier* and *Bell M. Shimada*, as well as Exploration Vessel (E/V) *Nautilus* for the first two days. The team moved to an area south of Santa Rosa Island called Rosen Ridge to target a previously surveyed area known to have target coral taxa for collection. Sites south of Anacapa Island were targeted to deploy two sets of temperature loggers and survey a site recently mapped by NOAA ship *Bell M. Shimada* in 2017. Leg 2 returned to shore on June 12. A third leg of two days duration took place June 14 – 15, led by Dirk Rosen of Marine Applied Research and Exploration (MARE). Leg 3 returned to The Rings to survey recently mapped areas by NOAA ship *Rainier* in 2017 and deploy two additional sets of temperature loggers.

Summary of ROV operations

The expedition explored sites off all four islands (Figure 1; Figure 2). A total of 30 ROV dives were conducted during the expedition, yielding a total bottom time of 32:06 h and a linear distance surveyed of 30.38 km. Depth ranges explored during the 30 ROV dives ranged from 18-415 m (Table 3). In total 69 seafloor transects were conducted during the expedition. Transects ranged between 54-915 m in length and were conducted at depths ranging between 34-404 m (Table 4). A total of 12 biological specimens were collected during the expedition. Nine of the

specimens were purposely collected; the remaining three specimens were incidentally collected as associated organisms on other samples. Specimens collected included ten corals, one squat lobster, and one sea urchin (Table 5). *In situ* images of the samples are shown in Figures 3 - 11. All specimens were maintained alive on the ship by Matt Wandell to support his studies for an aquarium exhibit of deep-sea corals at Monterey Bay Aquarium.

Two temperature loggers were deployed at 106 m and 182 m on The Footprint ridge, set to record *in situ* temperatures every 30 minutes. Two more temperature loggers were deployed at depths of 20 and 50 m on the northwest side of Anacapa Island. The loggers were deployed at established monitoring stations previously reported in Gugliotti et al. (2019). See Table 6 for the make, model, deployment data, depth and coordinates of the temperature loggers.

Expedition schedule

Table 1. Schedule of expedition R/V *Shearwater* SW-19-06 that surveyed mesophotic and deep-sea coral ecosystems in the Channel Islands National Marine Sanctuary.

Date (local time)	Operations	Comment
2019/06/04	Depart Santa Barbara and transit to San Miguel Island	Return to Ventura for repair
2019/06/05	R/V *Shearwater* in repair in Ventura	Replace 5 engine mounts
2019/06/06	Depart Ventura at 0830 local time for Anacapa Passage; 2 ROV dives at The Rings, Anacapa Passage	NA
2019/06/07	4 ROV dives at Santa Cruz Canyon at 0800 local time, SW Santa Cruz Island, Santa Cruz Canyon, and SE Santa Cruz Island	NA
2019/06/08	Arrive at Gull Island Reserve at 0800 local time, 4 ROV Dives SE Santa Cruz Island, Santa Cruz Canyon, Longshot, and W Santa Rosa Island	Harbor at Santa Barbara
2019/06/09	Depart Santa Barbara at 0630 local time, arrive at N San Miguel Island at 0900 local time to complete 2 ROV dives	Harbor at Cuyler
2019/06/10	Arrive W San Miguel Island at 0800 local time to complete 4 ROV dives	Harbor at S Santa Rosa Island
2019/06/11	1 ROV dive at W San Miguel Island; arrive Rosen Ridge at 0800 local time and completed 2 ROV dives; arrive at Footprint at 1400 local time to complete 2 ROV dives to deploy temperature loggers I and H.	Dive S Santa Cruz Island, transit to Scorpion's; Harbor at E Santa Cruz Island
2019/06/12	Arrive Chimney's at 0800 local time and complete 3 ROV dives; return to Santa Barbara Harbor	Transit to Santa Barbara
2019/06/13	NA	NA
2019/06/14	MARE day trip to CINMS (Discovery Days, Arrive Aquarium) to complete 3 ROV dives; Temperature logger F deployed at N Anacapa Island	Harbor at Santa Barbara
2019/06/15	MARE day trip to CINMS (Discovery Days, Arrive Aquarium 2) to complete 3 ROV dives; Temperature logger G deployed at NW Anacapa Island	Harbor at Santa Barbara

Participant list

Table 2. List of participants (not including ship crew) of expedition SW-19-06 that surveyed mesophotic and deep-sea coral ecosystems in the Channel Islands National Marine Sanctuary on June 4-15, 2019.

Name	Role	Affiliation	Email
Peter Etnoyer	Chief scientist	NOAA/NCCOS	peter.etnoyer@noaa.gov
Andrew Shuler	Biologist	NOAA/NCCOS, CSS	andrew.shuler@noaa.gov
Elizabeth Gugliotti	Biologist	NOAA/NCCOS, CSS	elizabeth.gugliotti@noaa.gov
Diana Watters	Biologist	NOAA/NMFS	diana.watters@noaa.gov
Matt Wandell	Biologist	Monterey Bay Aquarium	mwandell@mbayaq.org
Dirk Rosen	ROV Lead	MARE	dirk@maregroup.org
Andy Lauermann	ROV Navigator	MARE	andy@maregroup.org
Steve Holz	ROV Deck Operations	MARE	holzstevenc@gmail.com
Rick Botman	ROV Engineer	MARE	rick@maregroup.org
Heidi Lovig	ROV Navigator	MARE	heidi@maregroup.org

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Expedition maps

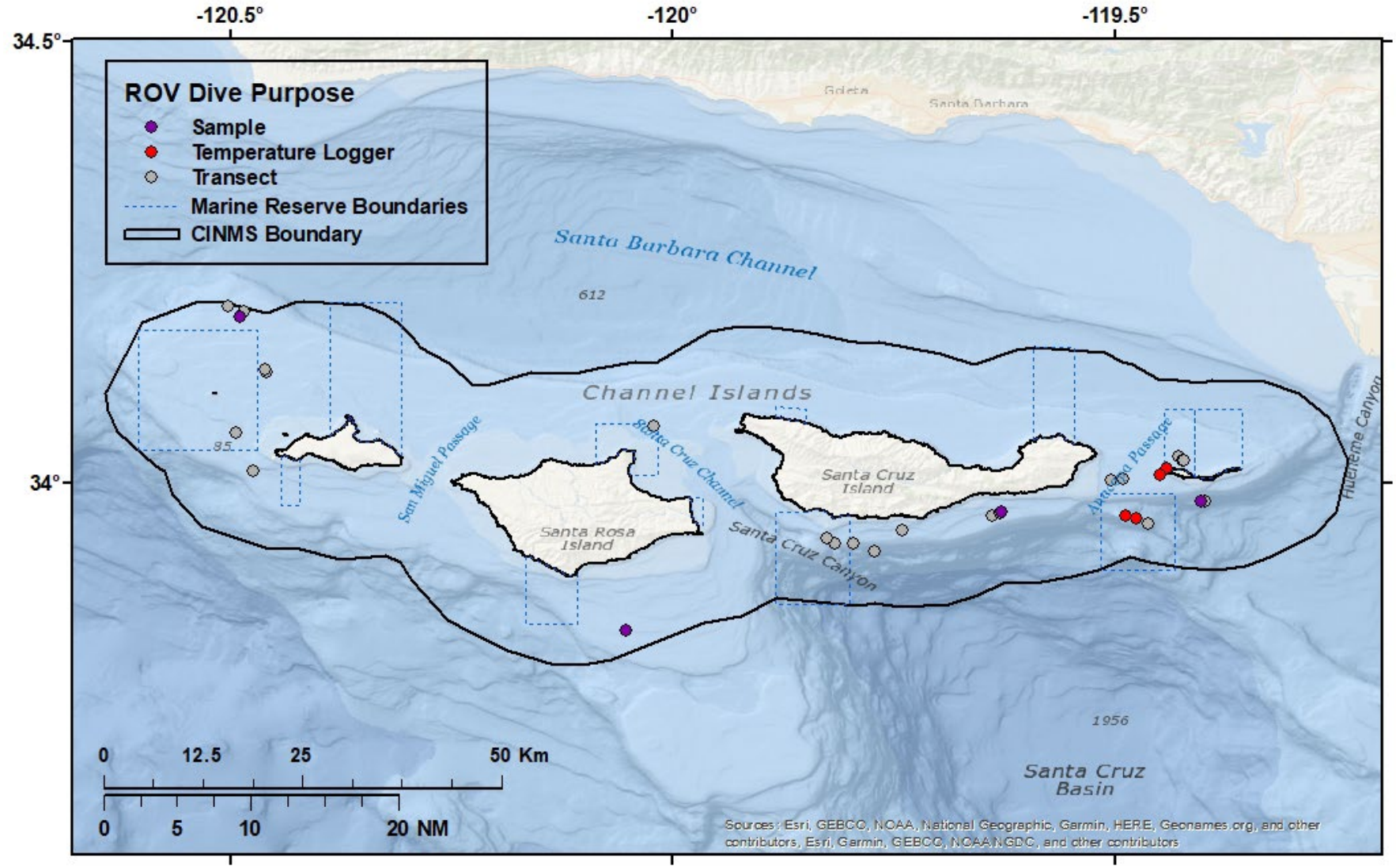

Figure 1. Map showing ROV dives according to purpose of the expedition aboard the R/V *Shearwater* (SW-19-06) that surveyed mesophotic and deep-sea coral ecosystems in the Channel Islands National Marine Sanctuary.

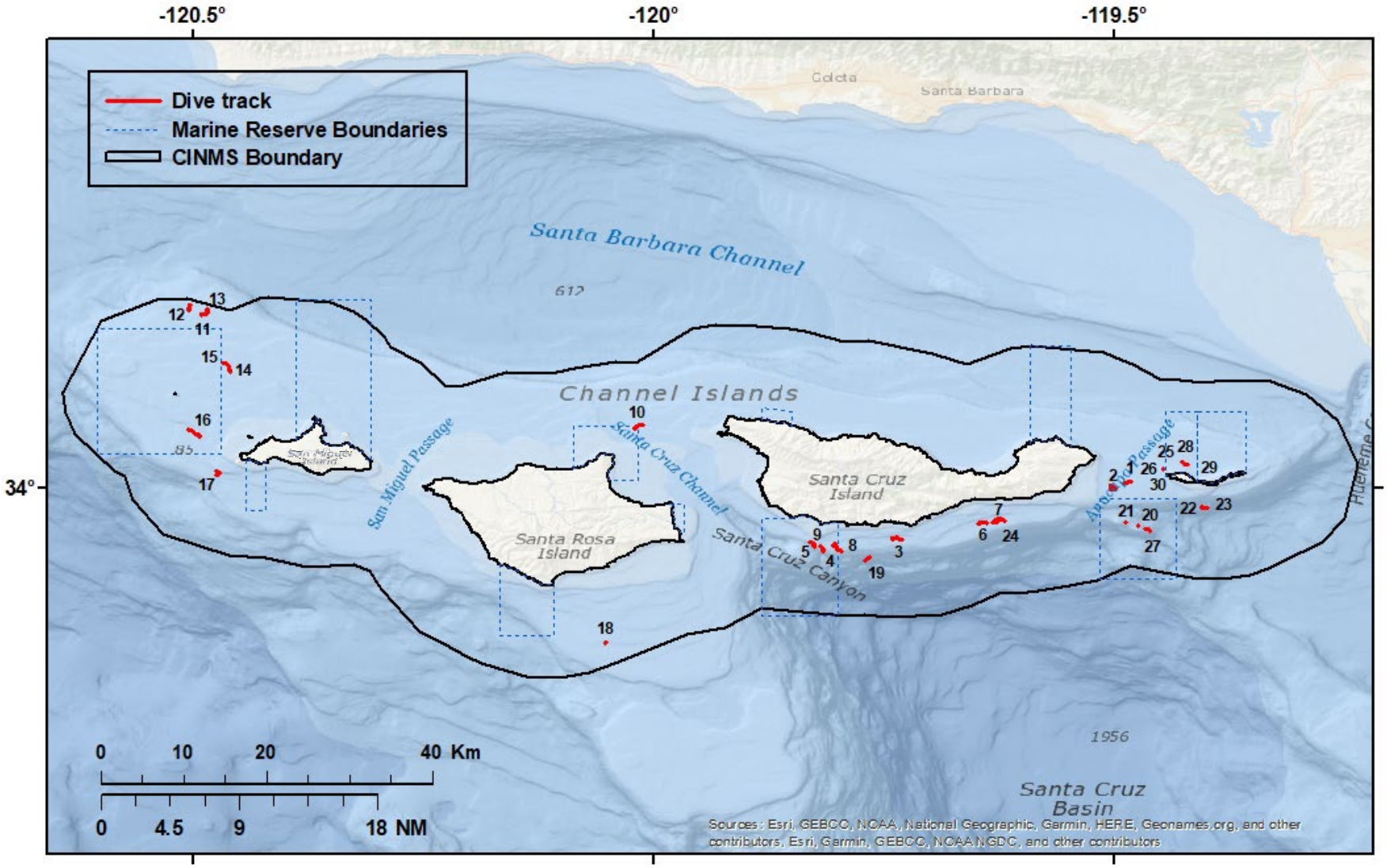

Figure 2. Map showing numbered dive tracks of all ROV dives conducted during SW-19-06 research cruise around the Channel Island National Marine Sanctuary.

Dive summary table

Table 3. Summary information for the dives of the ROV *Beagle* conducted during expedition SW-19-06 in the Channel Islands National Marine Sanctuary.

Date (UTC)	Dive number	Locality	SiteID	On bottom latitude	On bottom longitude	On bottom depth (m)	Off bottom latitude	Off bottom longitude	Off bottom depth (m)	Bottom time (h:min)	Specimens collected	Number of transects
2019/06/06	1	The Rings, Anacapa Passage	WA3	34.00570	-119.49019	53	34.00756	-119.48129	53	1:02	None	3
2019/06/06	2	The Rings, Anacapa Passage	WA1	34.00332	-119.50355	51	33.99869	-119.50415	45	1:43	None	4
2019/06/07	3	Gull Island, SW Santa Cruz Island	SWSC2	33.94552	-119.74078	72	33.94494	-119.73019	77	2:08	None	6
2019/06/07	4	Santa Cruz Canyon	SCC1 & SH17_X2	33.93110	-119.81730	309	33.93761	-119.81973	59	2:28	None	4
2019/06/07	5	Santa Cruz Canyon	SCC2 & SH17_X1	33.93621	-119.82542	332	33.93760	-119.82739	227	0:32	None	1
2019/06/07	6	Southeast Santa Cruz Island	SESC2	33.96212	-119.63862	81	33.96161	-119.64823	76	0:55	None	3
2019/06/08	7	Southeast Santa Cruz Island	SESC1	33.96512	-119.63049	75	33.96437	-119.61853	80	1:11	None	4
2019/06/08	8	Southeast Santa Cruz Island	SWSC1 & 4	33.93124	-119.79621	99	33.94017	-119.80356	54	1:46	None	4
2019/06/08	9	Santa Cruz Canyon	SCC2	33.93754	-119.82575	233	33.94143	-119.83093	74	1:31	None	3
2019/06/08	10	Longshot, W Santa Rosa Island	WSR1	34.06432	-120.02101	54	34.06921	-120.01199	61	1:08	None	3
2019/06/09	11	Love Rock 1, North San Miguel Island	NSM3722	34.19907	-120.50352	155	34.19259	-120.50534	124	1:14	None	3
2019/06/09	12	Great Rocks, North San Miguel Island	NSM8	34.19454	-120.48505	135	34.18773	-120.49136	119	2:09	None	4
2019/06/10	13	Great Rocks, North San Miguel Island	NSM8	34.18816	-120.48981	122	34.18831	-120.49046	107	0:40	*Lophelia pertusa* & cup coral	0
2019/06/10	14	North San Miguel Island	NSM6	34.12599	-120.45968	73	34.12848	-120.46078	62	0:46	None	3
2019/06/10	15	North San Miguel Island	NSM6	34.12870	-120.46070	53	34.13552	-120.46800	83	1:40	None	5
2019/06/10	16	Love Rocks 2, West San Miguel Island	WSM3	34.05683	-120.49383	74	34.06373	-120.50594	83	1:57	None	6

2019/06/11	17	Sponge Reefs, West San Miguel Island	WSM5	34.01395	-120.47529	87	34.01825	-120.47634	75	0:48	None	2
2019/06/11	18	Rosen Ridge, SW Santa Rosa Island	SH17_X6	33.83226	-120.05330	102	33.83332	-120.05190	101	0:52	*Plumarella longispina* (3) & *Adelogorgia phyllosclera* (2)	1
2019/06/11	19	Lauermann Ledge, SW Santa Cruz Island	SWSC6	33.92110	-119.77157	403	33.92556	-119.76517	307	1:28	None	3
2019/06/11	20	Footprint Ridge	Marker I 182 m	33.95943	-119.47481	176	33.95923	-119.47424	180	0:09	None	0
2019/06/11	21	Footprint Ridge	Marker H 106 m	33.96331	-119.48767	111	33.96342	-119.48867	107	0:12	None	0
2019/06/12	22	South Anacapa Island	Chimneys	33.97847	-119.39875	414	33.97940	-119.40585	357	1:04	None	2
2019/06/12	23	South Anacapa Island	Chimneys	33.97914	-119.40195	389	33.97934	-119.40426	362	0:51	*Antipathes dendrochristos* (2) & squat lobster	0
2019/06/12	24	Santa Cruz Canyon	SESC1	33.96607	-119.62192	73	33.96284	-119.63318	71	1:44	*Eugorgia rubens* & sea urchin	0
2019/06/14	25	NW Anacapa Island	AN1	34.02935	-119.42764	81	34.02635	-119.42434	77	0:36	None	1
2019/06/14	26	Etnoyer's Aquarium, North Anacapa Island	Marker F 20 m	34.01661	-119.44139	18	34.01726	-119.44126	19	0:12	None	0
2019/06/14	27	Anacapa Island	Footprint	33.95364	-119.46208	260	33.95633	-119.46672	192	0:37	None	1
2019/06/15	28	NW Anacapa Island	AN1	34.02593	-119.42368	75	34.02539	-119.42264	70	0:18	None	1
2019/06/15	29	NW Anacapa Island	AN1	34.02555	-119.42207	72	34.02530	-119.41983	77	0:33	None	2
2019/06/15	30	NW Anacapa Island	Marker G 50 m	34.02067	-119.44729	39	34.02048	-119.44763	42	0:13	None	0

Transect summary table

Table 4. Inventory of seafloor transect surveys conducted using the ROV *Beagle* during expedition SW-19-06 in the Channel Islands National Marine Sanctuary.

Transect number	Locality	Start time (UTC)	Start latitude	Start longitude	Start depth (m)	End time (UTC)	End latitude	End longitude	End depth (m)
WA3_1	Anacapa Passage	19:19:08	34.00577	-119.48963	53	19:34:04	34.00634	-119.48703	54
WA3_2	Anacapa Passage	19:36:05	34.00630	-119.48677	54	19:51:03	34.00683	-119.48455	53
WA3_3	Anacapa Passage	20:00:30	34.00709	-119.48325	54	20:15:21	34.00740	-119.48119	56
WA1_1	Anacapa Passage	21:05:06	34.00273	-119.50366	51	21:29:15	34.00032	-119.50320	49
WA1_2	Anacapa Passage	21:31:05	34.00030	-119.50272	49	21:46:12	34.00014	-119.49904	49
WA1_3	Anacapa Passage	22:03:10	33.99852	-119.49891	45	22:19:35	33.99859	-119.50153	45
WA1_4	Anacapa Passage	22:23:05	33.99889	-119.50201	45	22:43:17	33.99869	-119.50415	45
SWSC2_1	SW Santa Cruz Island	00:16:24	33.94493	-119.74158	77	00:31:32	33.94546	-119.73975	72
SWSC2_2	SW Santa Cruz Island	00:37:45	33.94523	-119.73950	73	00:53:44	33.94608	-119.73813	69
SWSC2_3	SW Santa Cruz Island	00:59:36	33.94590	-119.73792	69	01:08:00	33.94646	-119.73751	61
SWSC2_4	SW Santa Cruz Island	01:26:57	33.94680	-119.73680	66	01:41:51	33.94556	-119.73511	67
SWSC2_5	SW Santa Cruz Island	01:48:24	33.94497	-119.73429	78	02:02:02	33.94502	-119.73223	73
SWSC2_6	SW Santa Cruz Island	02:03:11	33.94500	-119.73205	72	02:18:14	33.94494	-119.73024	75
SCC1_1	Santa Cruz Canyon	15:36:00	33.93115	-119.81724	295	16:01:45	33.93211	-119.81661	203
SCC1_2	Santa Cruz Canyon	16:16:00	33.93229	-119.81673	192	16:34:45	33.93311	-119.81586	98
SCC1_3	Santa Cruz Canyon	16:41:15	33.93339	-119.81534	85	17:20:00	33.93527	-119.81705	82
SCC1_4	Santa Cruz Canyon	17:23:35	33.93552	-119.81746	85	17:55:25	33.93768	-119.81998	77
SCC2_1	Santa Cruz Canyon	18:39:40	33.93649	-119.82538	324	19:07:08	33.93731	-119.82679	222
SESC2_1	SE Santa Cruz Island	22:28:13	33.96229	-119.63862	80	22:50:29	33.96250	-119.64238	76
SESC2_2	SE Santa Cruz Island	22:54:34	33.96272	-119.64348	76	23:09:46	33.96208	-119.64619	75
SESC2_3	SE Santa Cruz Island	23:11:47	33.96201	-119.64661	75	23:19:19	33.96157	-119.64795	77
SESC1_1	SE Santa Cruz Island	00:11:47	33.96535	-119.62996	76	00:26:50	33.96525	-119.62783	76
SESC1_2	SE Santa Cruz Island	00:27:59	33.96595	-119.62769	75	00:43:00	33.96679	-119.62490	75
SESC1_3	SE Santa Cruz Island	00:46:09	33.96668	-119.62422	75	01:01:05	33.96564	-119.62139	79
SESC1_4	SE Santa Cruz Island	01:02:20	33.96558	-119.62125	79	01:17:25	33.96463	-119.61865	83
SWSC4_1	SW Santa Cruz Island	15:08:26	33.93183	-119.79700	96	15:24:35	33.93289	-119.79956	85
SWSC4_2	SW Santa Cruz Island	15:32:08	33.93311	-119.80077	81	15:47:02	33.93569	-119.80157	81
SWSC4_3	SW Santa Cruz Island	15:54:15	33.93689	-119.80192	76	16:10:07	33.93727	-119.80381	74
SWSC4_4	SW Santa Cruz Island	16:28:40	33.93783	-119.80505	67	16:47:10	33.93959	-119.80416	66
SCC2_1_1	Santa Cruz Canyon	17:35:13	33.93750	-119.82591	230	18:05:21	33.93962	-119.82685	120
SCC2_2_2	Santa Cruz Canyon	18:23:04	33.94043	-119.82653	78	18:37:53	33.94057	-119.82838	84
SCC2_4_3	Santa Cruz Canyon	18:41:45	33.94063	-119.82872	87	19:00:03	33.94129	-119.83085	85
WSR1_1	West Santa Rosa Island	20:43:28	34.06473	-120.02060	54	20:58:45	34.06701	-120.02070	58

WSR1_2	West Santa Rosa Island	21:01:09	34.06755	-120.02019	59	21:16:06	34.06806	-120.01691	56
WSR1_3	West Santa Rosa Island	21:18:28	34.06813	-120.01661	56	21:35:00	34.06881	-120.01408	58
NSM3722_1	North San Miguel Island	17:02:38	34.19866	-120.50329	155	17:18:14	34.19740	-120.50437	147
NSM3722_2	North San Miguel Island	17:19:28	34.19731	-120.50441	147	17:34:35	34.19533	-120.50479	136
NSM3722_3	North San Miguel Island	17:36:00	34.19517	-120.50471	135	17:51:04	34.19352	-120.50513	132
NSM_1	North San Miguel Island	18:53:05	34.19423	-120.48500	136	19:07:58	34.19200	-120.48498	130
NSM_2	North San Miguel Island	19:22:03	34.19144	-120.48494	109	19:32:00	34.19084	-120.48492	114
NSM_3	North San Miguel Island	19:45:23	34.18934	-120.48538	110	20:00:31	34.18933	-120.48798	109
NSM_4	North San Miguel Island	20:07:28	34.18927	-120.48837	113	20:57:00	34.18759	-120.49157	128
NSM6_1	North San Miguel Island	15:46:21	34.12532	-120.45953	74	15:54:25	34.12611	-120.46012	69
NSM6_2	North San Miguel Island	15:55:44	34.12636	-120.46016	66	16:12:00	34.12748	-120.46059	34
NSM6_3	North San Miguel Island	16:16:20	34.12776	-120.46053	41	16:21:54	34.12814	-120.46073	39
NSM6 (2)_1	North San Miguel Island	19:10:45	34.12849	-120.46080	55	19:23:47	34.12977	-120.46136	51
NSM6 (2)_2	North San Miguel Island	19:26:30	34.13027	-120.46145	52	19:33:40	34.13130	-120.46176	82
NSM6 (2)_3	North San Miguel Island	19:45:29	34.13306	-120.46257	85	20:01:10	34.13468	-120.46425	86
NSM6 (2)_4	North San Miguel Island	20:02:29	34.13490	-120.46445	86	20:17:40	34.13529	-120.46499	83
NSM6 (2)_5	North San Miguel Island	20:19:26	34.13521	-120.46526	72	20:35:00	34.13548	-120.46766	85
WSM3_1	West San Miguel Island	21:51:33	34.05604	-120.49405	76	22:02:30	34.05779	-120.49437	77
WSM3_2	West San Miguel Island	22:05:05	34.05817	-120.49469	71	22:22:10	34.05879	-120.49663	75
WSM3_3	West San Miguel Island	22:22:40	34.05883	-120.49679	75	22:37:45	34.05999	-120.49899	69
WSM3_4	West San Miguel Island	22:48:40	34.06083	-120.49931	68	23:04:07	34.06217	-120.50104	73
WSM3_5	West San Miguel Island	23:06:53	34.06198	-120.50129	72	23:26:16	34.06332	-120.50325	85
WSM3_6	West San Miguel Island	23:28:00	34.06337	-120.50347	85	23:38:05	34.06356	-120.50553	84
WSM5_1	West San Miguel Island	00:35:57	34.01391	-120.47407	88	00:51:07	34.01679	-120.47151	65
WSM5_2	West San Miguel Island	00:57:20	34.01741	-120.47171	63	01:12:37	34.01814	-120.47528	71
SH17-X6	SH17-X6	15:05:28	33.83238	-120.05322	102	15:12:49	33.83327	-120.05190	100
SWSC6_1	SW Santa Cruz Island	18:13:48	33.92166	-119.77185	385	18:29:00	33.92209	-119.77032	381
SWSC6_2	SW Santa Cruz Island	18:39:10	33.92256	-119.76952	396	18:54:13	33.92344	-119.76859	383
SWSC6_3	SW Santa Cruz Island	19:01:07	33.92426	-119.76815	361	19:25:41	33.92523	-119.76608	335
Chimney_1	South Anacapa Island	01:15:53	33.97917	-119.40059	404	01:31:33	33.97920	-119.40260	395
Chimney_2	South Anacapa Island	01:35:49	33.97930	-119.40298	396	01:43:00	33.97925	-119.40374	370
AN1_1	NW Anacapa Island	18:08:00	34.02873	-119.42760	79	18:22:43	34.02771	-119.42517	78
Footprint	NW Anacapa Island	20:38:36	33.95499	-119.46218	241	21:05:25	33.95634	-119.46661	197
AN1_2	NW Anacapa Island	17:53:08	34.026045	-119.42393	77	18:05:00	34.02541	-119.42244	76
AN1_3	NW Anacapa Island	18:40:33	34.025627	-119.42216	77	18:56:22	34.02549	-119.42097	77
AN1_4	NW Anacapa Island	18:57:13	34.025439	-119.42080	77	19:12:22	34.02530	-119.41983	77

Sample summary table

Table 5. Inventory of specimens collected during expedition SW-19-06 in the Channel Islands National Marine Sanctuary.

Sample number	Scientific Name	Date (UTC)	Time (UTC)	Locality	Latitude	Longitude	Depth (m)	Preservation	Specimen destination after cruise[10]
SW1906-Dive13-Spec01	*Lophelia pertusa*	2019/06/10	01:09:00	Great Rocks, N San Miguel Island	34.18820	-120.49020	116	Live	Monterey Bay Aquarium
SW1906-Dive13-Spec02	*Desmophyllum dianthus*	2019/06/10	01:09:00	Great Rocks, N San Miguel Island	34.18820	-120.49020	116	Live	Monterey Bay Aquarium
SW1906_Dive18-Spec03	*Plumarella longispina*	2019/06/11	15:21:30	Rosen Ridge, SE Santa Rosa Island	33.83340	-120.05170	101	Live	Monterey Bay Aquarium
SW1906_Dive18-Spec04	*Plumarella longispina*	2019/06/11	15:31:00	Rosen Ridge, SE Santa Rosa Island	33.83320	-120.05160	101	Live	Monterey Bay Aquarium
SW1906_Dive18-Spec05	*Plumarella longispina*	2019/06/11	15:35:30	Rosen Ridge, SE Santa Rosa Island	33.83320	-120.05170	101	Live	Monterey Bay Aquarium
SW1906_Dive18-Spec06	*Adelogorgia phyllosclera*	2019/06/11	15:44:45	Rosen Ridge, SE Santa Rosa Island	33.83340	-120.05180	101	Live	Monterey Bay Aquarium
SW1906_Dive18-Spec07	*Adelogorgia phyllosclera*	2019/06/11	15:54:00	Rosen Ridge, SE Santa Rosa Island	33.83330	-120.05170	101	Live	Monterey Bay Aquarium
SW1906_Dive23-Spec08	*Antipathes dendrochristos*	2019/06/12	16:07:43	Chimneys; South Anacapa Island	33.97920	-119.40280	378	Live	Monterey Bay Aquarium
SW1906_Dive23-Spec09	*Antipathes dendrochristos*	2019/06/12	16:45:00	Chimneys; South Anacapa Island	33.97890	-119.40410	364	Live	Monterey Bay Aquarium
SW1906_Dive23-Spec10	Squat Lobster (on *Antipathes*)	2019/06/12	16:45:00	Chimneys; South Anacapa Island	33.97890	-119.40410	364	Live	Monterey Bay Aquarium
SW1906_Dive24-Spec11	*Eugorgia rubens*	2019/06/12	19:06:00	Unnamed site, SE Santa Cruz Island	33.96640	-119.62780	73	Live	Monterey Bay Aquarium
SW1906_Dive24-Spec12	Sea urchin	2019/06/12	19:06:00	Unnamed site, SE Santa Cruz Island	33.96640	-119.62780	73	Live	Monterey Bay Aquarium

Temperature logger summary table

Table 6. Temperature logger deployment around Anacapa Island using the ROV *Beagle* during expedition SW-19-06 in the Channel Islands National Marine Sanctuary.

Depth (m)	Deployment Date	Temperature Logger Brand	Latitude	Longitude
20	6/15/2019	HOBO® TidbiT® (MX2204)	34.01717	-119.44128
50	6/14/2019	HOBO® TidbiT® (MX2204)	34.02093	-119.44702
106	6/11/2019	HOBO® TidbiT® (MX2204)	33.96346	-119.48863
182	6/11/2019	HOBO® TidbiT® (MX2204)	33.95936	-119.47443

Sample photographs

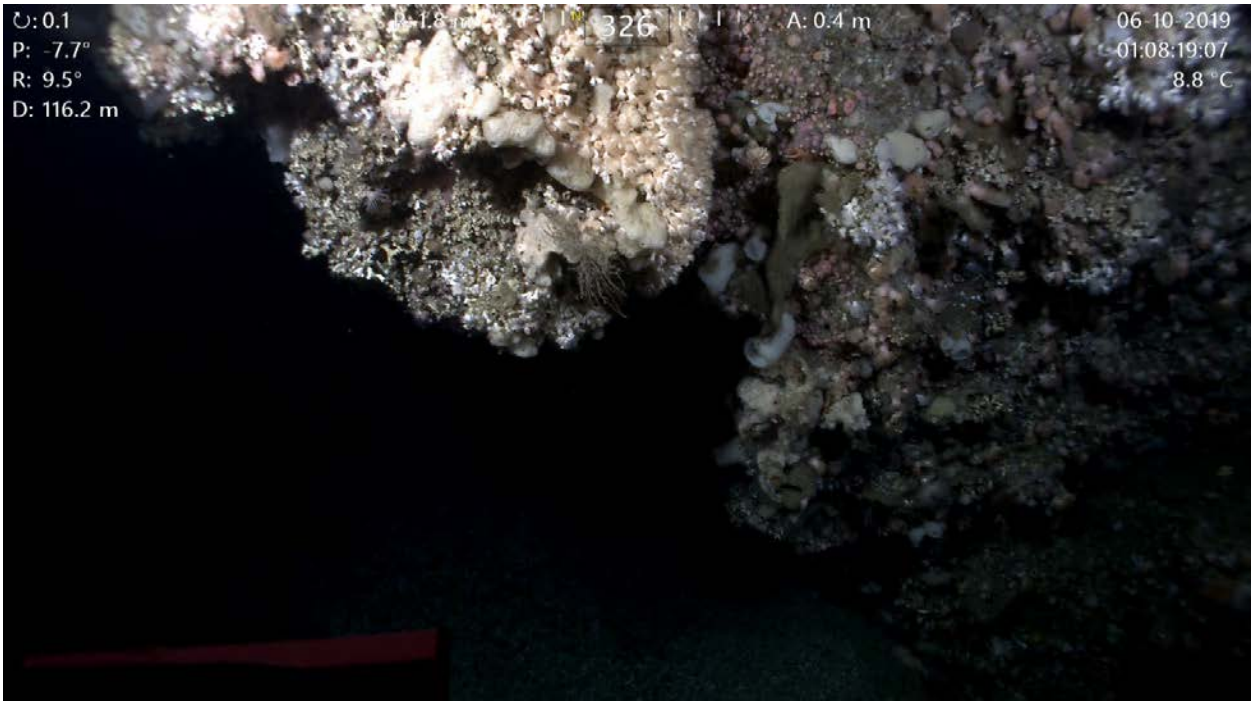

Figure 3. *In situ* image of *Lophelia pertusa* (SW1906-Dive13-Spec01) sample from Great Rocks, North San Miguel Island at 116 m. Image was captured from the video since the still camera was disabled during the dive. Sample *Desmophyllum dianthus* (SW1906-Dive13-Spec02) was presumably collected from the same patch of stony corals.

Figure 4. *In situ* image of sample *Plumarella longispina* (SW1906-Dive18-Spec03) from Rosen Ridge, SE Santa Rosa Island at 101 m.

Figure 5. *In situ* image of sample *Plumarella longispina* (SW1906-Dive18-Spec04) from Rosen Ridge, SE Santa Rosa Island at 101 m.

Figure 6. *In situ* image of sample *Plumarella longispina* (SW1906-Dive18-Spec05) from Rosen Ridge, SW Santa Rosa Island at 101 m.

Figure 7. *In situ* image of sample *Adelogorgia phyllosclera* (SW1906-Dive18-Spec06) from Rosen Ridge, SW Santa Rosa Island at 101 m.

Figure 8. *In situ* image of sample *Adelogorgia phyllosclera* (SW1906-Dive18-Spec07) from Rosen Ridge, SE Santa Rosa Island at 101 m.

Figure 9. *In situ* image of sample *Antipathes dendrochristos* (SW1906-Dive23-Spec08) from Chimneys, South Anacapa Island at 378 m.

Figure 10. *In situ* image of sample *Antipathes dendrochristos* (SW1906-Dive23-Spec09) and squat lobster (SW1906-Dive23-Spec10) from Chimneys, South Anacapa Island at 364 m.

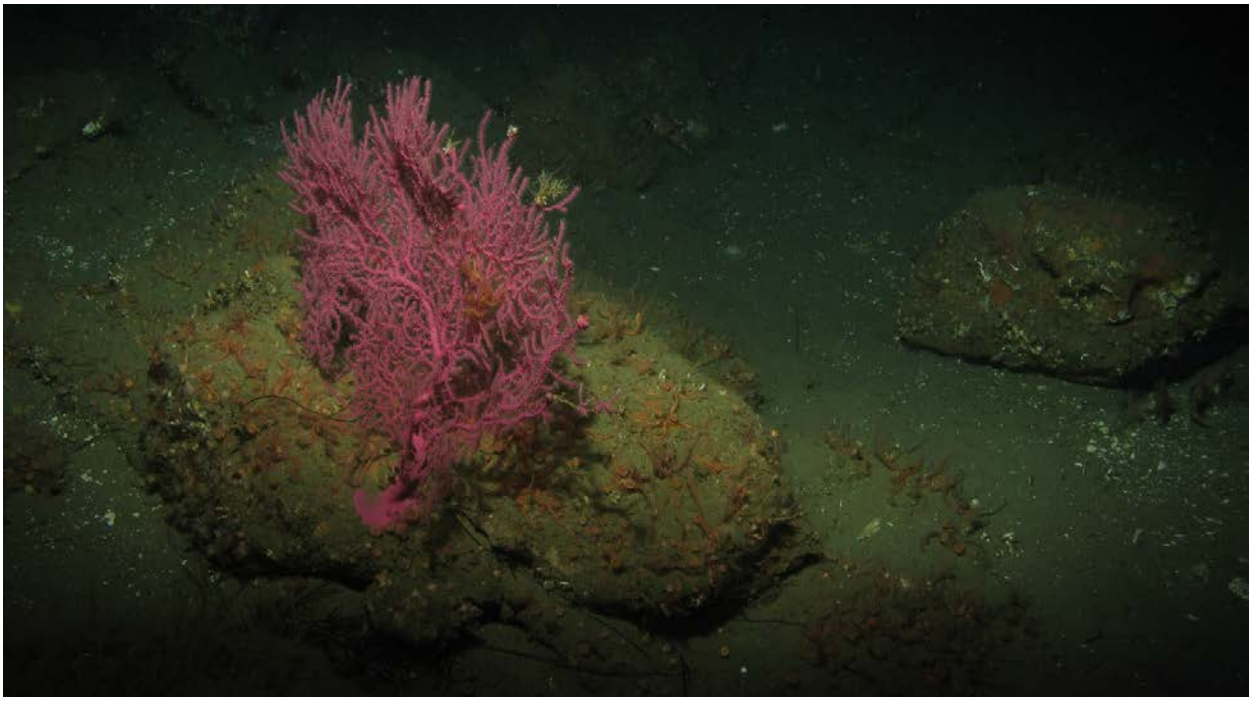

Figure 11. *In situ* image of sample *Eugorgia rubens* (SW1906-Dive24-Spec11) and presumably the associated sea urchin (SW1906-Dive24-Spec12) from SE Santa Cruz Island at 73 m.

Acknowledgements

We thank the officers and crew of the NOAA R/V *Shearwater*, and in particular the ship captain Terrence Shinn, who provided extraordinary support for all operations. Special thanks to the ROV pilots Dirk Rosen and Andy Lauermann, who exhibited superb skills in operating the ROV. We would also like to thank the reviewers Tom Laidig, Ryan Freedman, and Rachel Bassett. The scientific results and conclusions, as well as any views or opinions expressed herein, are those of the authors and do not necessarily reflect the views of NOAA nor the Department of Commerce.

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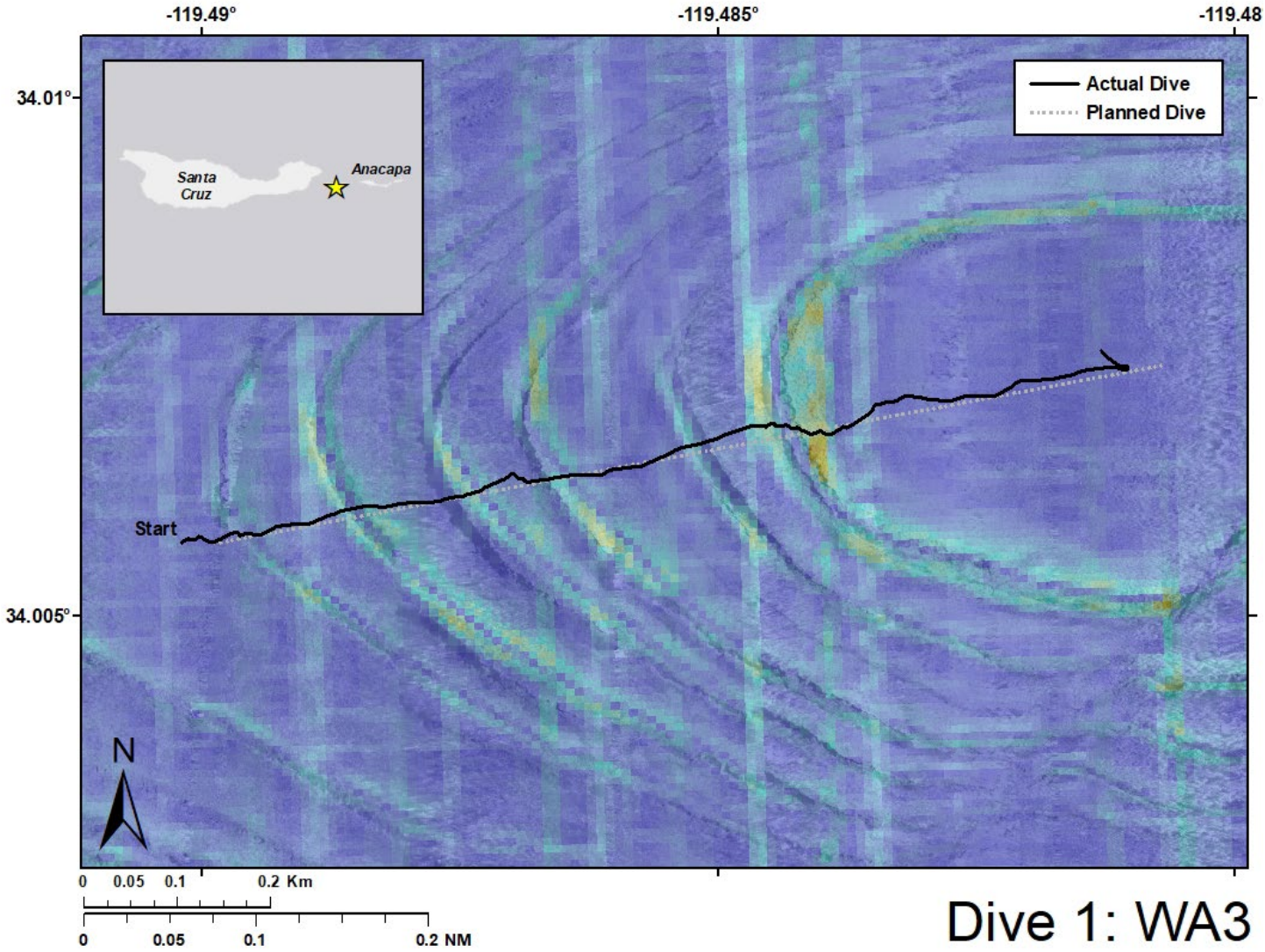
Appendix 1: Dive summaries

Dive 01
Start Coordinate: 34.00570, -119.49019
Depth Range: 53-56 m

SCS Site ID: WA3, The Rings
End Coordinate: 34.00756, -119.48129
Bottom Time: 1 hour 02 minutes

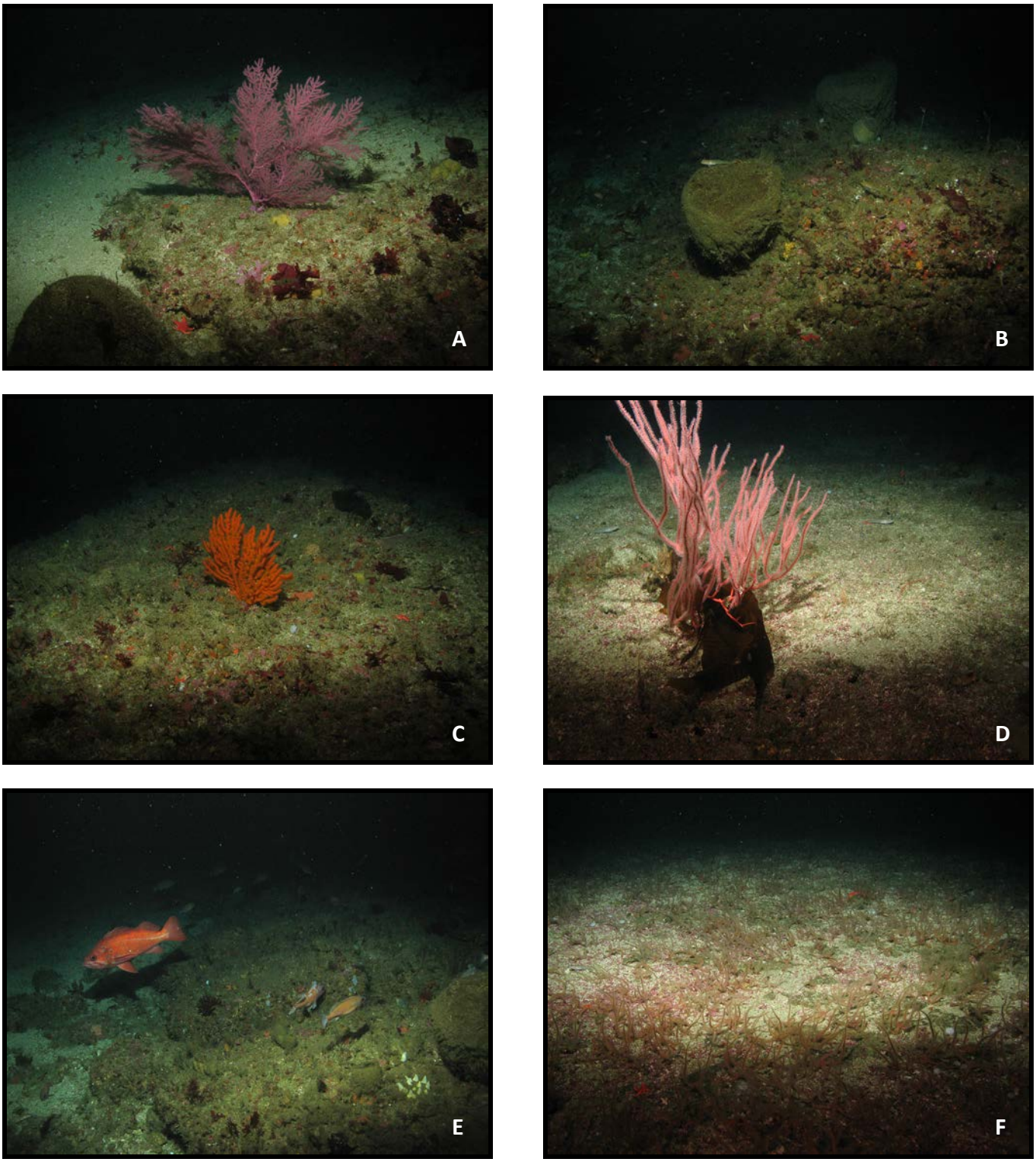


Map Caption. *The planned trajectory for ROV Dive 1 is shown as a gray dashed line, with the actual trajectory in black. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and side-scan imagery (in grey-scale).*

Dive Summary:
The first dive of the expedition surveyed an area newly mapped by the NOAA ship *Bell M. Shimada* in 2017 (8 m bathymetry used to create slope and hillshade for predicting topography) within the Anacapa Passage between East Santa Cruz Island and West Anacapa Island. The mapped area is characterized by a series of concentric rings, which were interpreted as rocky ledge features, based upon the topographic relief and acoustic backscatter.

The dive was on bottom at 19:15 UTC for a duration of 1 hour 02 minutes. The Secchi disk depth was 10 m in overcast skies. Bottom temperature was 10.3 °C at a depth of 53 m. This dive ran from west to east through the center of the rings. The dive was oriented perpendicular to the rings to calibrate multibeam. The spatial offset was negligible as rocky ledges were observed by the ROV where they were expected from the maps. The relief of the features was less than predicted, at 1-2 m. Three 15-minute video transects were completed during the dive.

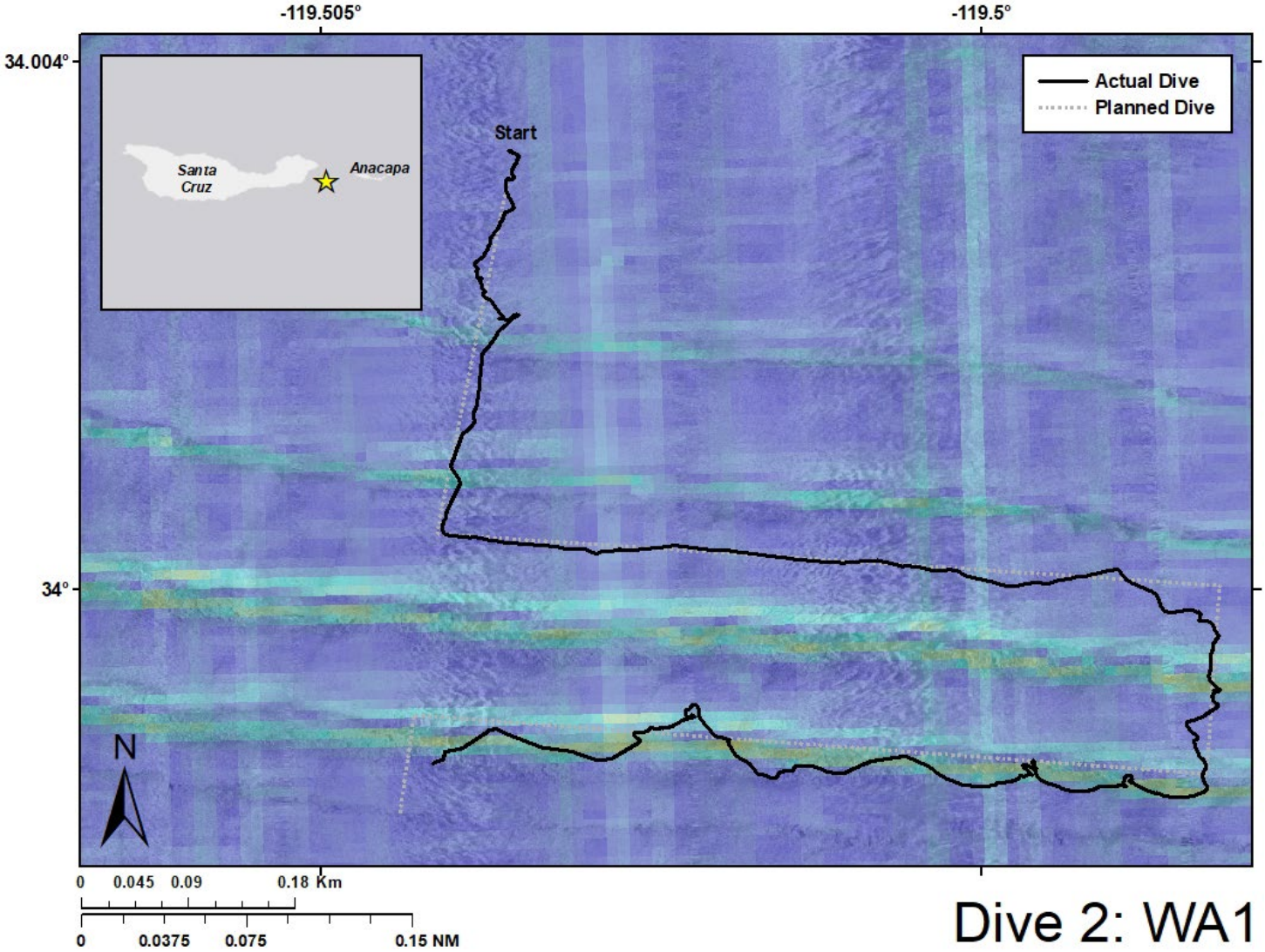
In general, abundance of fish and corals appeared relatively low. Key coral species observed included *Eugorgia rubens* (purple gorgonian), *Leptogorgia chilensis*, *Adelogorgia phyllosclera* (orange gorgonian), and several sea pens. At least two colonies of *Eugorgia rubens* were toppled and lying on their side. Rockfish species included halfbanded, blues, coppers, flag, treefish, squarespot, and vermilion. There was one small aggregation of flag rockfish on a rock pile. Other fish species included scorpionfish and lingcod. No fishing gear was observed.



Dive 1 took place in Anacapa Passage at depths ranging from 53 to 56 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) *Eugorgia rubens* (purple gorgonian) on mixed bottom. B) Sponges with overgrowth and gobies on rocky substrate. C) *Adelogorgia phyllosclera* (orange gorgonian) on hard bottom. D) *Leptogorgia chilensis* and gobies on mixed bottom. E) Vermilion, copper, and squarespot rockfish over mixed substrate. F) Flat substrate with numerous brittle stars.

Dive 02
Start Coordinate: 34.00332, -119.50355
Depth Range: 45-51 m

SCS Site ID: WA1, The Rings
End Coordinate: 33.99869, -119.50415
Bottom Time: 1 hour 43 minutes

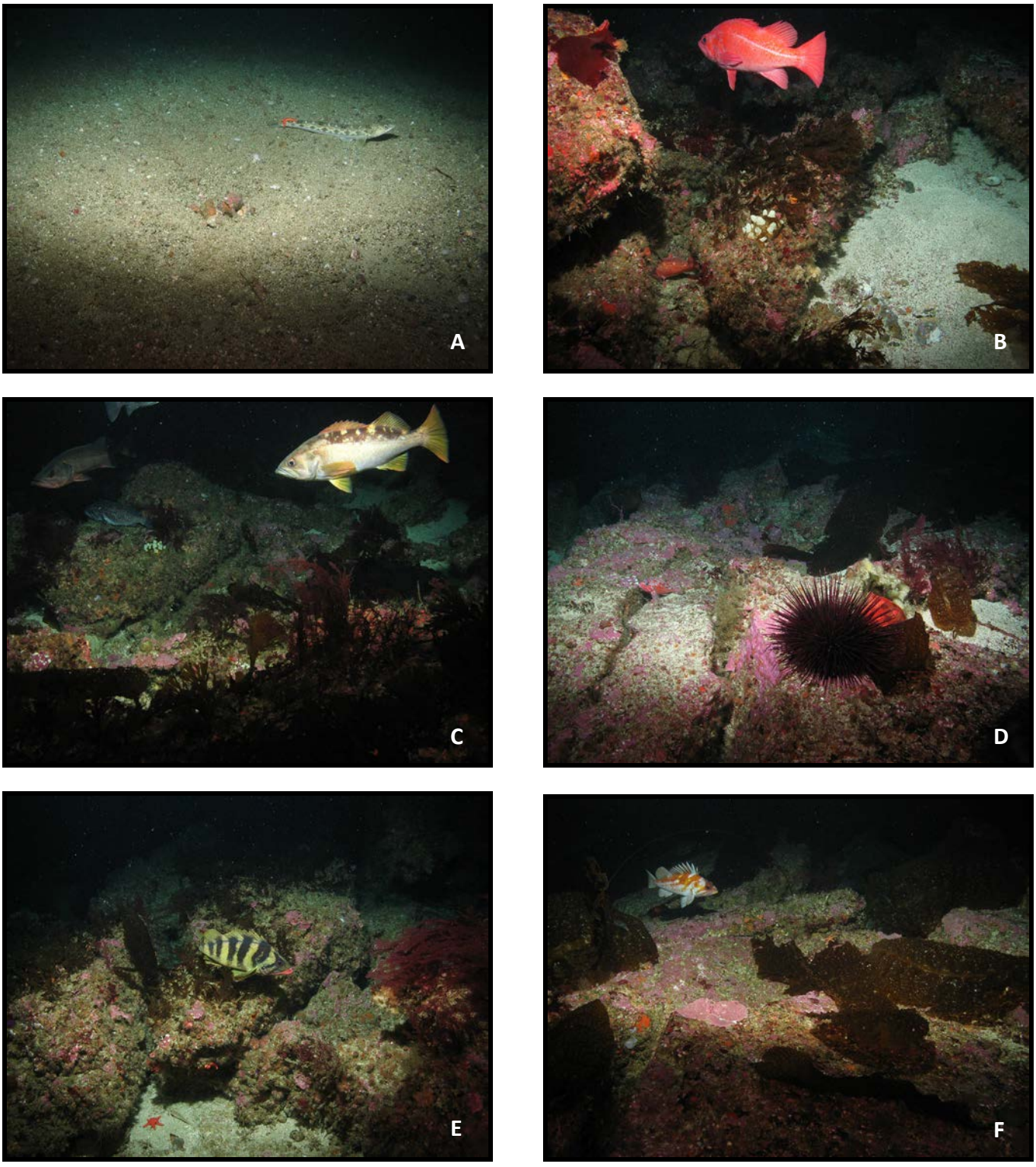


Map Caption. *The planned trajectory for ROV Dive 2 is shown as a gray dashed line, with the actual trajectory in black. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and side-scan imagery (in grey-scale).*

Dive Summary:
The second dive surveyed an area mapped by the NOAA ship *Bell M. Shimada* in 2017 (8 m bathymetry used to create slope and hillshade for predicting topography). This dive explored the outer concentric rings to the WSW of Anacapa Island; these were shallower than inner rings. The dive was on bottom at 21:00 UTC for a duration of 1 hour 43 minutes. The Secchi disk depth was 10 m. Bottom temperature was 10.3 °C at a depth of 45 m.

This dive ran from north to south and then east and west along the features. The trough was sandy, as expected. The relief of the ledge features was again less than predicted, at 1-2 m. The ROV transects examined both sides of the rocky ledge. The north side was smooth and sloped, covered with kelp and algae. The south side was rugose, also with high cover of kelp and algae. Four 15-minute video transects were completed during the dive. The ROV was pulled off course by the boat a few times, due to the heading.

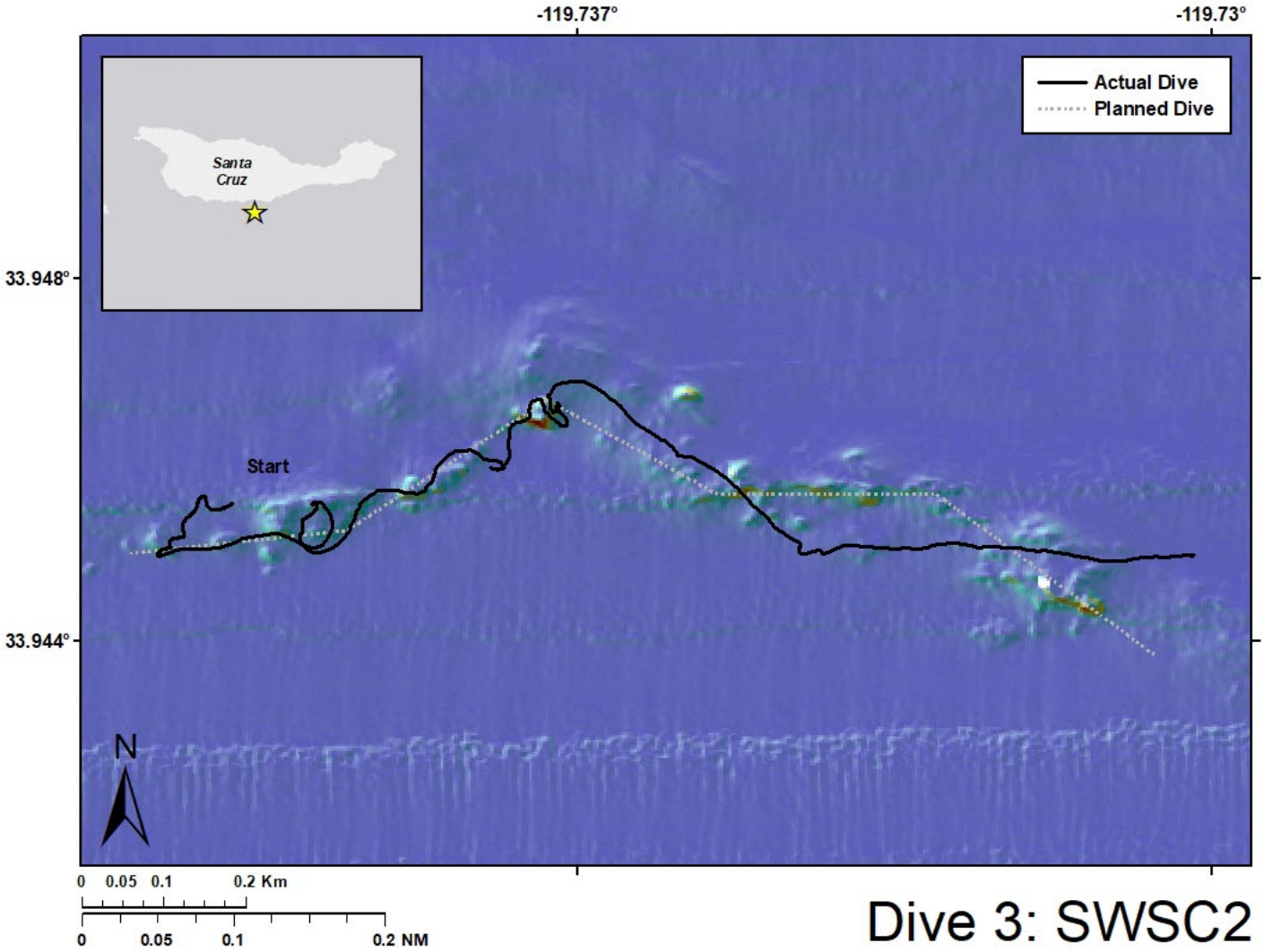
Corals were absent, except for one sea pen. In general, there appeared to be more fish rocky ledges than in the sandy troughs. Fish species included a large school of silversides, possibly anchovy, at the beginning of the dive as well as lingcod, garibaldi, California lizardfish, painted greenling, sea perches, and sheephead. The rockfish species observed were blue, halfbanded, copper, squarespot, olive, bocaccio, treefish, rosy, and vermilion. One monofilament line was seen.



Dive 2 took place West of Anacapa Island at depths ranging from 45 to 51 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) California lizardfish on soft sediment. B) Vermilion rockfish over rocky substrate. C) Olive rockfish on rocky bottom. D) Red sea urchin (*Mesocentrotus franciscanus*). E) Treefish on rocky bottom. F) Copper rockfish over rocky substrate with fallen kelp.

Dive 03
Start Coordinate: 33.94552, -119.74078
Depth Range: 72-77 m

SCS Site ID: SWSC2
End Coordinate: 33.94494, -119.73019
Bottom Time: 2 hours 08 minutes

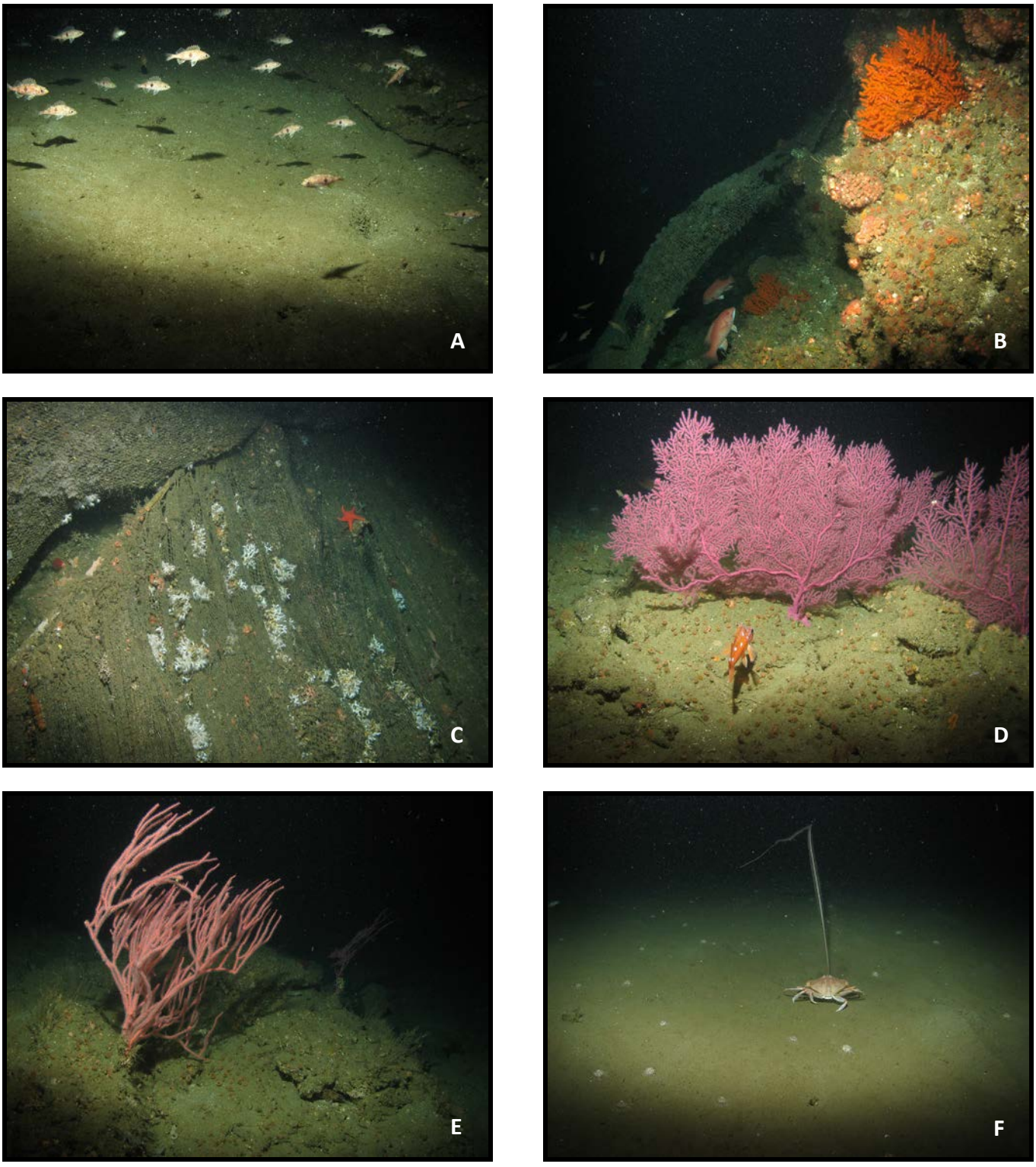


Map Caption. *The planned trajectory for ROV Dive 3 is shown as a gray dashed line, with the actual trajectory in black. The map background is two layers - slope (in color, partially transparent, red = high slope) and hillshade (in grey-scale).*

Dive Summary:
The third dive surveyed the south side of Santa Cruz Island, navigating over side-scan sonar and bathymetry data (8 m) by the NOAA ship *Bell M. Shimada* in 2017. The dive was on bottom at 00:10 on June 7, 2019 UTC for a duration of 2 hours 08 minutes. The Secchi disk depth was 9 m. Bottom temperature was 9.5 °C at a depth of 72 m. We surveyed a 'blank area' of side scan that we called Area 51 characterized by hazardous rocks and snags.

The full SWSC2 line was completed running from SW to NE, NE to SW, and then E along a nadir line. The beginning and end of the dive were over soft sediment. Most of the dive transited rocky pinnacles, some of which were visible in maps. These maps underestimated the extent of hard bottom that was observed during the dive. The vertical relief of the pinnacles ranged from 1-10 m. Six transects were completed. One transect (T3) was 7 minutes, due to a snag where the ROV tether wrapped around a rocky pinnacle with fishing debris.

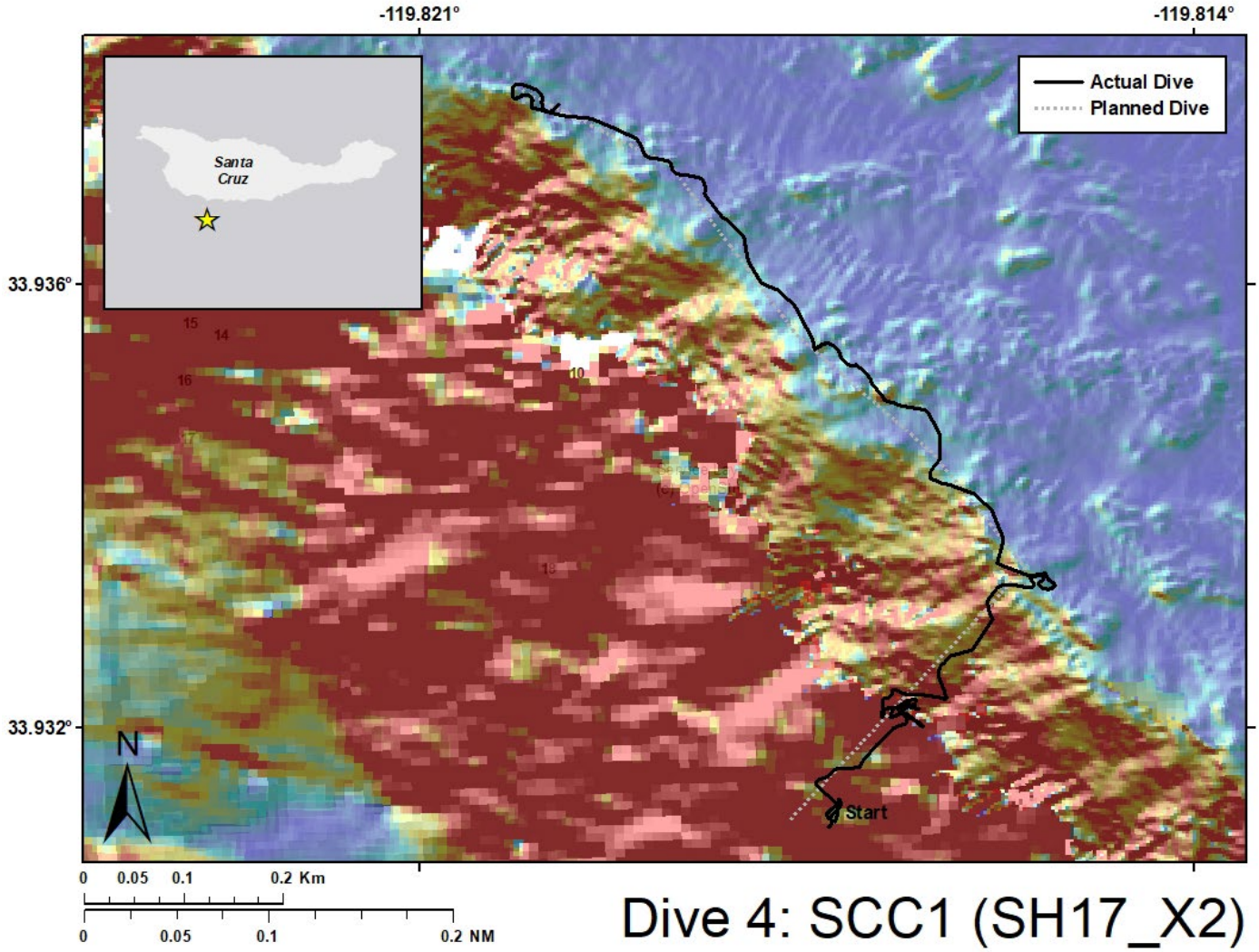
In general, abundance of fish and corals appeared to be relatively moderate. A large school of small fish was seen between T3 and T4. Large sea fan corals (> 1 m), sea apples, sponges, and bryozoans were present on rock. The sea fans on rocky bottom were *Eugorgia rubens*, *Leptogorgia chilensis*, *Adelogorgia phyllosclera*, and a small yellow gorgonian. A few dead and injured *Eugorgia rubens* corals were seen, one colonized by *Parazoanthus*. Sea pens (*Halipteris/Funiculina* sp.) were present in soft bottom. Rockfish species were greenspotted, halfbanded, copper, squarespot, bocaccio, treefish, rosy, and vermilion. Kelp greenlings, painted greenlings, and sheephead, were also observed. Soft bottom fish included combfish, poacher, torpedo ray, pink sea perch, gobies, and a skate. Seine nets and thick lines were seen strewn around large rocks and *Lophelia pertusa*.



Dive 3 took place on the south side of Santa Cruz Island at depths ranging from 72 to 77 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) School of halfbanded rockfish. B) Net on rocks with *Adelogorgia phyllosclera* and sheephead. C) Net on rocks with *Lophelia pertusa*. D) *Eugorgia rubens* and rosy rockfish. E) *Leptogorgia chilensis* on hard substrate. F) *Acanthoptilum gracile* and crab on soft sediment.

Dive 04
Start Coordinate: 33.93110, -119.81730
Depth Range: 59-309 m

SCS Site ID: SCC1 (formerly SH17_X2)
End Coordinate: 33.93761, -119.81973
Bottom Time: 2 hours 28 minutes

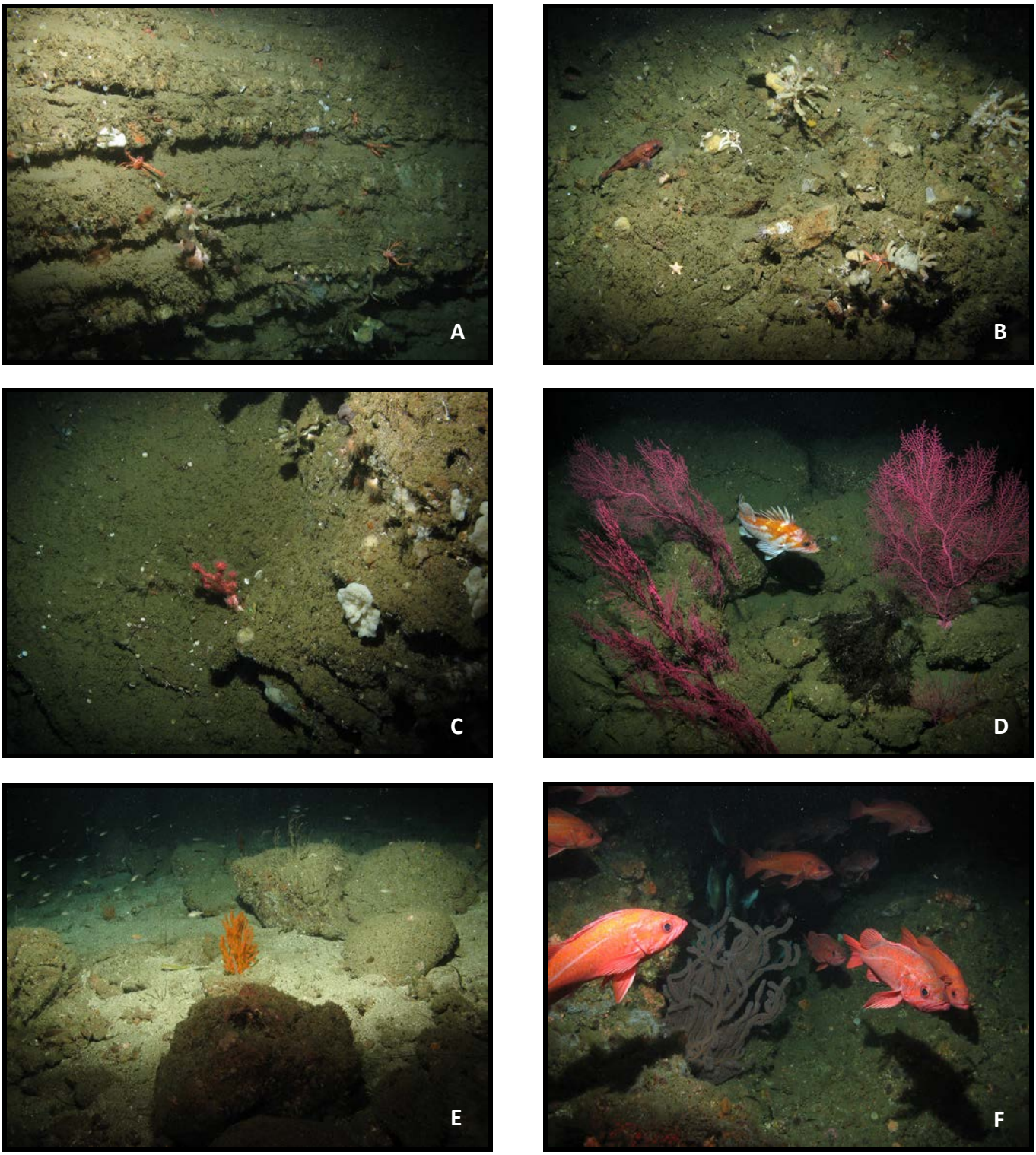


Map Caption. *The planned trajectory for ROV Dive 4 is shown as a gray dashed line, with the actual trajectory in black. The map background is two layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale).*

Dive Summary:
The fourth dive of the expedition surveyed the NE wall of Santa Cruz Canyon, navigating over multibeam bathymetry data collected by the California State University Monterey Bay (CSUMB) in 2006. The dive was on bottom at 15:30 on June 7, 2019 UTC. Dive duration was 2 hours 28 minutes. The Secchi disk depth was 9 m. Bottom temperature was 8.2 °C at a depth of 309 m. We surveyed a steep wall and the rim of the canyon.

This dive ran from S to N and then SE to NW. Most of the dive transited steep rocky wall and high relief rocky features, with boulders and small pockets of sediment. The full SCC1 line was completed. Four transects were completed; two transects were a vertical distance of 100 m (T1 & T2). Two other transects were a horizontal distance of about 300 m (T3 & T4) along the rim of the canyon.

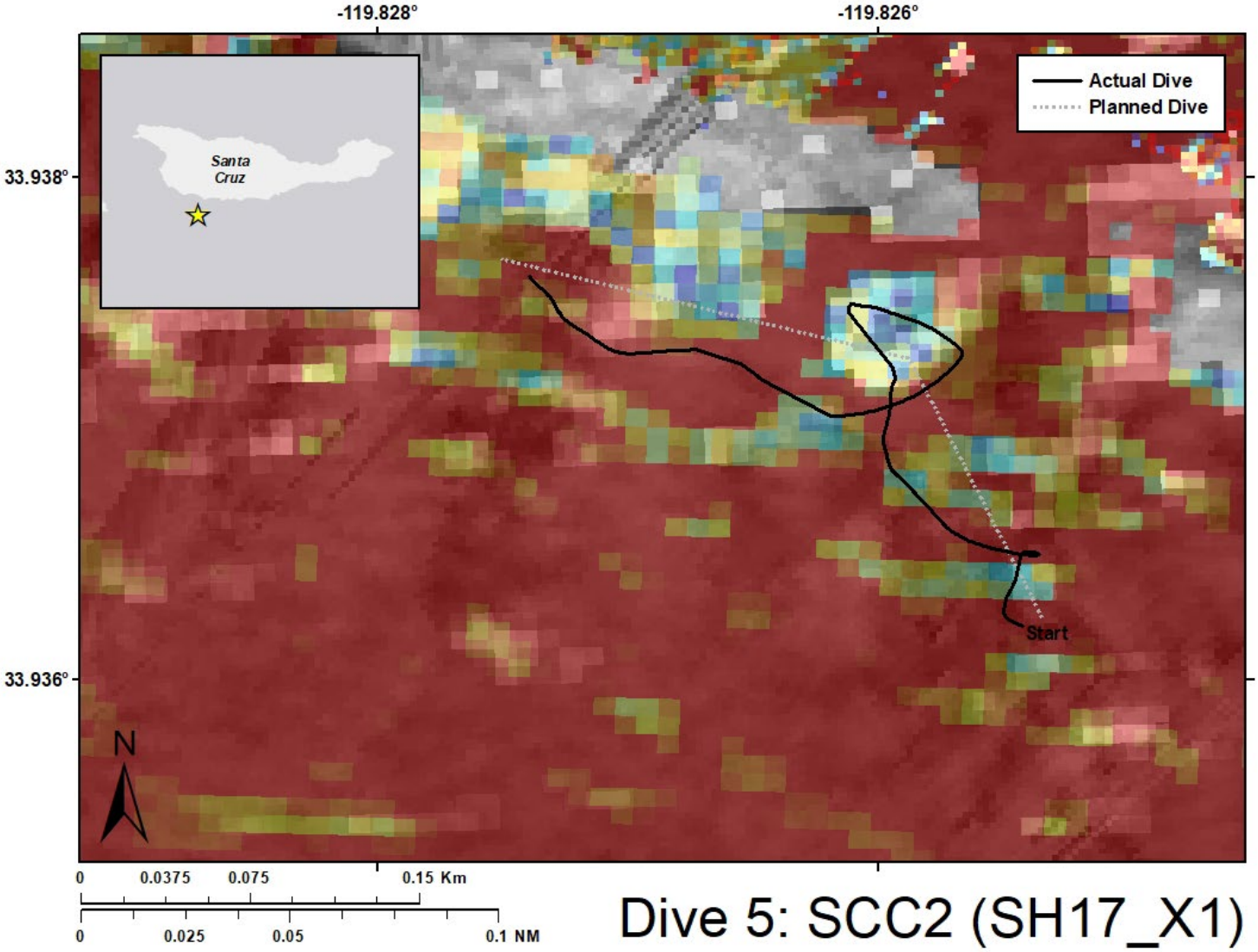
In general, few fish were observed in the area surveyed except for one large aggregation in high relief rock on the rim of the canyon. Many corals and sponges were observed. Sponges were diverse in form, but of unknown identity. Large sea fan corals (> 1 m) were present on rock, and some sea pens on soft bottom. Corals observed on the deep wall were *Antipathes dendrochristos, Muricea fruticosa, Paragorgia* sp., and *Lophelia pertusa*. Crinoids, basket stars, and *Adelogorgia phyllosclera* were present on the shallower part of the wall. *Eugorgia rubens, Leptogorgia chilensis,* and *Adelogorgia phyllosclera* were abundant on the rim. Rockfish species on the deep wall included banks and *Sebastomus*. The shallower (< 100 m) part of the canyon along the rim had greenspot, widow, blue, olive, rosy, bocaccio, squarespot, rosethorn, flag, copper, and vermilion rockfish. Lingcod and pink sea perch were also observed. Soft bottom fish were combfish, gobies, and poachers. There was an exceptional aggregation of many rockfish species at 76 m around two *Muricea fruticosa* colonies. A video highlight was made without an overlay for outreach purposes.



Dive 4 took place on the Northeast wall of Santa Cruz Canyon at depths ranging from 59 to 309 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) Squat lobsters and cup corals on rocky ledge. B). Bank rockfish with cup corals and various sponges. C) *Paragorgia* sp. on hard substrate. D) *Eugorgia rubens* and copper rockfish on hard substrate. E) *Adelogorgia phyllosclera* in mixed sediment. F) Vermilion rockfish with *Muricea fruticosa.*

Dive 05
Start Coordinate: 33.93621, -119.82542
Depth Range: 227-332 m

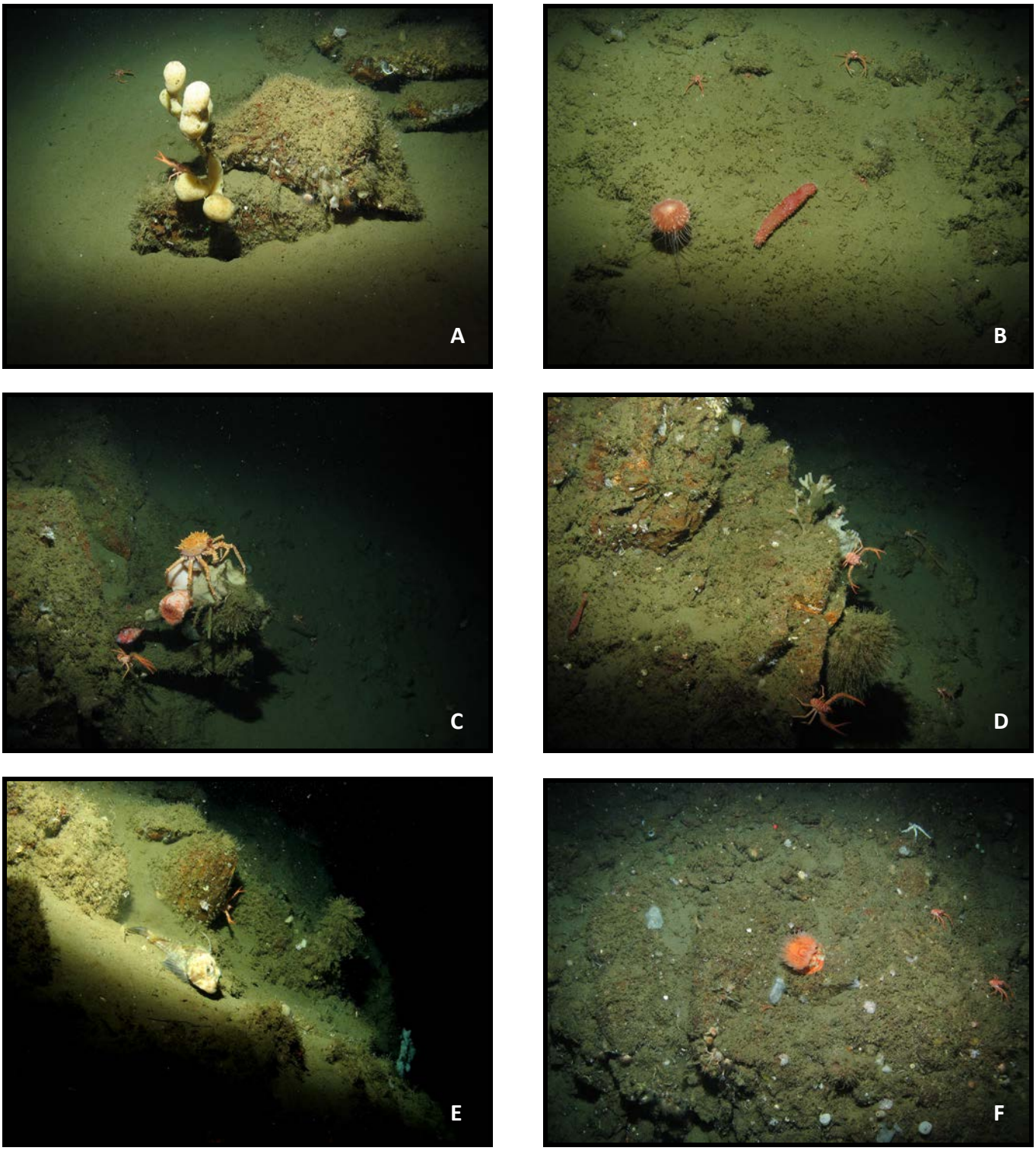
SCS Site ID: SCC2 (formerly SH17_X1)
End Coordinate: 33.93760, -119.82739
Bottom Time: 0 hours 32 minutes



Map Caption. *The planned trajectory for ROV Dive 5 is shown as a gray dashed line, with the actual trajectory in black. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

Dive Summary:
The fifth dive of the expedition surveyed the NE wall of Santa Cruz Canyon, navigating over multibeam bathymetry (16 m) from the NOAA ship *Bell M. Shimada* in 2017. The dive was on bottom at 18:37 on June 7, 2019 UTC at a depth of 332 m. Dive duration was 32 minutes. Bottom temperature was 8.4 °C at a depth of 227 m. We surveyed a steep rocky wall. Only one transect was completed during the SCC2 dive, covering a vertical distance of 100 m.

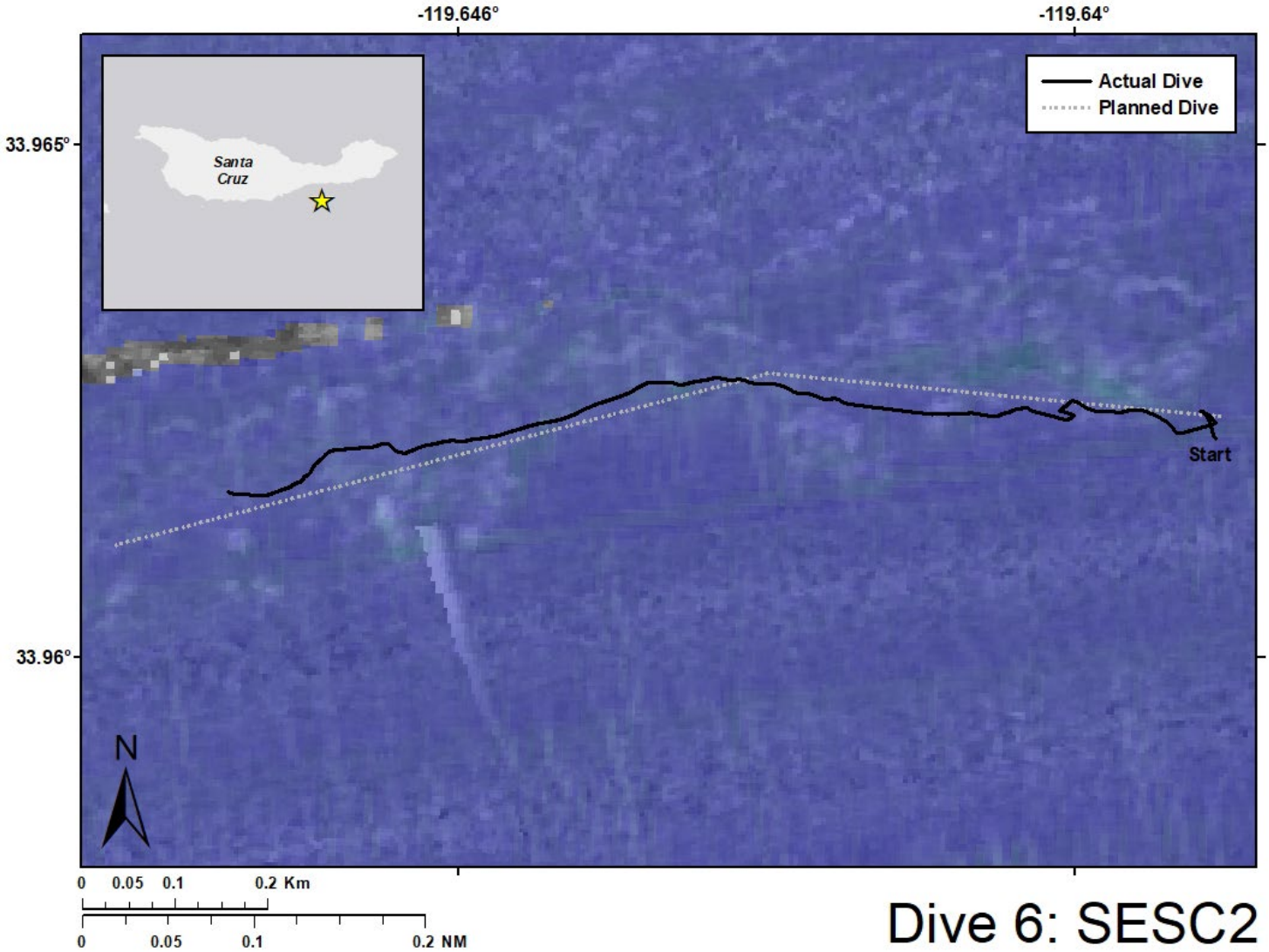
Many sponges were observed that were diverse in form, but of unknown identity. Mobile invertebrates included spot prawns, galatheid crabs, California king crab, benthic siphonophore *Dromalia*, and sea cucumbers. Rockfishes on the deep wall included bank and *Sebastomus*. The shallower part of the wall (< 100 m) had greenspotted, widow, blue, splitnose/aurora, and greenblotched rockfish. Threadfin sculpin and blackeye gobies were also observed. Currents were strong, making ROV navigation difficult. The dive ended prematurely due to electrical problems.



Dive 5 took place on the Northeast wall of Santa Cruz Canyon at depths ranging from 227 to 332 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) *Rhizaxinella gadus* previously seen on the SH-17-05 cruise. B) Benthic siphonophore *Dromalia* with sea cucumbers and squat lobsters. C) California king crab on sponge with anemone and squat lobster. D) Squat lobsters on rocky substrate. E) Threadfin sculpin and squat lobster. F) Anemone with squat lobsters on rocky substrate.

Dive 06
Start Coordinate: 33.96212, -119.63862
Depth Range: 76-81 m

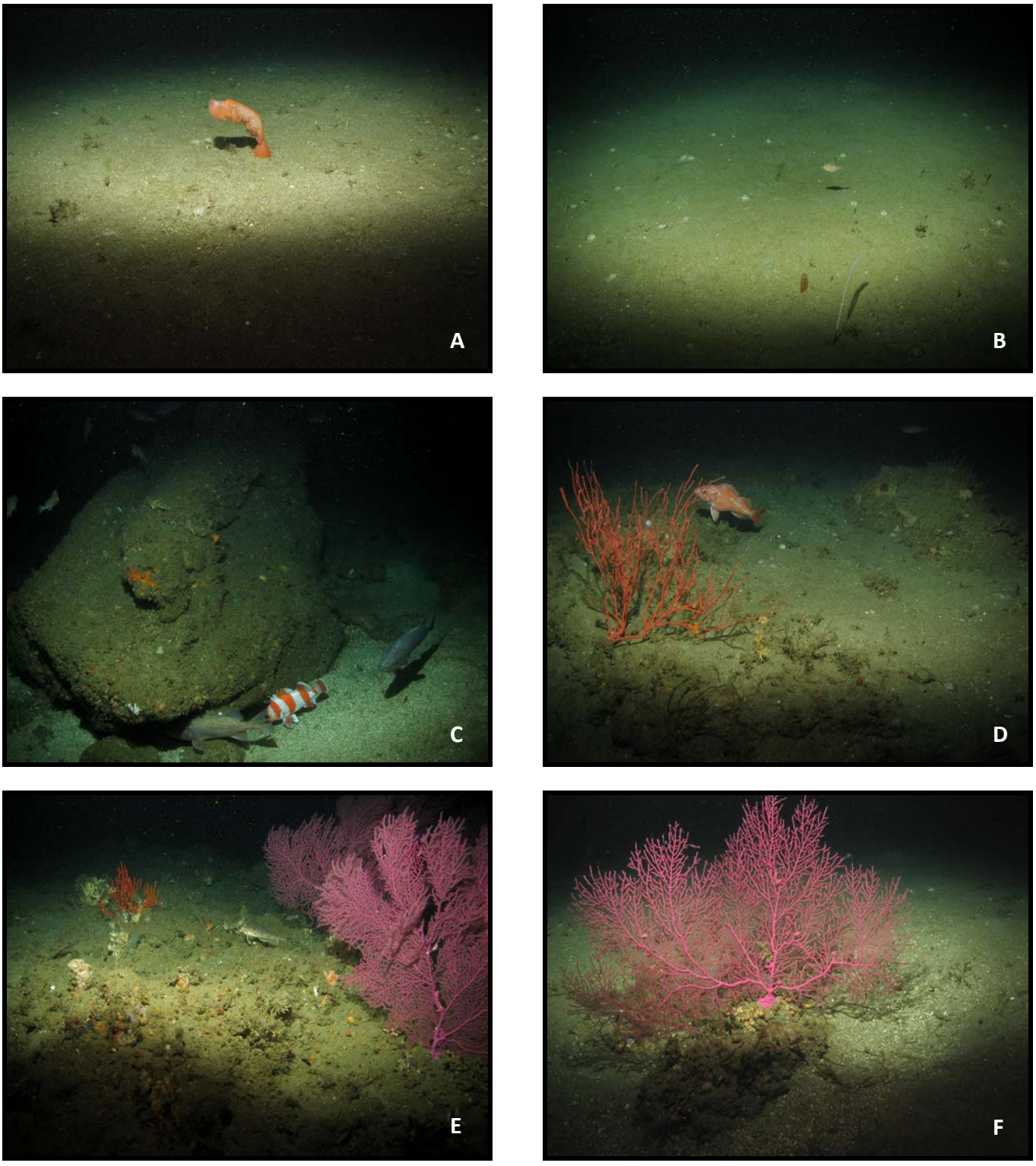
SCS Site ID: SESC2
End Coordinate: 33.96161, -119.64823
Bottom Time: 0 hours 55 minutes



Map Caption. *The planned trajectory for ROV Dive 6 is shown as a gray dashed line, with the actual trajectory in black. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

Dive Summary:
The sixth dive of the expedition surveyed the SE Santa Cruz shelf area, navigating over multibeam bathymetry (8 m) from the NOAA ship *Reuben Lasker* in 2016. Secchi depth was 6-7 m. The dive was on bottom at 22:25 on June 7, 2019 UTC at a depth of 81 m. Dive duration was 55 minutes. Bottom temperature was 11 °C. We surveyed soft, sandy sediment with occasional rocks and boulders. The planned dive line for SESC2 was completed. Three transects were completed during the dive, over a total distance of 1000 m. The third transect was brief at only 100 m (about 5 minutes).

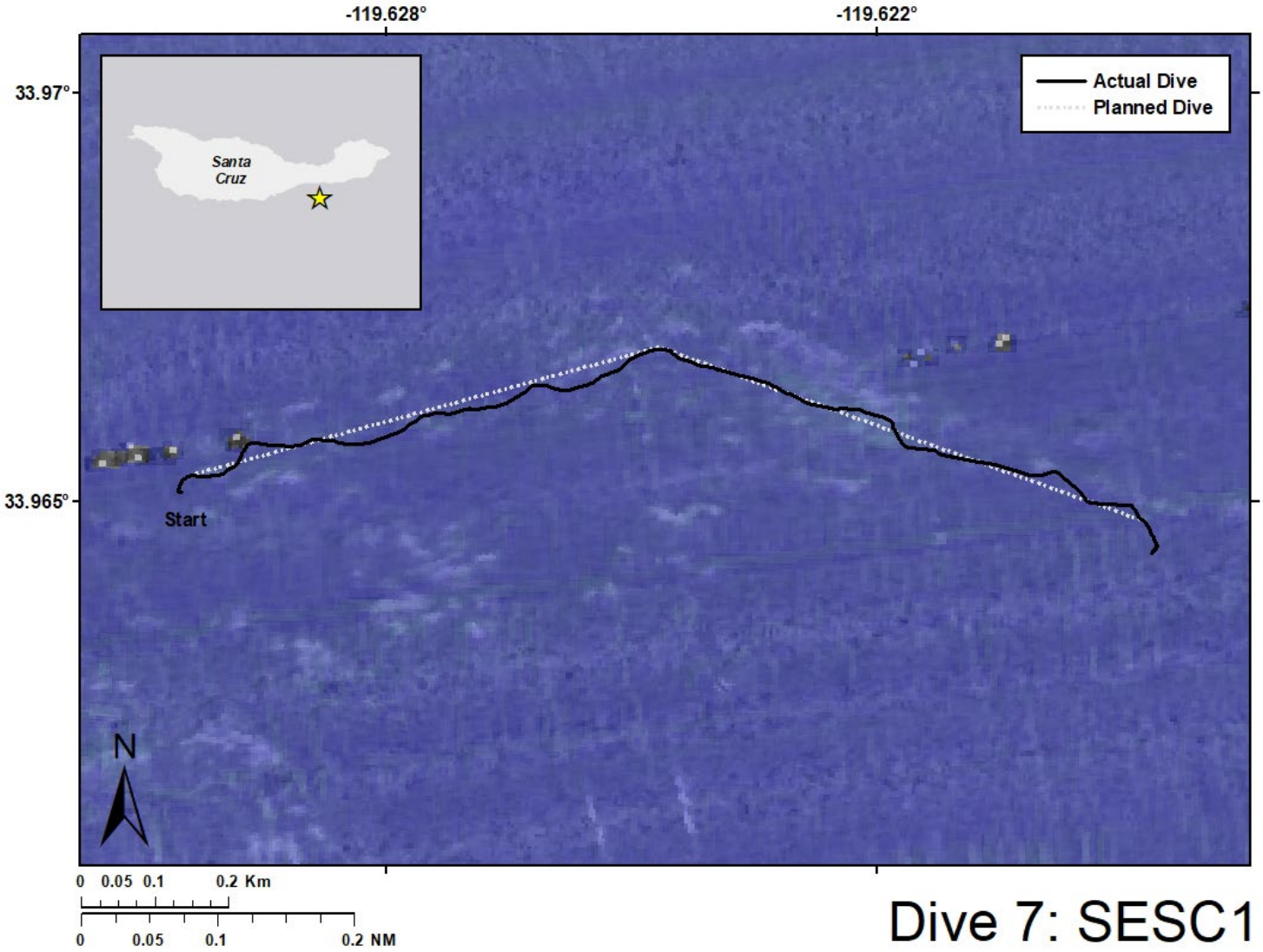
In general, abundance of corals and fish appeared relatively low, except for localized aggregations on rocky outcrops. Coral species *Eugorgia rubens* and *Adelogorgia phyllosclera* were on rock while *Halipteris/Funiculina* sp. and *Ptilosarcus gurneyi* sea pens were on soft bottom. Mobile invertebrates were common, including sea urchins and sea cucumbers. Rockfish species observed were halfbanded, flag, squarespot, vermilion, bocaccio, and copper.



Dive 6 took place on the Southeast Santa Cruz Island shelf at depths ranging from 76 to 81 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) *Ptilosarcus gurneyi* on soft bottom. B) *Halipteris*/*Funiculina* on soft bottom. C) Flag and bocaccio rockfish. D) *Leptogorgia chilensis* with vermilion rockfish. E) *Eugorgia rubens* and *Adelogorgia phyllosclera*. F) *Eugorgia rubens*.

Dive 07
Start Coordinate: 33.96512, -119.63049
Depth Range: 75-80 m

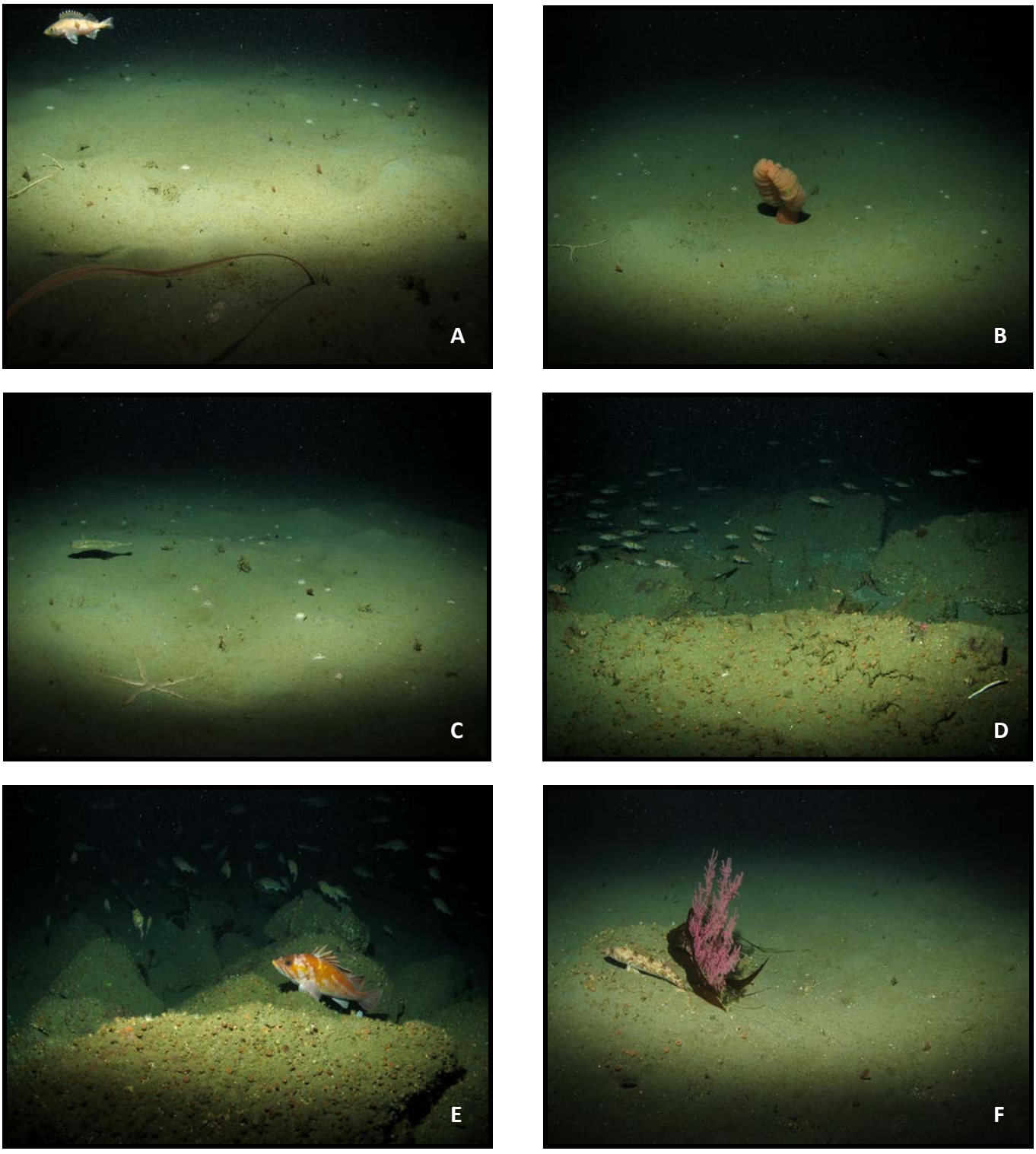
SCS Site ID: SESC1
End Coordinate: 33.96437, -119.61865
Bottom Time: 1 hour 11 minutes



Map Caption. *The planned trajectory for ROV Dive 7 is shown as a gray dashed line, with the actual trajectory in black. The map background is three layers- slope (in color, partially transparent, warm colors= high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

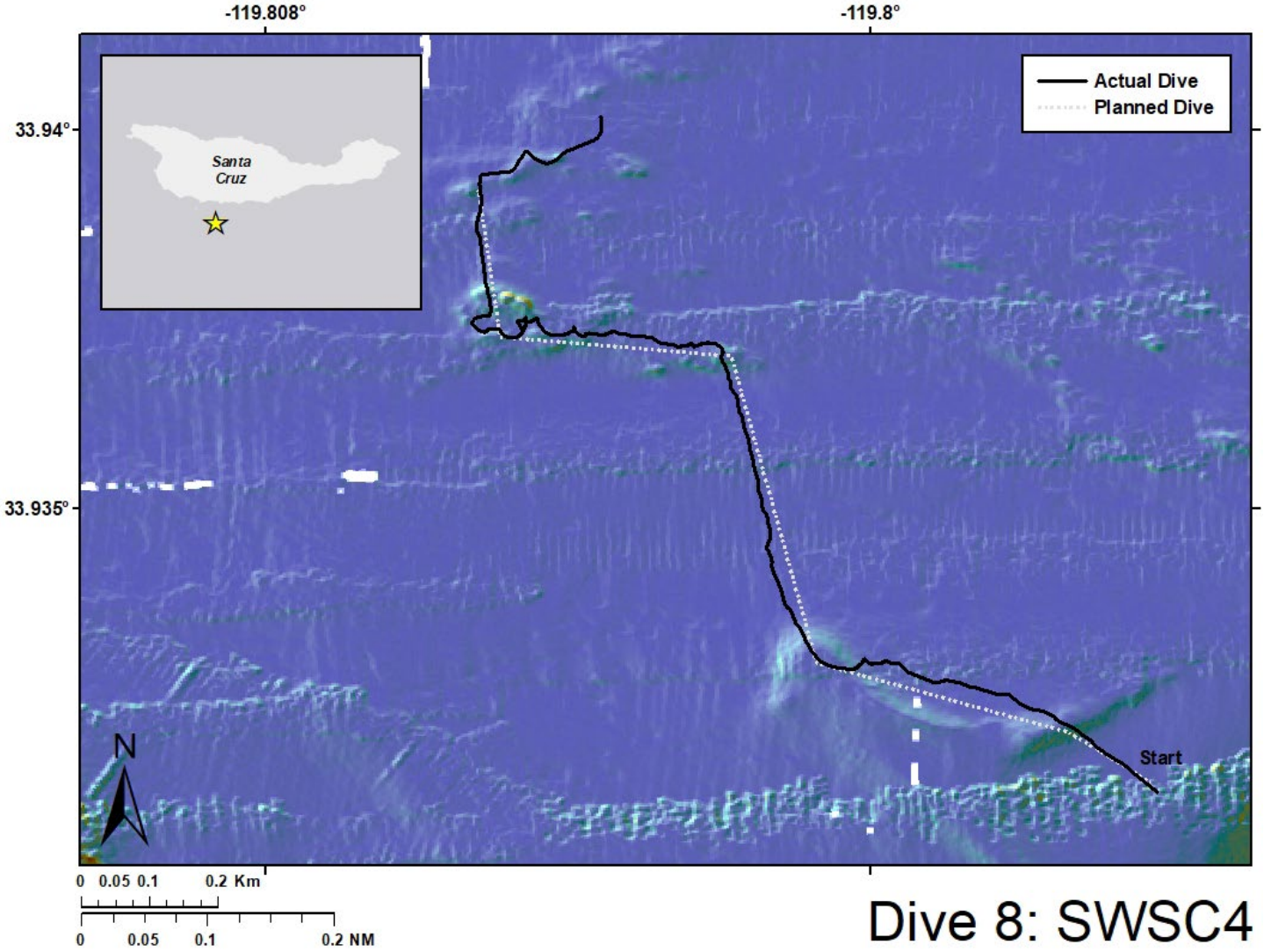
Dive Summary:
The seventh dive of the expedition surveyed the SE Santa Cruz shelf area, navigating over multibeam bathymetry (16 m) from the NOAA ship *Bell M. Shimad*a in 2017. The dive was on bottom at 00:08 on June 8, 2019 UTC at a depth of 75 m. Dive duration was 71 minutes. Bottom temperature was 9.8 °C. We surveyed soft, hummocky sediment with occasional rocks and boulders. The line was completed and extended slightly. Four 15-minute transects were completed, over a distance of about 1200 m.

In general, abundance of corals and fish appeared relatively low. Coral species *Eugorgia rubens* and *Adelogorgia phyllosclera* were on rock while *Halipteris* sp., *Acanthoptilum gracile*, and *Ptilosarcus gurneyi* sea pens were on soft bottom. There were some large *Eugorgia rubens* colonies intermittent on rock. Mobile inverts were common, including sea cucumbers and an octopus. Rockfish species observed were halfbanded, flag, squarespot, *Sebastomus*, and copper. Soft bottom fishes were sanddabs, combfish, poachers, blackeye gobies, and pink sea perches.



Dive 7 took place on the SE Santa Cruz Island shelf at depths ranging from 75 to 80 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) *Acanthoptilum gracile* and halfbanded rockfish on soft sediment. B) *Ptilosarcus gurneyi*. C) Sanddab with sea urchins on soft sediment. D) School of halfbanded rockfish on hard substrate. E) Copper rockfish. F) *Eugorgia rubens* and lingcod on mixed sediment.

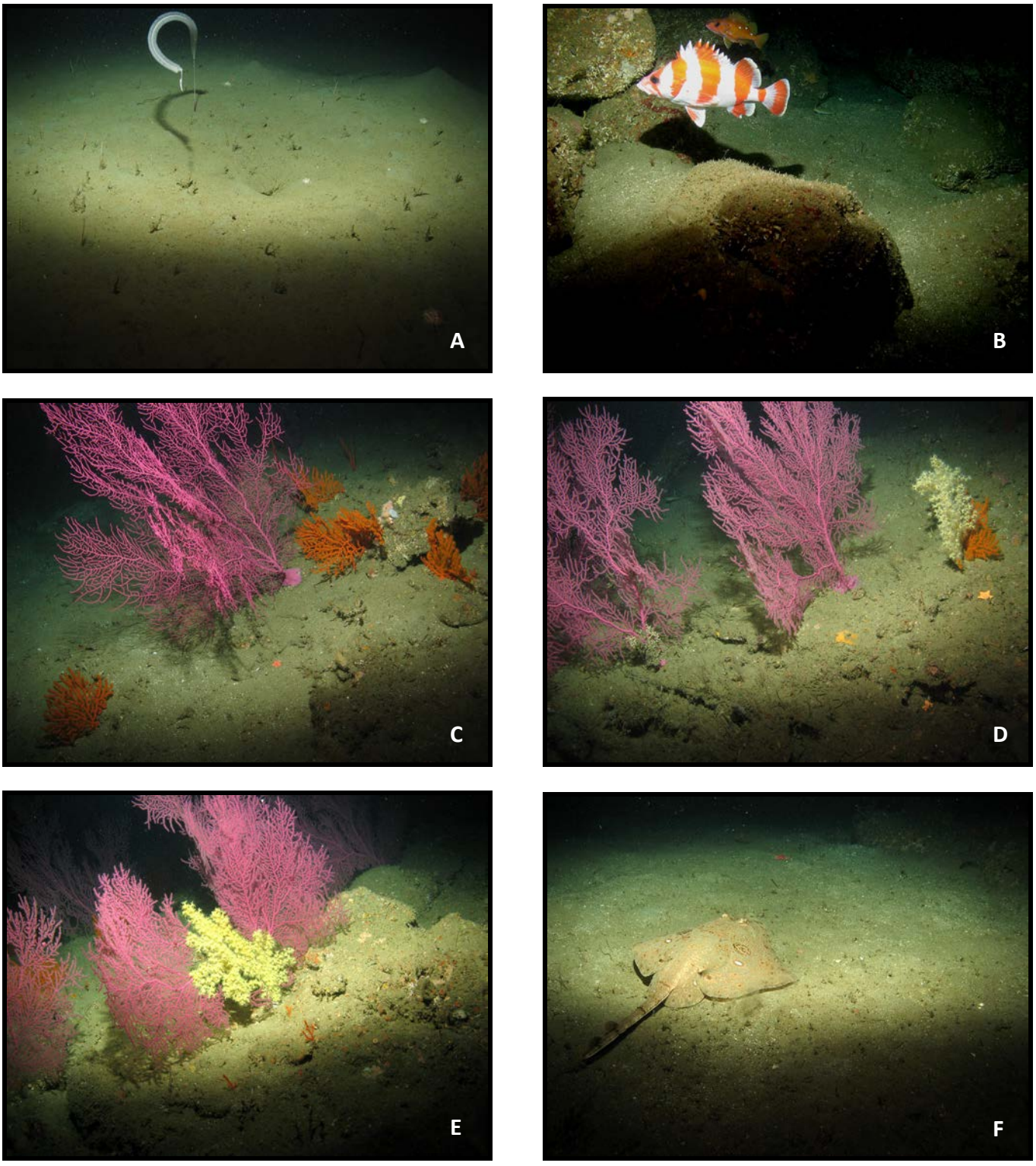
Dive 08 **SCS Site ID: SWSC4**
Start Coordinate: 33.93124, -119.79621 **End Coordinate: 33.94017, -119.80356**
Depth Range: 54-99 m **Bottom Time: 1 hour 46 minutes**



Map Caption. *The planned trajectory for ROV Dive 8 is shown as a gray dashed line, with the actual trajectory in black. The map background is two layers- slope (in color, partially transparent, yellow= moderate slope) and hillshade (in grey-scale, partially transparent).*

Dive Summary:
The eighth dive surveyed the SW Santa Cruz Island shelf area in Gull Island Marine Reserve over multibeam bathymetry from the E/V *Nautilus* NA080 expedition in 2017. The dive was on bottom at 15:04 on June 8, 2019 UTC at a depth of 99 m. Dive duration was 1 hour 46 minutes. Temperature was 9.5 °C. We surveyed soft sediment with occasional rocks and boulders. The line was completed and extended. Four transects of 15 – 20 minutes duration were completed.

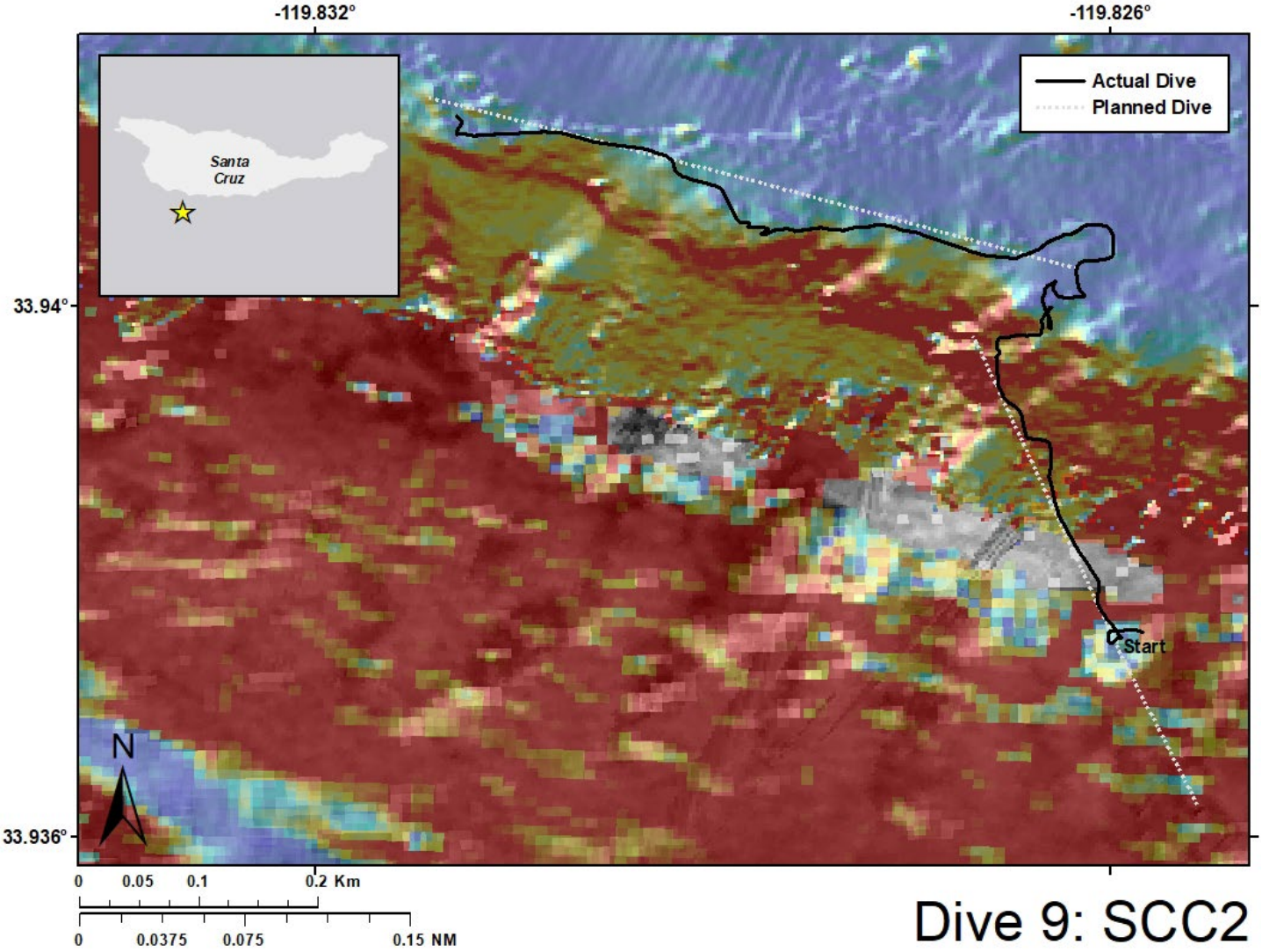
In general, abundance of corals and fish appeared to be relatively high. Coral species present on rock were *Eugorgia rubens, Adelogorgia phyllosclera, and Leptogorgia chilensis.* There was some zoanthid overgrowth on *Eugorgia rubens* and *Adelogorgia phyllosclera*. *Halipteris/Funiculina* sp. and *Acanthoptilum gracile* were present on soft bottom. The survey encountered a dense aggregation of large corals at the end of transect 3. Highlight video was collected from 16:15:40 to 16:25:30 UTC to aid outreach. The site was dubbed “Magic Kingdom” by Diana Watters, NMFS. Rockfish species observed were bocaccio, rosy, lingcod, vermilion, yellowtail, blue, and copper.



Dive 8 took place in the Gull Island Marine Reserve, SW Santa Cruz Island at depths ranging from 54 to 99 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) *Acanthoptilum gracile* on soft bottom. B) Flag and rosy rockfish. C) *Eugorgia rubens* and *Adelogorgia phyllosclera* colonies. D) *Eugorgia rubens* and injured *Adelogorgia phyllosclera* colony with yellow zoanthid overgrowth. E) Injured *Eugorgia rubens* with yellow zoanthid overgrowth. F) Starry skate on soft bottom.

Dive 09
Start Coordinate: 33.93754, -119.82575
Depth Range: 74-233 m

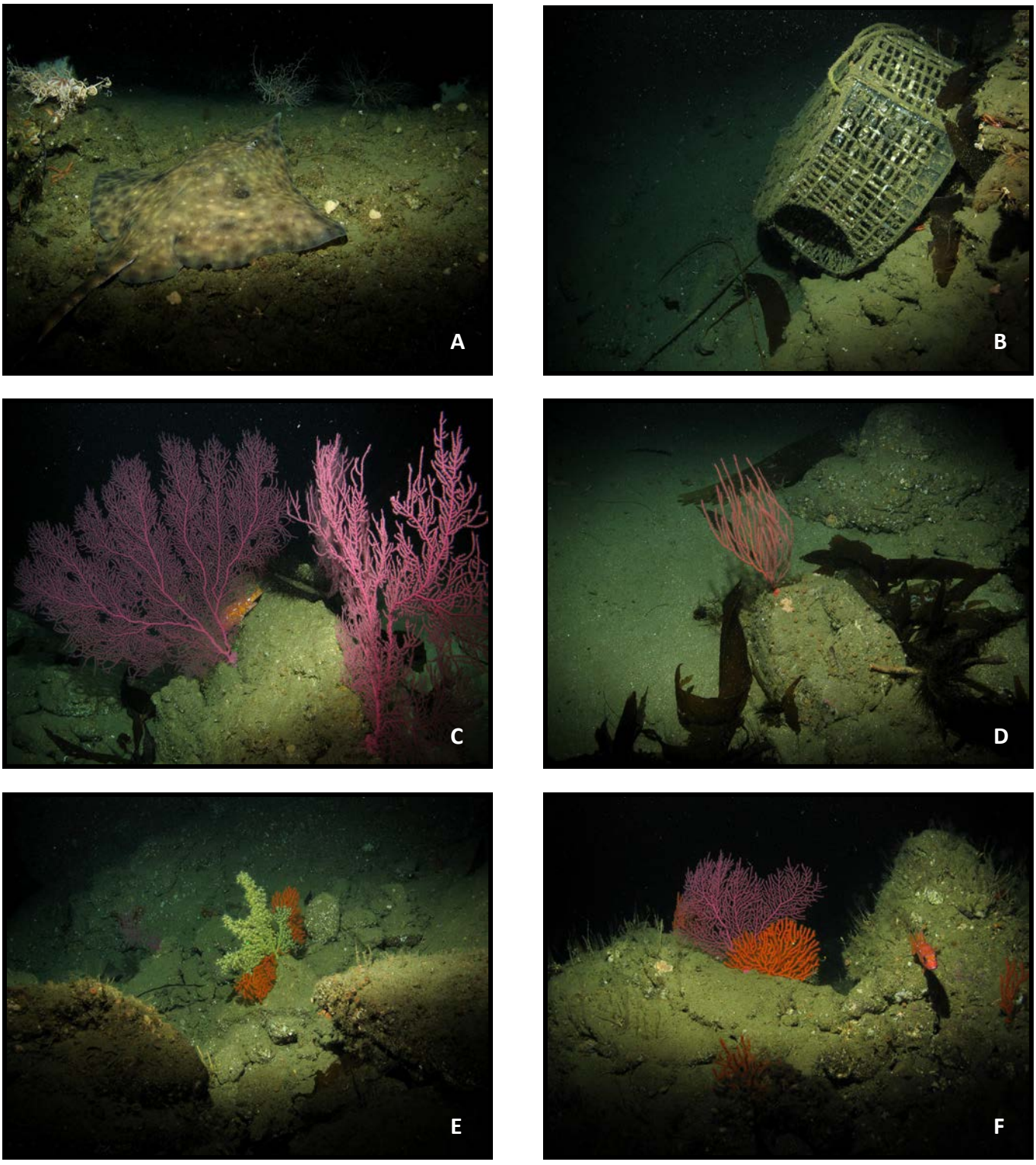
SCS Site ID: SCC2 (part 2, < 225 m)
End Coordinate: 33.94143, -119.83093
Bottom Time: 1 hour 31 minutes



Map Caption. *The planned trajectory for ROV Dive 9 is shown as a gray dashed line, with the actual trajectory in black. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

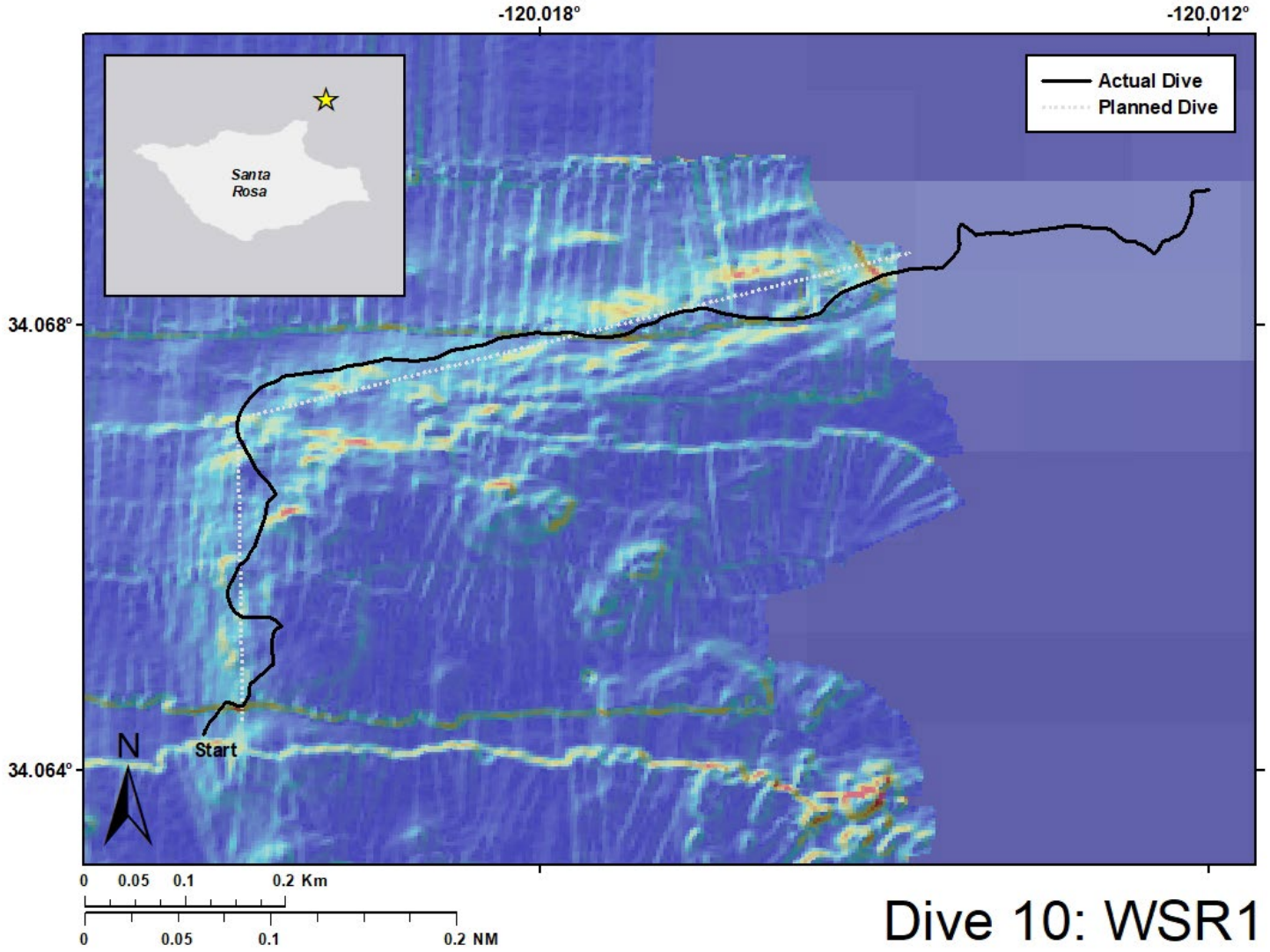
Dive Summary:
The ninth dive surveyed Santa Cruz Canyon in Gull Island Marine Reserve, navigating over multibeam maps from NOAA ship *Bell M. Shimada* (16 m). The dive was on bottom at 17:32 on June 8, 2019 UTC at a depth of 233 m. Temperature was 8.6 °C. Dive duration was 1 hour 31 minutes. We surveyed a steep wall with sand and cobble, then came up on the canyon rim at 78 m, which was predominantly rocks and boulders. The line was completed and extended onto a second planned dive line. Four transects were completed; T1 was 100 m vertical distance and T2 – T3 were 15 – 18 minutes duration.

In general, abundance of corals and fish appeared to be relatively low. The dive landed near a school of shortbelly rockfish with spot prawns. The crinoid *Florometra serratissima* was common. Octopus and box crabs were seen. Rockfish species were greenspotted, greenstriped, bocaccio, starry, bank, stripetail, and swordspine. On the rocky rim, corals present were *Eugorgia rubens, Adelogorgia phyllosclera, Lophelia pertusa* (86 m), and *Leptogorgia chilensis.* There was zoanthid overgrowth on a few of the gorgonian corals. Fishing gear – one circular spotprawn or lobster trap with a line and a thick anchor rope, and some debris – a beer can and coffee cup were observed near the rim of the canyon.



Dive 9 took place in the Gull Island Reserve in the Santa Cruz canyon at depths ranging from 74 to 233 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) Longnose skate with several basket stars. B) Circular spotprawn or lobster trap. C) Large *Eugorgia rubens* colonies with *Sebastomus* rockfish. D) *Leptogorgia chilensis* on mixed substrate. E) Injured *Adelogorgia phyllosclera* with yellow zoanthid overgrowth. F) *Eugorgia rubens* and *Adelogorgia phyllosclera* on rocky substrate with rosy rockfish.

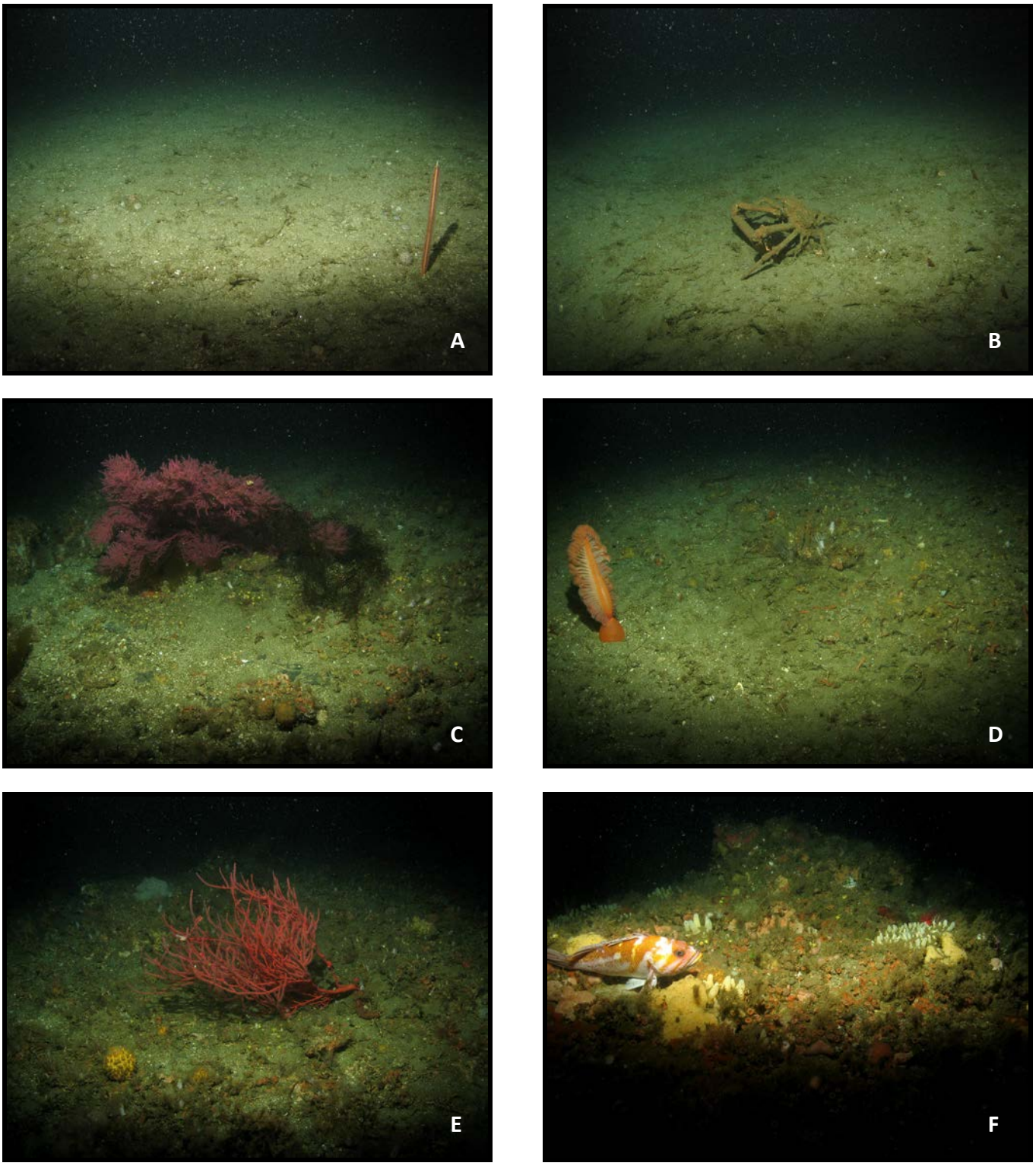
Dive 10 **SCS Site ID: WSR1**
Start Coordinate: 34.06432, -120.02101 **End Coordinate: 34.06921, -120.01199**
Depth Range: 54-61 m **Bottom Time: 1 hour 08 minutes**



Map Caption. *The planned trajectory for ROV Dive 10 is shown as a gray dashed line, with the actual trajectory in black. The map background is two layers- slope (in color, partially transparent, red = high slope) and hillshade (in grey-scale, partially transparent), and side-scan imagery (in grey-scale).*

Dive Summary:
The tenth dive surveyed Santa Rosa Island passage, navigating over multibeam bathymetry (3 m) from the NOAA ship *Rainier* in 2018. The dive was on bottom at 20:40 on June 8, 2019 UTC at a depth of 54 m. Temperature was 10.6 °C. Dive duration was 1 hour 08 minutes. We surveyed low relief rocky features with intermittent sand channels. The line was completed and extended into an unmapped area in the east. Three transects of 15 – 18 minutes duration were completed.

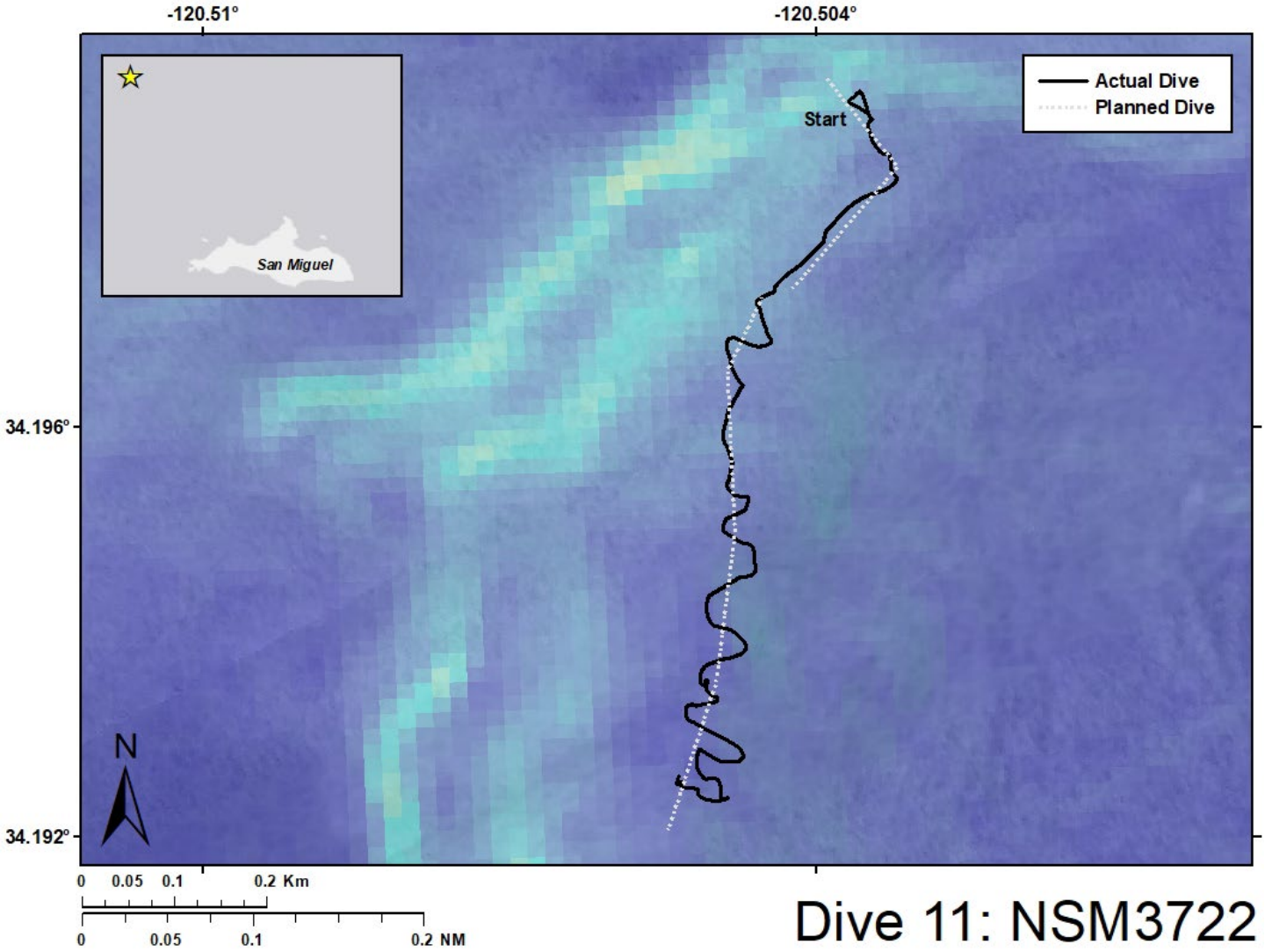
In general, the relative abundance of corals was low, but live cover on the rocks was very high and sponges were common. *Eugorgia rubens* and *Leptogorgia chilensis* were present on rock. On soft bottom, *Ptilosarcus gurneyi* and *Halipteris/Funiculina* sp. sea pens were observed. Rockfish species were copper, halfbanded, lingcod, and gopher. A wolfeel was also observed. On soft bottom, pink sea perch and combfish were present. There were also sea anemones observed on soft sediment and many large sea scallops on the rock. This dive concluded Leg 1 of the Deep Coral Gardens 2019 Expedition.



Dive 10 took place west of Santa Rosa Island at depths ranging from 54 to 61 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) Sea pen (*Halipteris*/*Funiculina* sp.) on soft sediment. B) Crab on soft sediment. C) *Eugorgia rubens* on mixed substrate. D) *Ptilosarcus gurneyi* on soft substrate. E) *Leptogorgia chilensis* on hard bottom. F) Copper rockfish on hard substrate.

Dive 11
Start Coordinate: 34.19907, -120.50352
Depth Range: 124-155 m

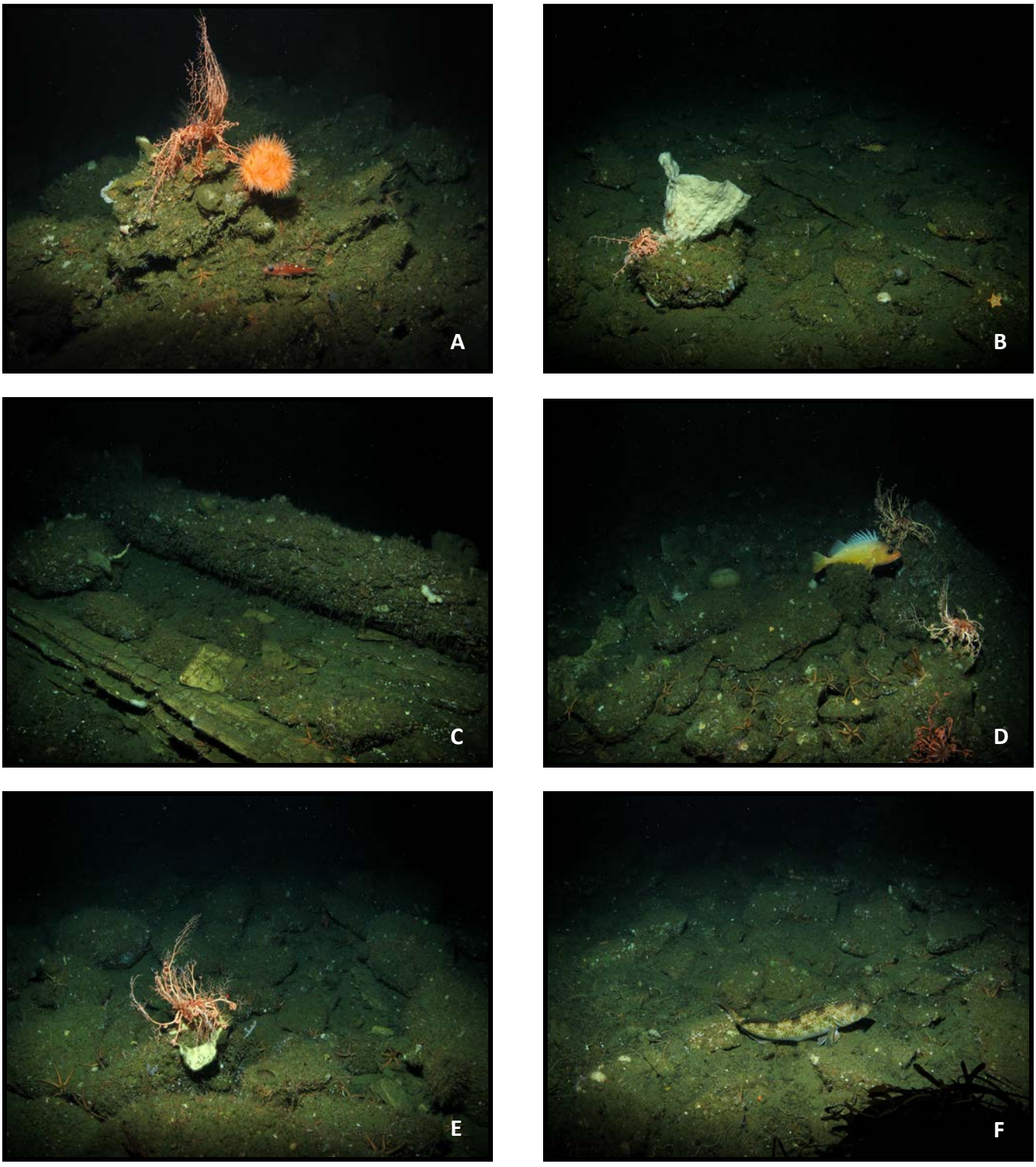
SCS Site ID: NSM3722
End Coordinate: 34.19259, -120.50534
Bottom Time: 1 hour 14 minutes



Map Caption. *The planned trajectory for ROV Dive 11 is shown as a gray dashed line, with the actual trajectory in black. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

Dive Summary:
The eleventh dive surveyed North San Miguel Island, over maps from the E/V *Nautilus* NA074 expedition in 2016. During the dive, the ROV navigated from north to south of coordinates provided by Dr. Milton Love to NOAA Southwest Fishery Science Center (SWFSC). The dive was on bottom at 16:53 on June 9, 2019 UTC at a maximum depth of 155 m and minimum depth of 124 m. Temperature was 8.6 °C. Secchi depth was 4-5 m. Dive duration was 1 hour 14 minutes. We surveyed low relief rocky features with intermittent sand channels. The features appeared to be uplifted sedimentary rock, with a linear, layered appearance. The planned dive line was completed in full. Three, 15-minute transects were completed.

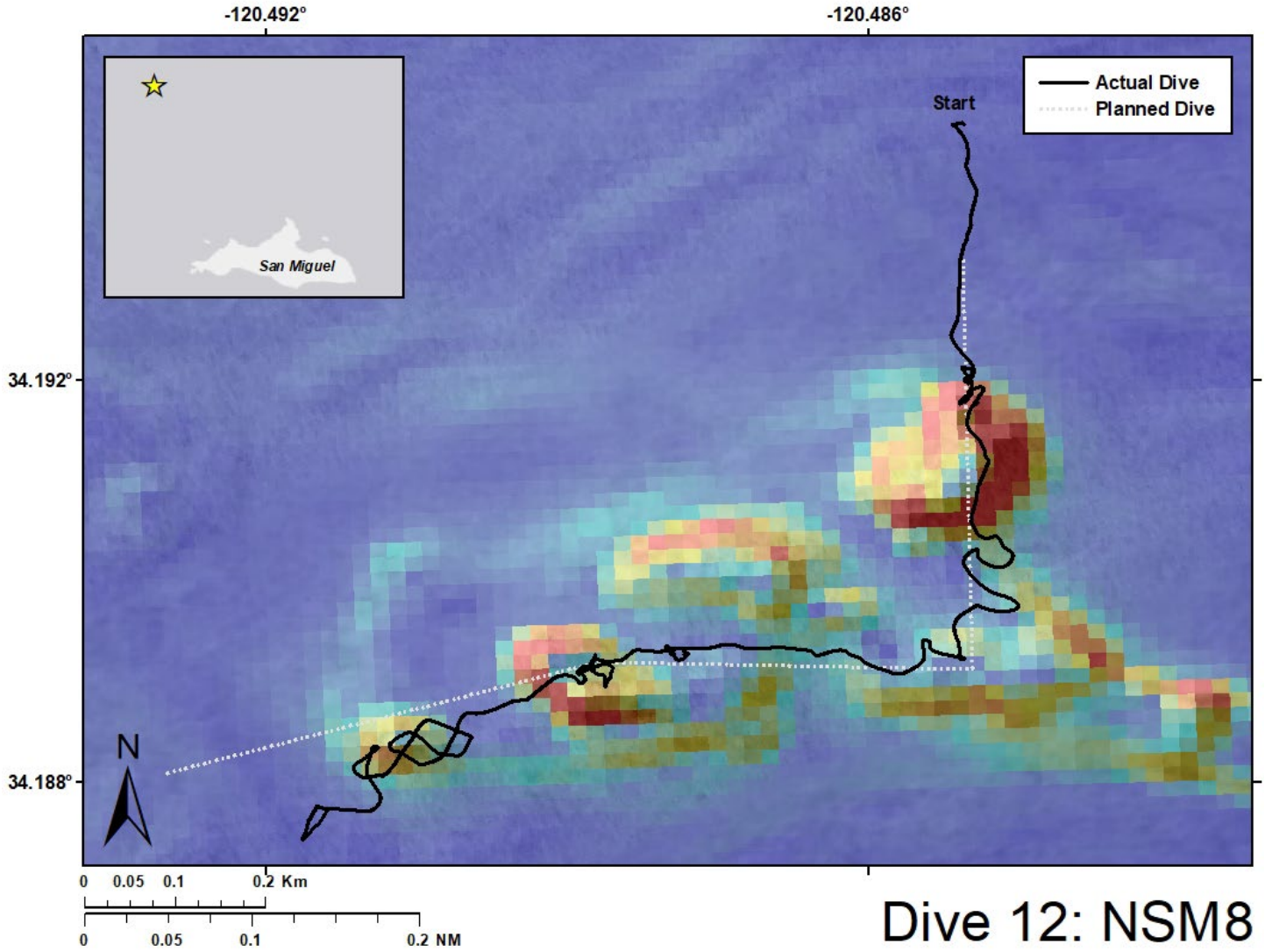
In general, the relative abundance of corals was low, but sponges were common. *Lophelia pertusa* was seen, as well as some small unknown white gorgonians. Rockfish species were flags, starry, and greenspotted. Lingcod, chimeras, flatfish, and a skate egg case was also observed. Basket stars were very abundant, as well as crinoids and small polychaete tubeworms.



Dive 11 took place at North San Miguel Island at depths ranging from 124 to 155 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) Anemone and basket star on hard substrate with swordspine rockfish. B) Basket star, sea star, and sponge on hard substrate. C) Layered, uplifted sedimentary rock. D) Greenspotted rockfish and basket stars on hard substrate. E) Basket star and sponge on hard substrate. F) Lingcod on rocky substrate.

Dive 12
Start Coordinate: 34.19454, -120.48505
Depth Range: 119-135 m

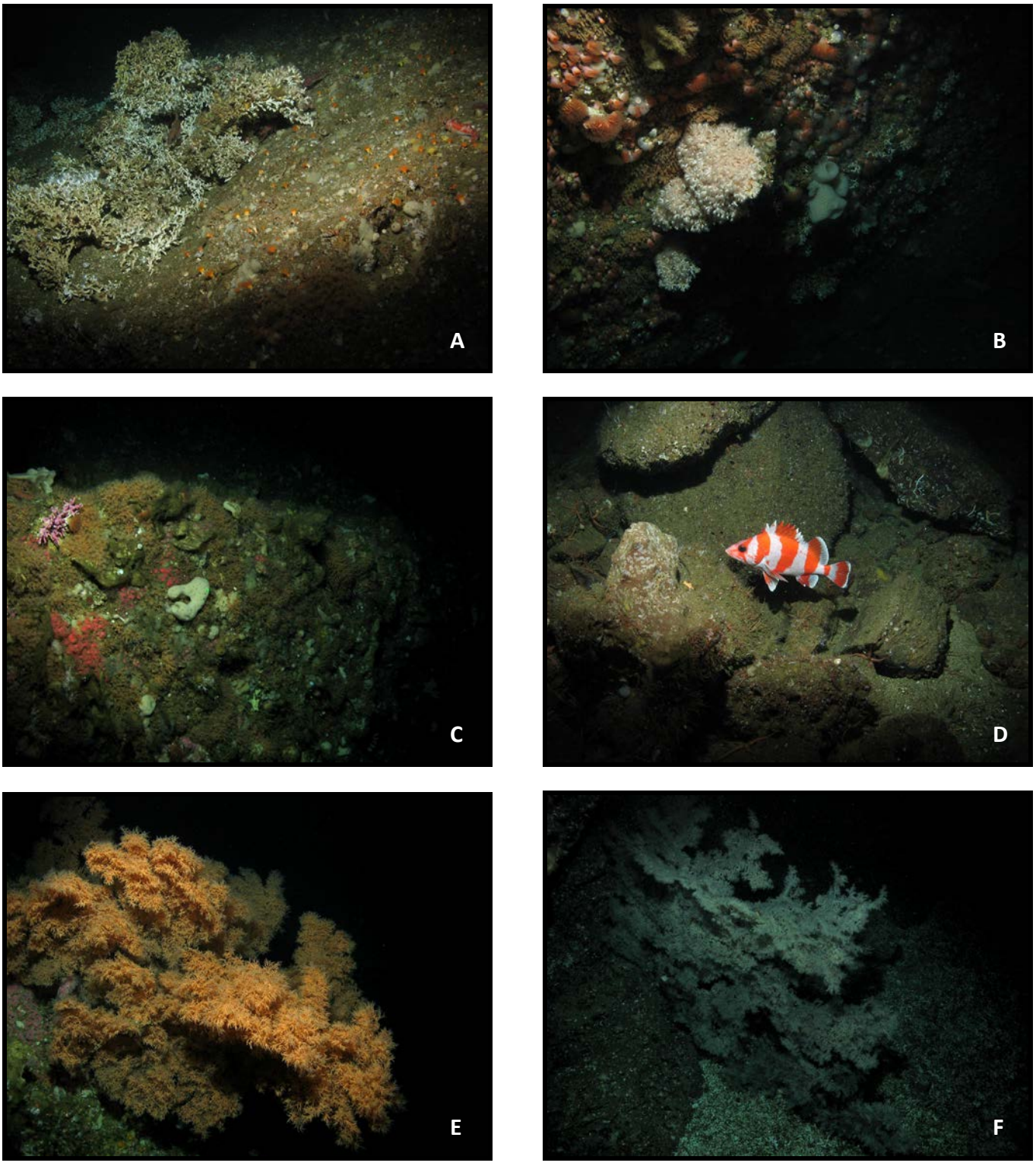
SCS Site ID: NSM8
End Coordinate: 34.18773, -120.49136
Bottom Time: 2 hours 09 minutes



Map Caption. *The planned trajectory for ROV Dive 12 is shown as a gray dashed line, with the actual trajectory in black. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

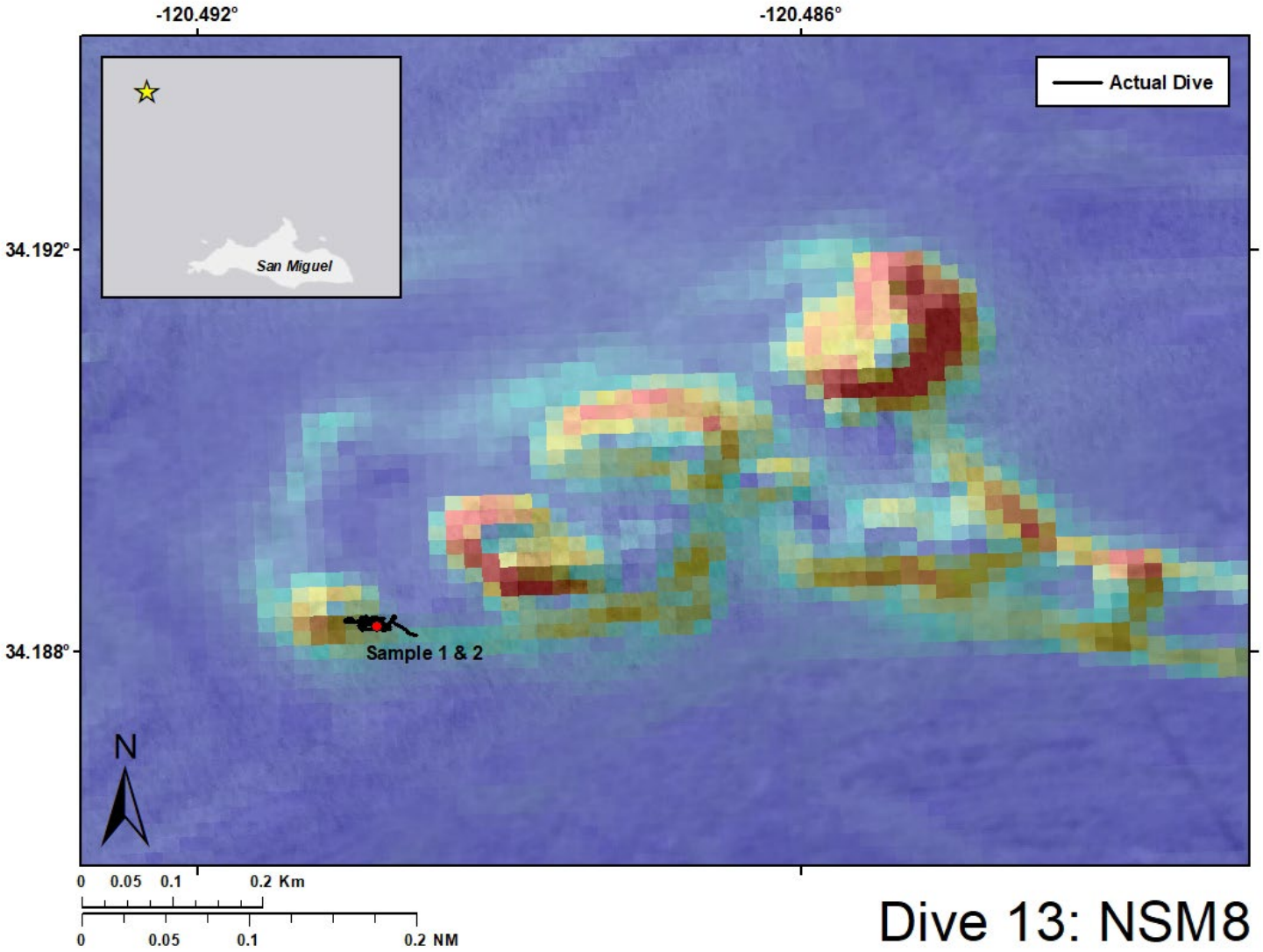
Dive Summary:
The twelfth dive surveyed North San Miguel Island, over a high relief feature observed in multibeam (16 m) from E/V *Nautilus* NA074 expedition in 2016. The dive was on bottom at 18:50 on June 9, 2019 UTC at a maximum depth of 135 m and minimum depth of 119 m. Temperature was 8.6 °C. Dive duration was 2 hours 9 minutes. We surveyed flat bottom with jagged cobble and then high relief rocky features with high live cover. The line was completed in full, but modified slightly. Three transects were completed of 10 -15 minutes duration. One transect (T4) was extended to 50 minutes, due to video highlight clips of large back corals and a six-gill shark.

In general, many corals, sponges, and fish were observed. *Lophelia pertusa* was common and live cover was very high on the rocks. Several large colonies of *Antipathes dendrochristos* were present, as well as *Desmophyllum* or *Flabellum* cup corals, and *Stylaster californicus* hydrocorals. *Antipathes dendrochristos* colonies had orange and blue forms. Rockfish were abundant and diverse. The rockfish species were greenstriped, olive, rosy, cowcod, flag, canary, vermilion, yelloweye, and bocaccio. Some rockfish had distended bellies, as if gravid with eggs. Other fishes included lingcod and ratfish. Basket stars were present as well as some sea cucumbers. Fishing lines were wrapped around some rocks.



Dive 12 took place at North San Miguel Island at depths ranging from 119 to 135 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) *Lophelia pertusa* with about 15 % live tissue. B) *Lophelia pertusa* and cup corals on wall. C) High live coverage on rock with *Stylaster californicus* D) Flag rockfish over hard substrate. E) Large *Antipathes dendrochristos* (orange morphotype). F) Large *Antipathes dendrochristos* (blue morphotype) with *Lophelia pertusa* rubble.

Dive 13 **SCS Site ID: NSM8**
Start Coordinate: 34.18816, -120.48981 **End Coordinate: 34.18831, -120.49046**
Depth Range: 107-122 m **Bottom Time: 0 hours 40 minutes**



Map Caption. *The trajectory for ROV Dive 13 is shown as a black line, with the sample locations as red dots. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

Dive Summary:
The thirteenth dive surveyed the Dive 12 site again over multibeam bathymetry (16 m) from E/V *Nautilus* NA074 expedition in 2016. The goal of the dive was to sample *Lophelia pertusa* and *Antipathes dendrochristos* for Matt Wandell from the Monterey Bay Aquarium. The dive was on bottom at 00:47 on June 10, 2019 UTC at a depth of 121 m. Temperature was 8.8 °C. Dive duration was 40 minutes. The sample targets were *Lophelia pertusa* (Latitude: 34.18828, Longitude: -120.49060) and *Antipathes dendrochristos* (Latitude: 34.18901, Longitude: -120.48879). We sampled *Lophelia pertusa* and *Desmophyllum dianthus* in small amounts (Samples 1 and 2), but did not sample *Antipathes dendrochristos*. The still camera was disabled for the duration of the dive to support the improvised sampling gear.

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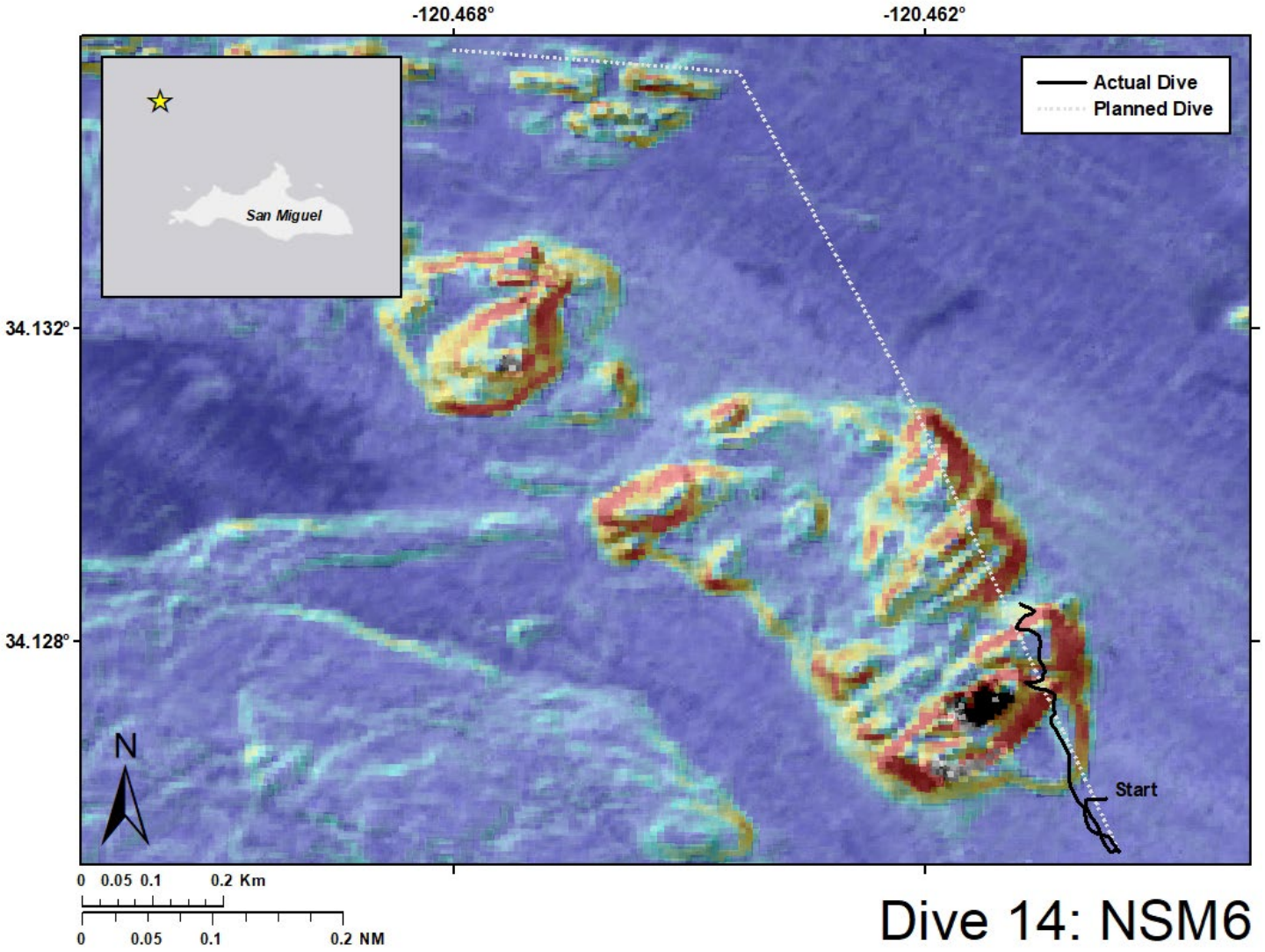
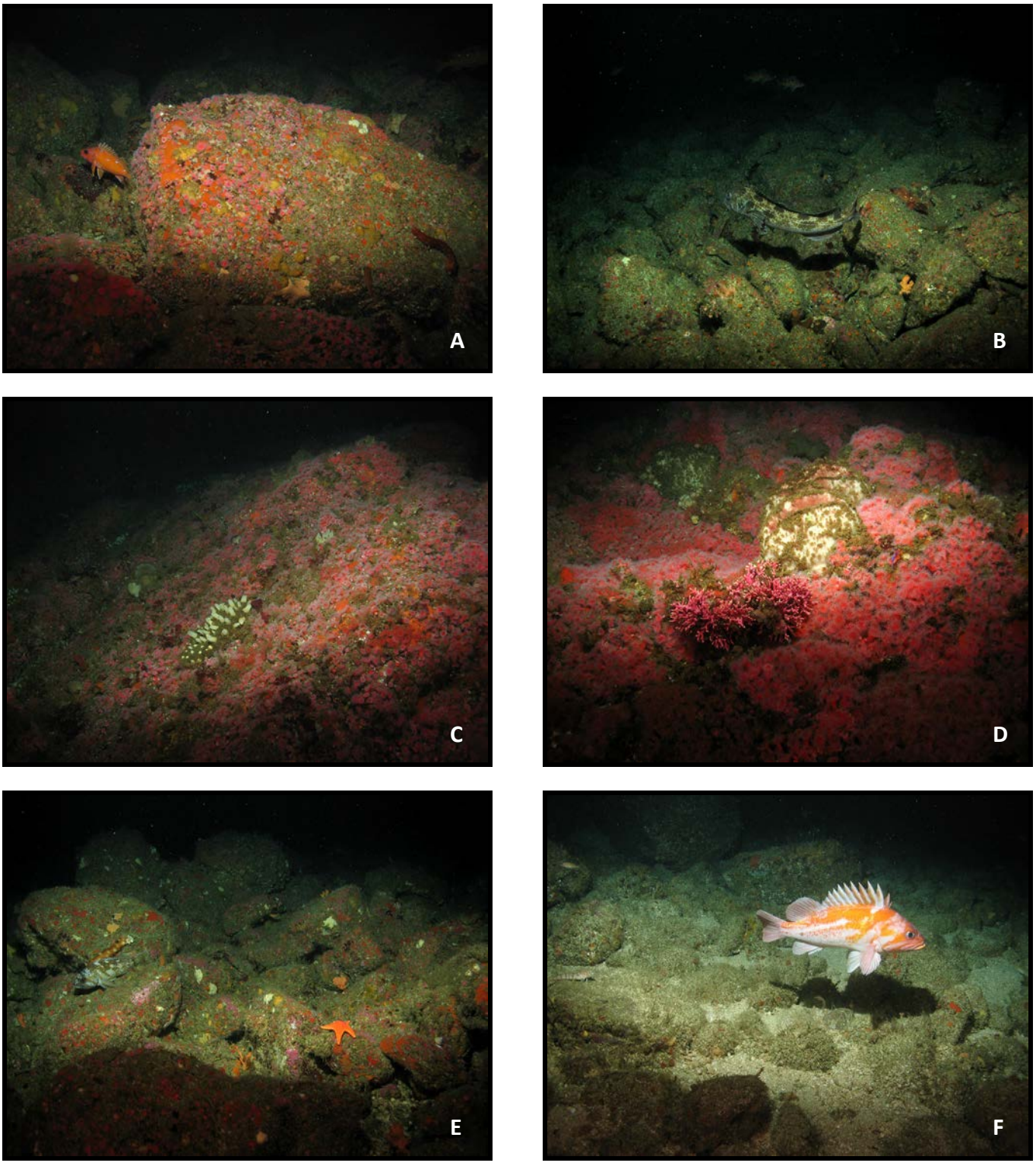
Dive 14 **SCS Site ID: NSM6**
Start Coordinate: 34.12599, -120.45968 **End Coordinate: 34.12848, -120.46078**
Depth Range: 39-74 m **Bottom Time: 0 hours 46 minutes**



Map Caption. *The planned trajectory for ROV Dive 14 is shown as a gray dashed line, with the actual trajectory in black. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

Dive Summary:
The fourteenth dive surveyed North San Miguel Island, over a high relief feature observed in multibeam bathymetry (16 m) from the NOAA ship *Bell M. Shimada* in 2016. The dive was on bottom at 15:41 on June 10, 2019 UTC with a maximum depth of 74 m and minimum depth of 39 m. Temperature was 11 °C. Secchi disk depth was 5.5 – 6.0 m. Dive duration was 46 minutes. Three transects of 5-15 minutes duration were completed.

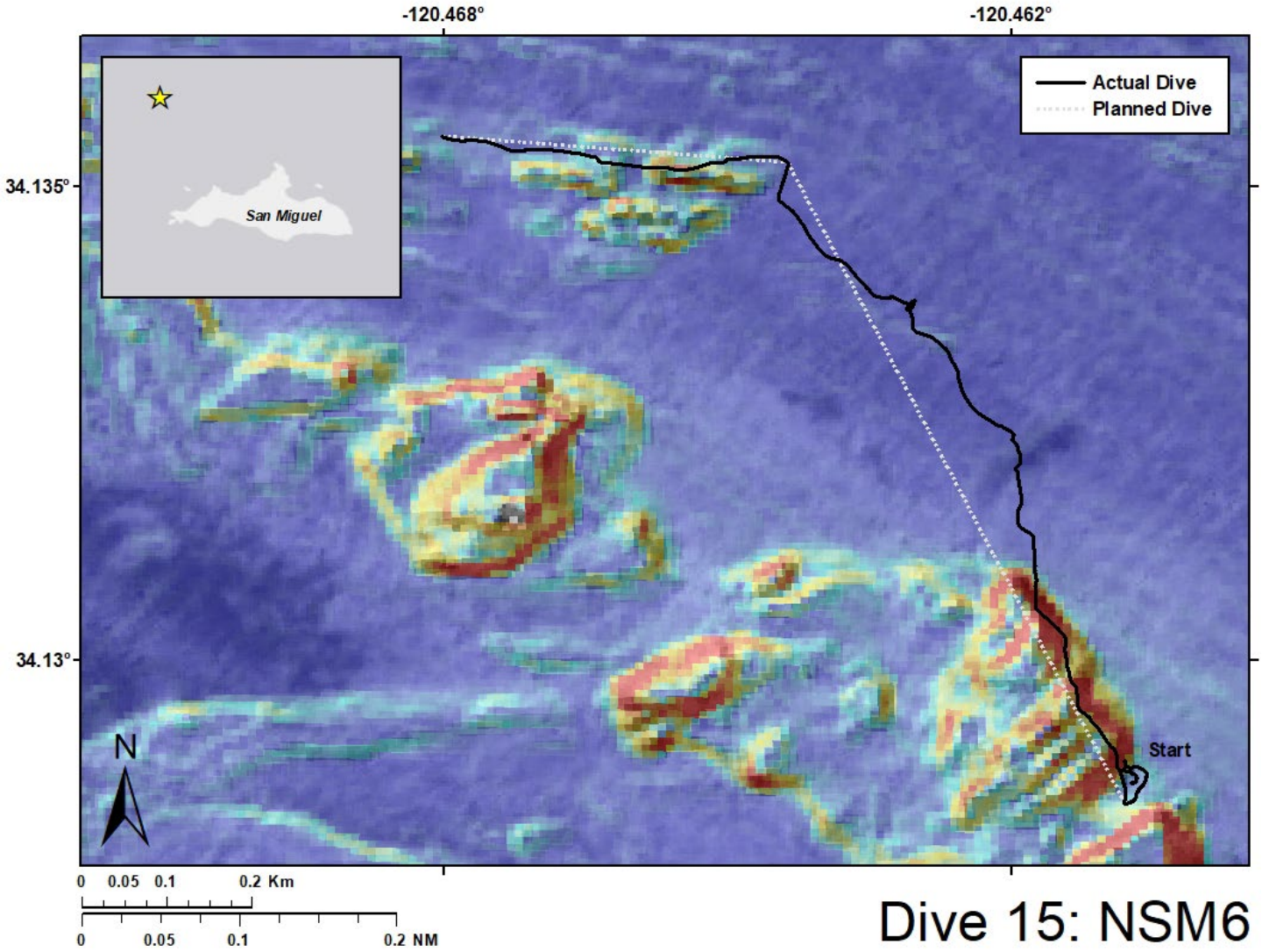
In general, the relative abundance of sponges and fish was high. Live cover was also high on the rocks. Colonies of *Stylaster californicus* hydrocorals, and *Eugorgia rubens* were present. Other invertebrates included sea cucumbers, sea stars, zoanthids, and encrusting sponges on rock. The rockfish species were starry, rosy, copper, and gopher. Lingcod and senorita wrasse were also observed. Several highlight clips were made showing very steep and dramatic topography. The ROV suffered multiple electronic failures, after which a computer crashed. The ROV came on deck for 2 hours while it was repaired.



Dive 14 took place at North San Miguel Island at depths ranging from 39 to 74 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) Rosy rockfish over live, rocky substrate. B) Lingcod over hard substrate. C) High live coverage on rocks including encrusting sponges and zoanthids. D) *Stylaster californicus* on hard bottom with high live coverage. E) Gopher rockfish and sea star on hard substrate. F) Copper rockfish over hard substrate.

Dive 15
Start Coordinate: 34.12870, -120.46070
Depth Range: 53-86 m

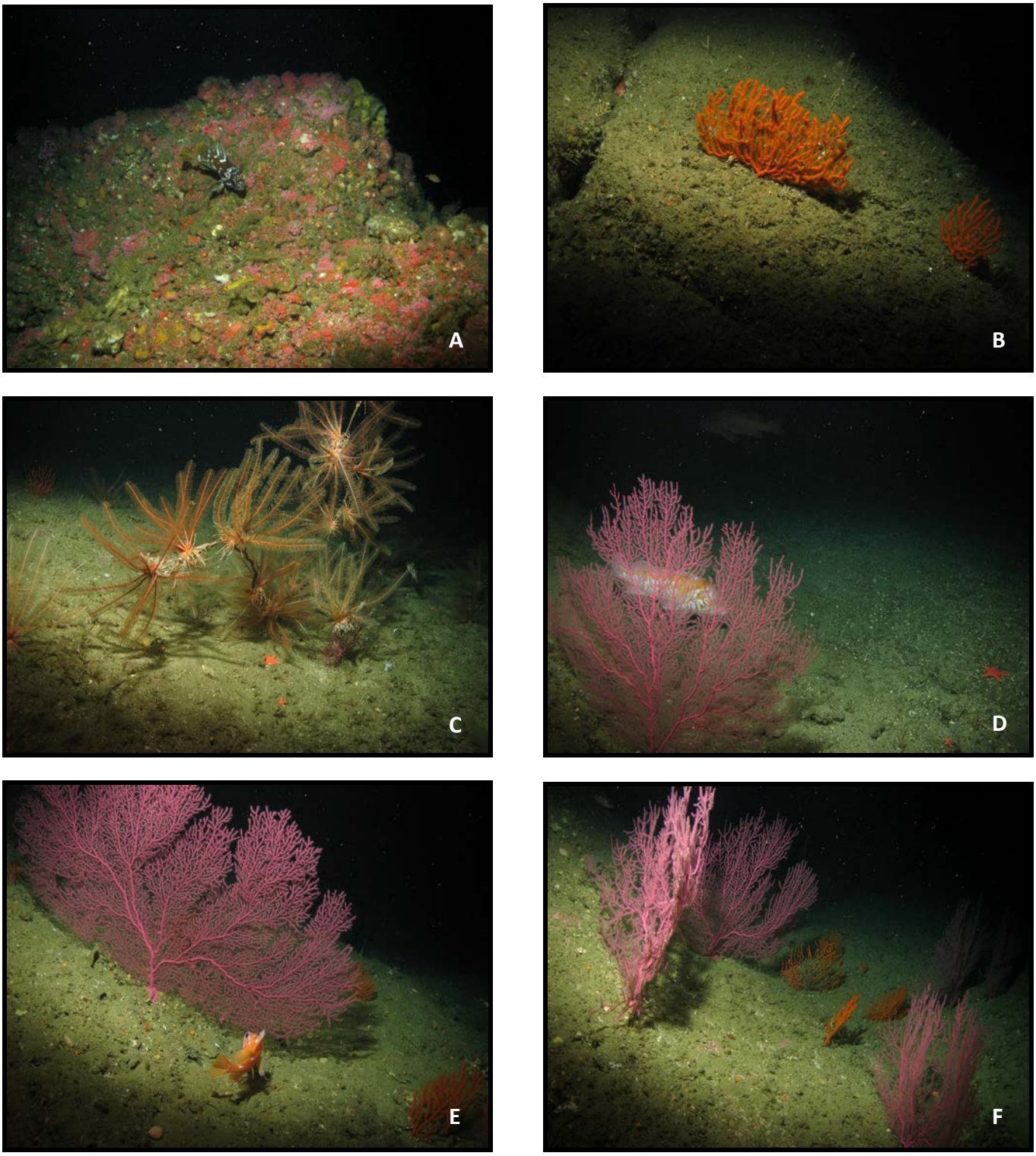
SCS Site ID: NSM6
End Coordinate: 34.13552, -120.46800
Bottom Time: 1 hour 40 minutes



Map Caption. *The planned trajectory for ROV Dive 15 is shown as a gray dashed line, with the actual trajectory in black. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

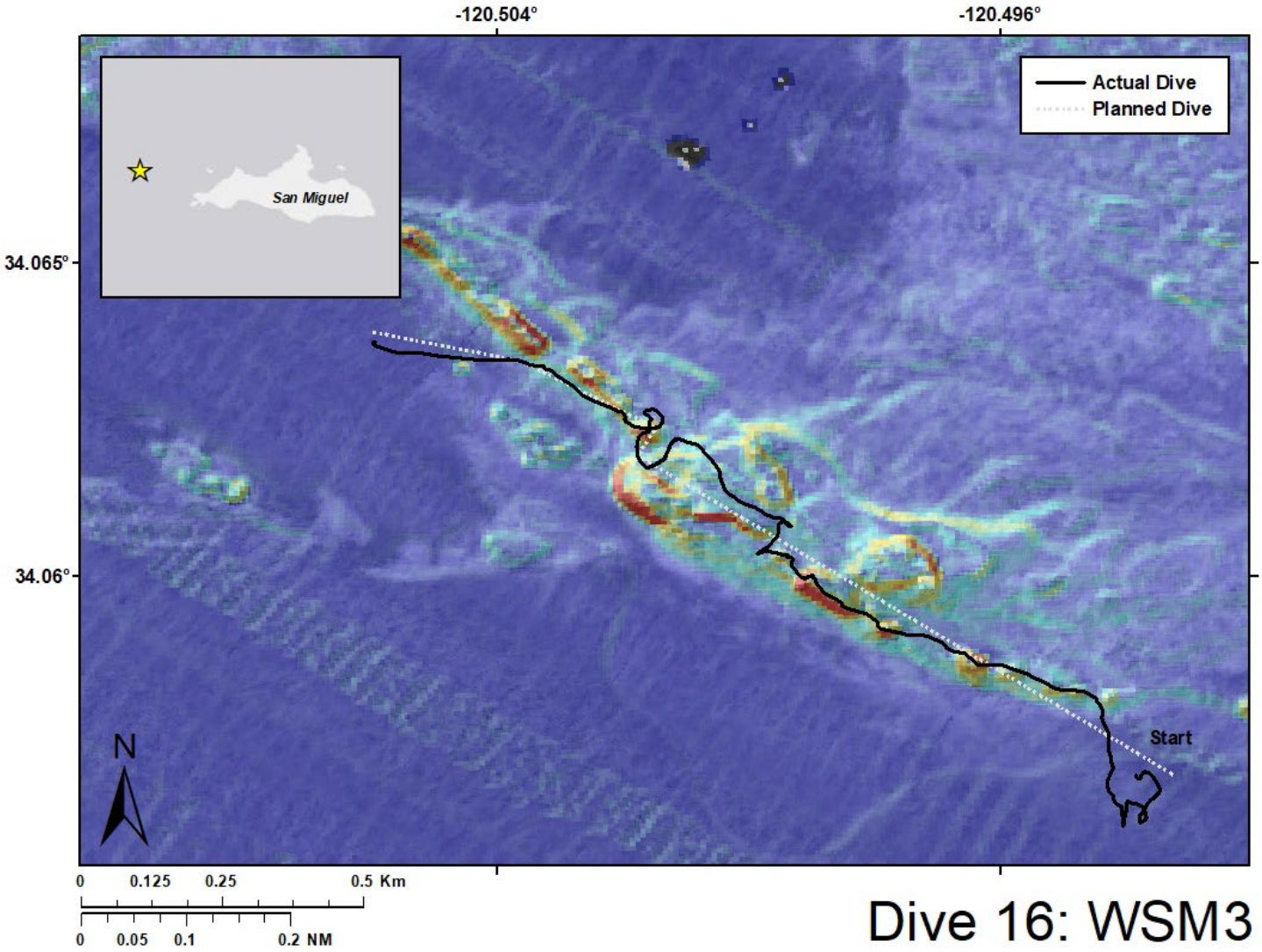
Dive Summary:
The fifteenth dive surveyed North San Miguel Island, over high and low relief features with sand channels in between observed in multibeam bathymetry (16 m) from the NOAA ship *Bell M. Shimada* in 2016. The dive was on bottom at 18:57 on June 10, 2019 UTC at a maximum depth of 86 m and minimum depth of 53 m. Temperature was 10 °C. Dive duration was 1 hour 40 minutes. The planned dive line was completed. Five transects were completed of 13-16 minutes in duration.

Many large *Eugorgia rubens* and *Adelogorgia phyllosclera* colonies were observed on low relief rock. Many dozens were photographed with lasers. Most were healthy, but some injuries were present and some dead stalks were seen with crinoids. Live cover was high on the high relief rocks and colonies of *Stylaster californicus* were present, but gorgonians were absent. Invertebrates on high relief rock included strawberry anemones, sea cucumbers, sponges, nudibranchs, scallops, and sea stars. *Ptilosarcus gurneyi* sea pens were present on sand. Other invertebrates present on sand were crinoids, sea cucumbers, sea stars, and many brittle stars. The rockfish species observed were gopher, olive, copper, blue, starry, canary, and vermilion. Lingcod and small gobies were also present.



Dive 15 took place at North San Miguel Island at depths ranging from 53 to 86 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) Gopher rockfish over hard substrate with live cover. B) *Adelogorgia phyllosclera* on hard substrate. C) Coral skeleton covered in crinoids. D) *Eugorgia rubens* with copper rockfish. E) *Eugorgia rubens* and *Adelogorgia phyllosclera* on hard substrate with rosy rockfish. F) *Eugorgia rubens* and *Adelogorgia phyllosclera* on hard substrate.

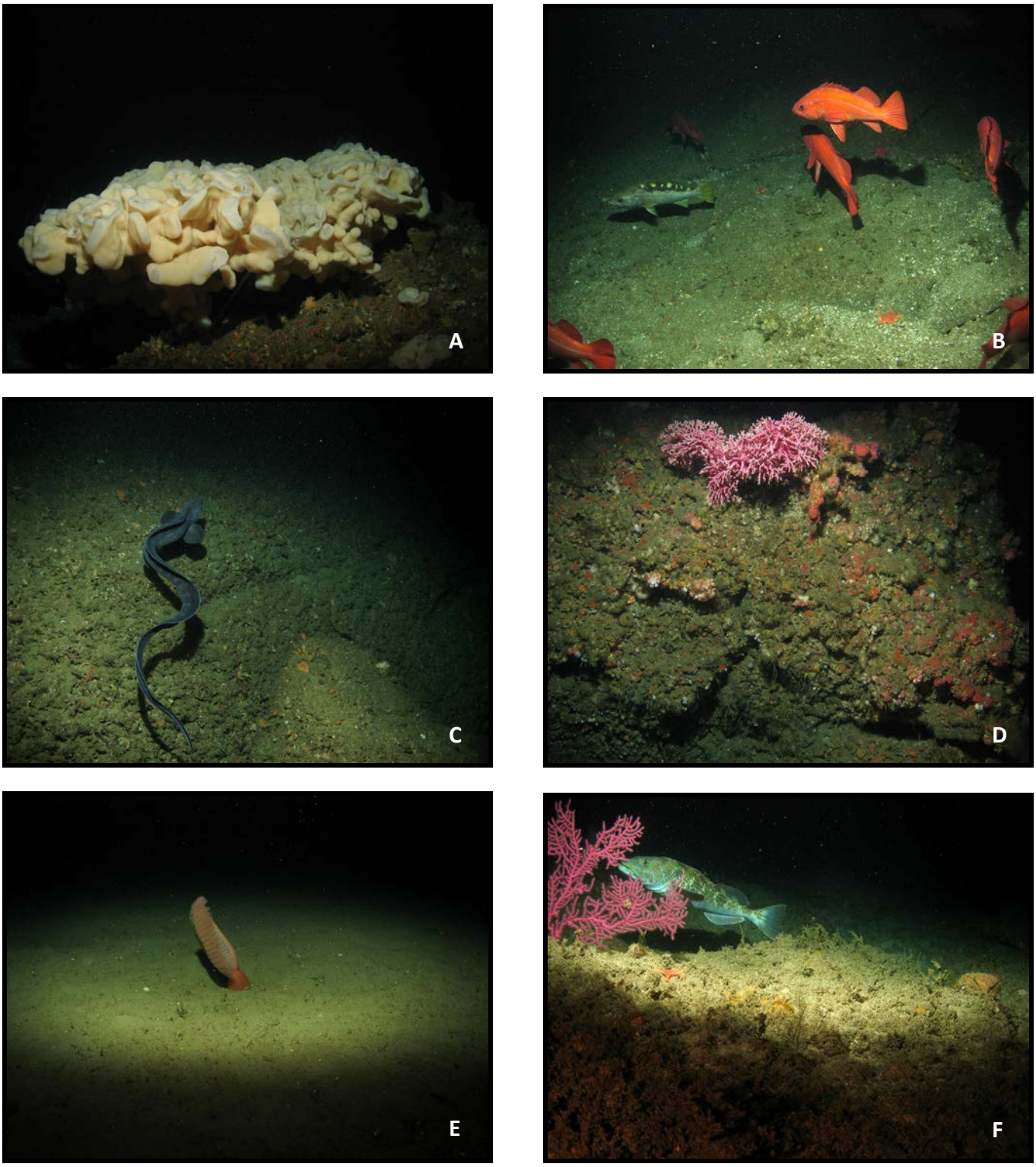
Dive 16 **SCS Site ID: WSM3**
Start Coordinate: 34.05683, -120.49383 **End Coordinate: 34.06373, -120.50594**
Depth Range: 61-85 m **Bottom Time: 1 hour 57 minutes**



Map Caption. *The planned trajectory for ROV Dive 16 is shown as a gray dashed line, with the actual trajectory in black. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

Dive Summary:
The sixteenth dive surveyed West San Miguel Island, over high relief features with sand channels in between observed in multibeam bathymetry (16 m) from the NOAA ship *Bell M. Shimada* in 2016. The dive was on bottom at 21:43 on June 10, 2019 UTC at a maximum depth of 85 m and minimum depth of 61 m. Temperature was 9.8 °C. Dive duration was 1 hour 57 minutes. Bottom currents were strong. The dive was cut short at 23:40 UTC (6:40 PM local time) to accommodate a long transit back to the harbor. Six transects were completedd up to 20 minutes in duration. The longest transect was extended to make up for time 'pulled' by the ship.

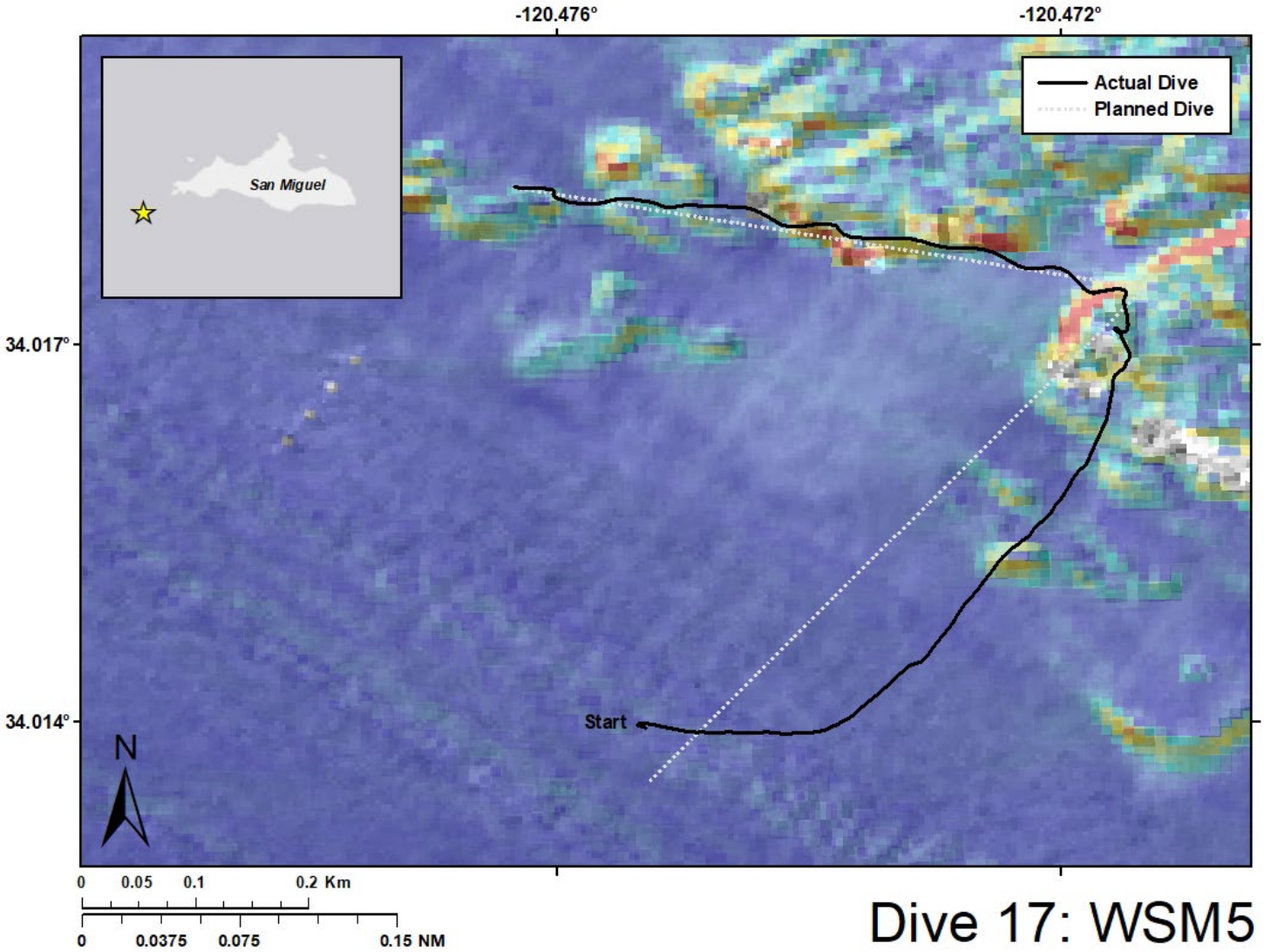
In general, live cover was relatively high on the high relief rocks, but gorgonians were absent. Invertebrates on high relief rock included strawberry anemones, *Stylaster californicus* hydrocorals, sea cucumbers, sponges, nudibranchs, scallops, and sea stars. *Ptilosarcus gurneyi* and *Halipteris/Funiculina* sp. sea pens were present on sand, along with crinoids, sea stars, and brittle stars. The rockfish species were gopher, yelloweye, and rosy. Sheephead, lingcod, flatfishes, and wolfeels were also seen around the rocks.



Dive 16 took place at West San Miguel Island at depths ranging from 61 to 85 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) Large lobate sponge. B) Olive and vermilion rockfish. C) Wolfeel swimming over hard substrate. D) *Stylaster californicus* on rocky substrate. E) *Ptilosarcus gurneyi* on soft substrate. F) *Eugorgia rubens* and lingcod.

Dive 17
Start Coordinate: 34.01395, -120.47529
Depth Range: 63-87 m

SCS Site ID: WSM5
End Coordinate: 34.01825, -120.47634
Bottom Time: 0 hours 48 minutes



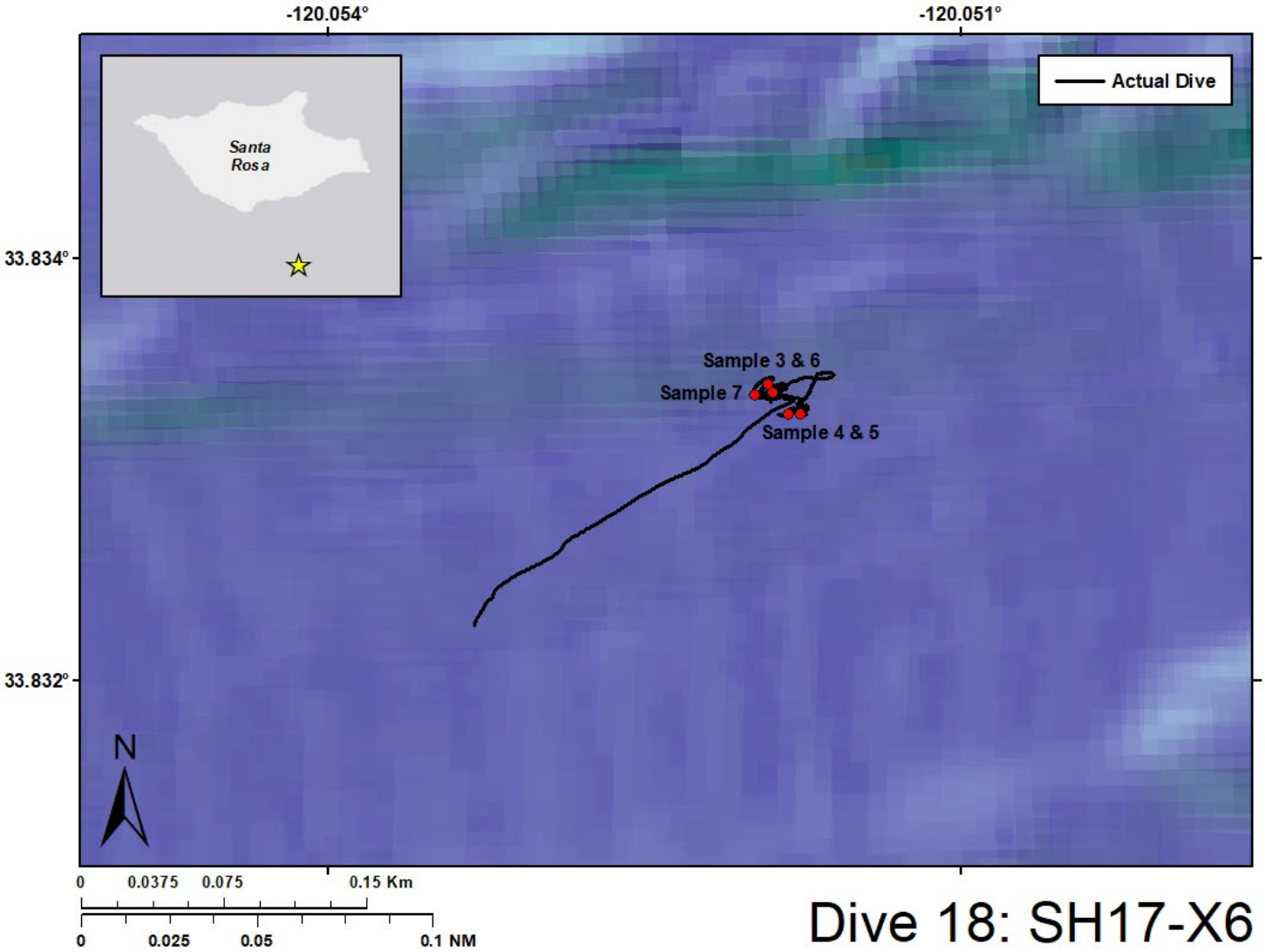
Map Caption. *The planned trajectory for ROV Dive 17 is shown as a gray dashed line, with the actual trajectory in black. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

Dive Summary:
The seventeenth dive surveyed West San Miguel Island, over high relief features with sand channels in between observed in multibeam bathymetry (16 m) from the NOAA ship *Bell M. Shimada* in 2016. The dive was on bottom at 00:30 on June 11, 2019 UTC with a maximum depth of 87 m and minimum depth of 63 m. Temperature was 10.1 °C. Dive duration was 48 minutes. Two transects were completed that were 15 minutes in duration. No still images are available for this dive.

The geology was dramatic, with pinnacles and large boulders. *Eugorgia rubens* were present on the west side of rocks, near sediment interface. Some of the boulders had multiple indentations reminiscent of urchin pits near a modern seashore. High relief rocks had high live coverage including anemones and *Stylaster californicus*. *Staurocalyptus* sponges, cloud sponges, and numerous other sponges were present. *Ptilosarcus gurneyi* and many brittle stars were present in the sand channels. Rockfish species were olive, copper, starry, vermilion, blue, and gopher. Lingcod were also observed. The black and white rear view camera of the ROV offered spectacular views of the rockfish schools, against the steep submarine topography.

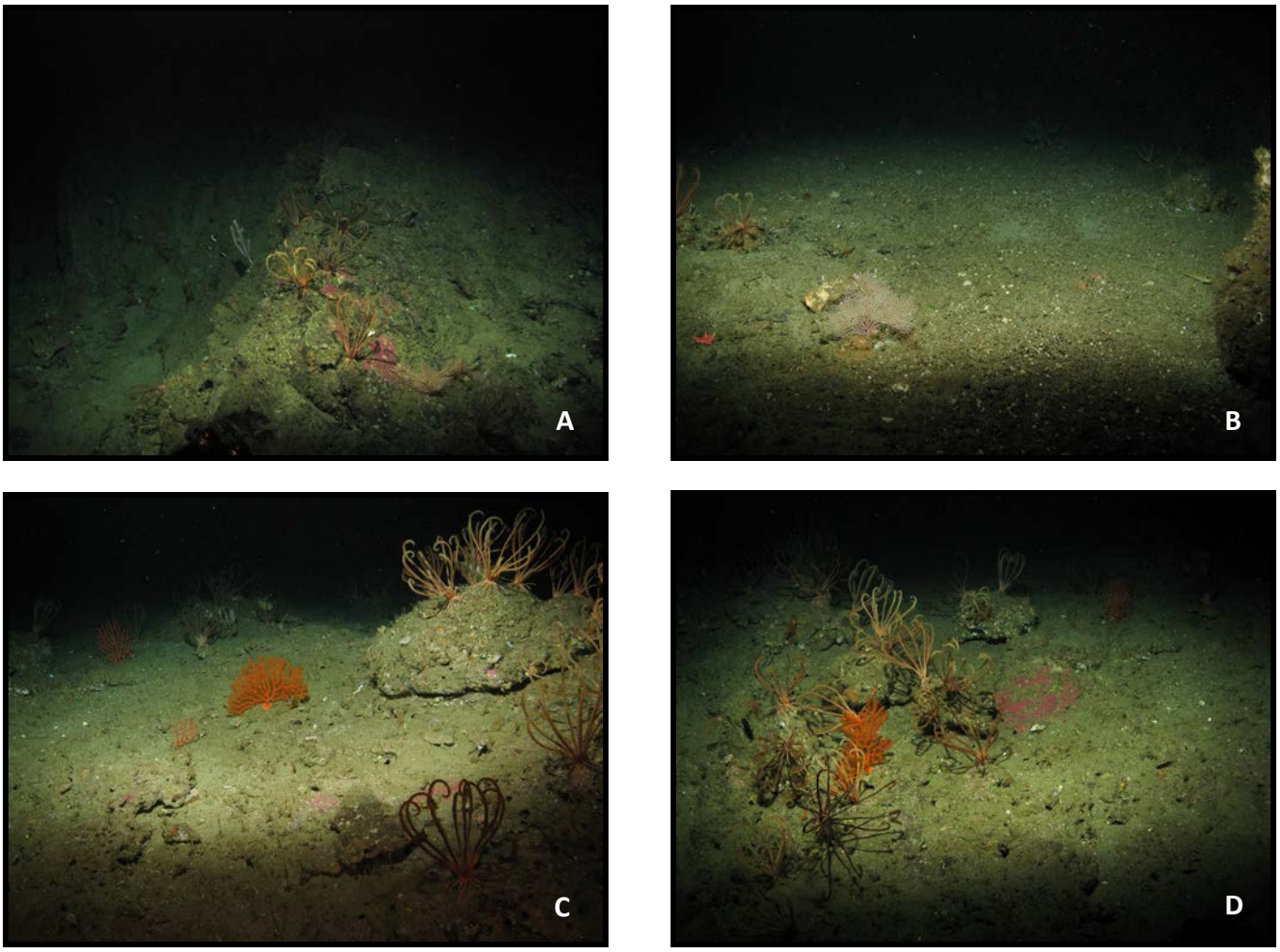
No still images are available for this dive

Dive 18 **SCS Site ID: SH17-X6**
Start Coordinate: 33.83226, -120.05330 **End Coordinate: 33.83332, -120.05190**
Depth Range: 101-102 m **Bottom Time: 0 hours 52 minutes**



Map Caption. *The trajectory for ROV Dive 18 is shown as a black line, with the sample locations as red dots. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

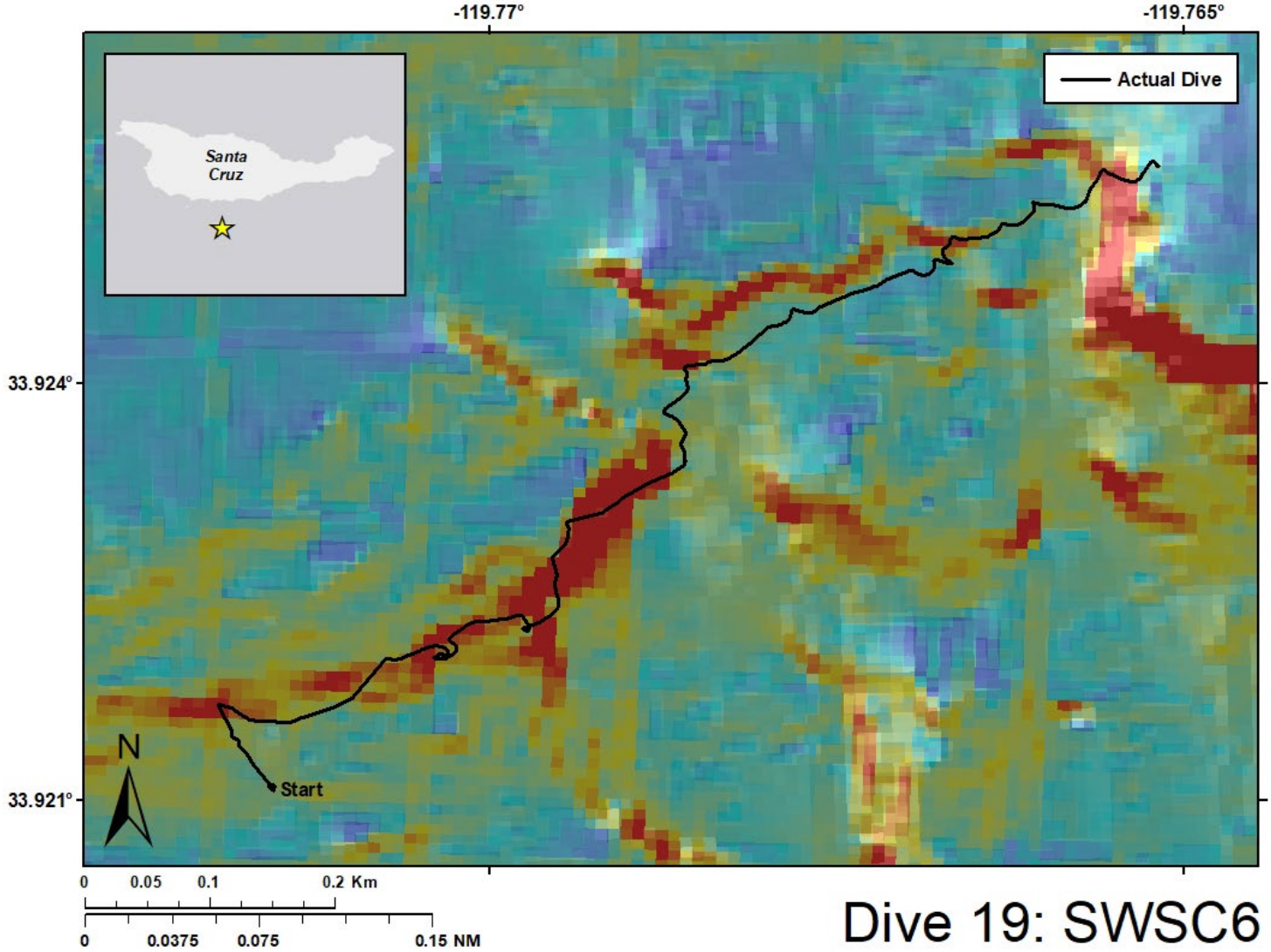
Dive Summary:
The eighteenth dive returned to the Rosen Ridge site mapped by the E/V *Nautilus* NA088 expedition in 2017, to sample *Adelogorgia phyllosclera* and *Plumarella longispina* for Matt Wandell from the Monterey Bay Aquarium. The dive was on bottom at 15:04 on June 11, 2019 UTC at a depth of 102 m. Temperature was 9.5 °C. Dive duration was 52 minutes. Five samples were collected (sample numbers 3-7), including three *Plumarella longispina* colonies (Latitude: 33.8334, Longitude: -120.0517) and two *Adelogorgia phyllosclera* colonies (Latitude: 33.8334, Longitude: -120.0518). The manipulator malfunctioned after Sample 7, but all five samples were recovered.



Dive 18 took place at Rosen Ridge at depths ranging from 101 to 102 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) Unidentified white gorgonian coral (possibly *Placogorgia* sp.) on rocky substrate. B) *Plumarella longispina* sampled (SW1906_Dive18-Spec05). C) *Adelogorgia phyllosclera* sampled (larger colony) with crinoids on rocky substrate (SW1906_Dive18-Spec06). D) *Adelogorgia phyllosclera* colony sampled with crinoids (SW1906_Dive18-Spec07).

Dive 19
Start Coordinate: 33.92110, -119.77157
Depth Range: 307-403 m

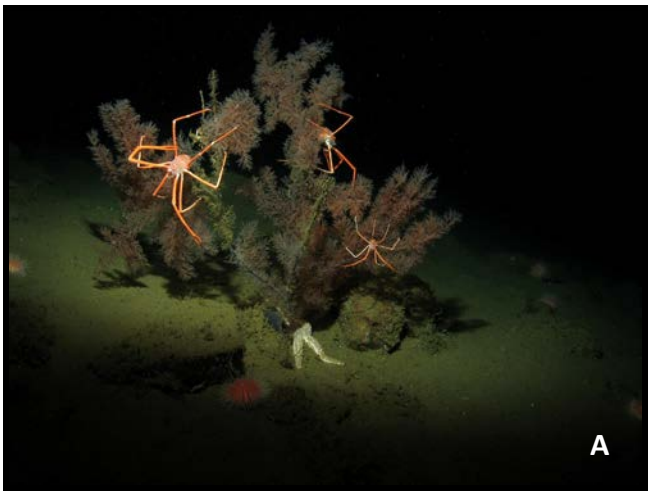
SCS Site ID: SWSC6 ('Lauermann Ridge')
End Coordinate: 33.92556, -119.76517
Bottom Time: 1 hour 28 minutes



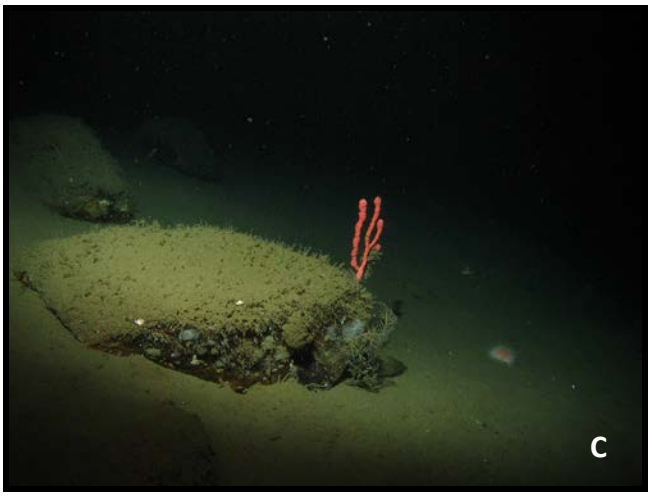
Map Caption. *The trajectory for ROV Dive 19 is shown as a black line. The map background is two layers- slope (in color, partially transparent, red = high slope) and hillshade (in grey-scale).*

Dive Summary:
The nineteenth dive surveyed a deep site (> 400 m) Southwest Santa Cruz Island that was identified from recent multibeam bathymetry (16 m) collected from the NOAA ship *Bell M. Shimada* in 2017. The layers suggested a fairly complex seafloor, which proved to be true. The dive was on bottom at 18:06 on June 11, 2019 UTC at a depth of 403 m. Temperature was 7.9 °C. Secchi disk depth was 9 - 9.5 m. Dive duration was 1 hour 28 minutes. Three transects 15-24 minutes in duration were completed. The minimum depth was 307 m. The full line was completed, as planned. The site was named after MARE ROV pilot Andy Lauermann, who assisted with the dive planning and site selection.

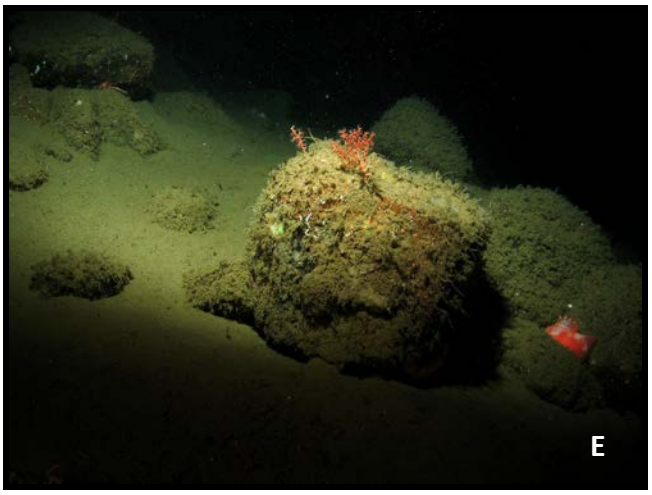
The geology consisted of a moderate slope draped with sediment, and interspersed by small to moderate boulders and rocky outcrops. Key species of corals were *Plumarella longispina*, *Antipathes dendrochristos*, *Paragorgia* sp., and *Swiftia* sp. on hard bottom, and *Halipteris/Funiculina* sp. and other sea pens on soft bottom. Sponges were common, including *Staurocalyptus* 'boot' sponges, orb sponges, and yellow and white foliose forms. The rockfish were aurora, splitnose, and thornyhead. Flatfish were present on sediment, in a variety of forms. Mobile invertebrates present at this site were fragile sea urchins (*Strongylocentrotus fragilis*), black coral crabs, spot prawns, California king crabs, red rock crabs, octopus, and a few of the benthic siphonophore *Dromalia*. Some monofilament line was observed.

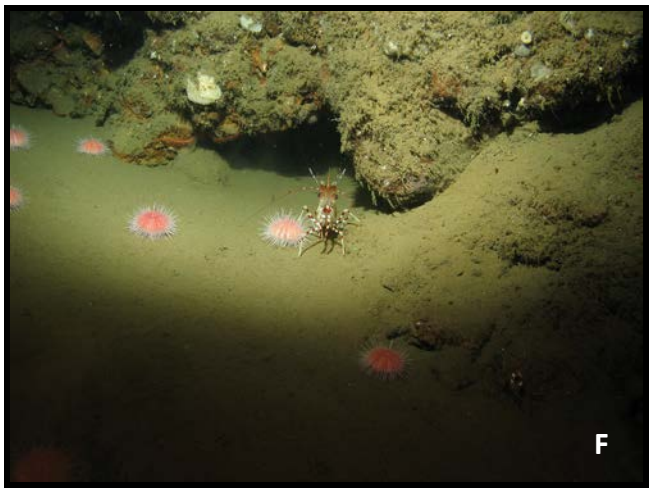

A

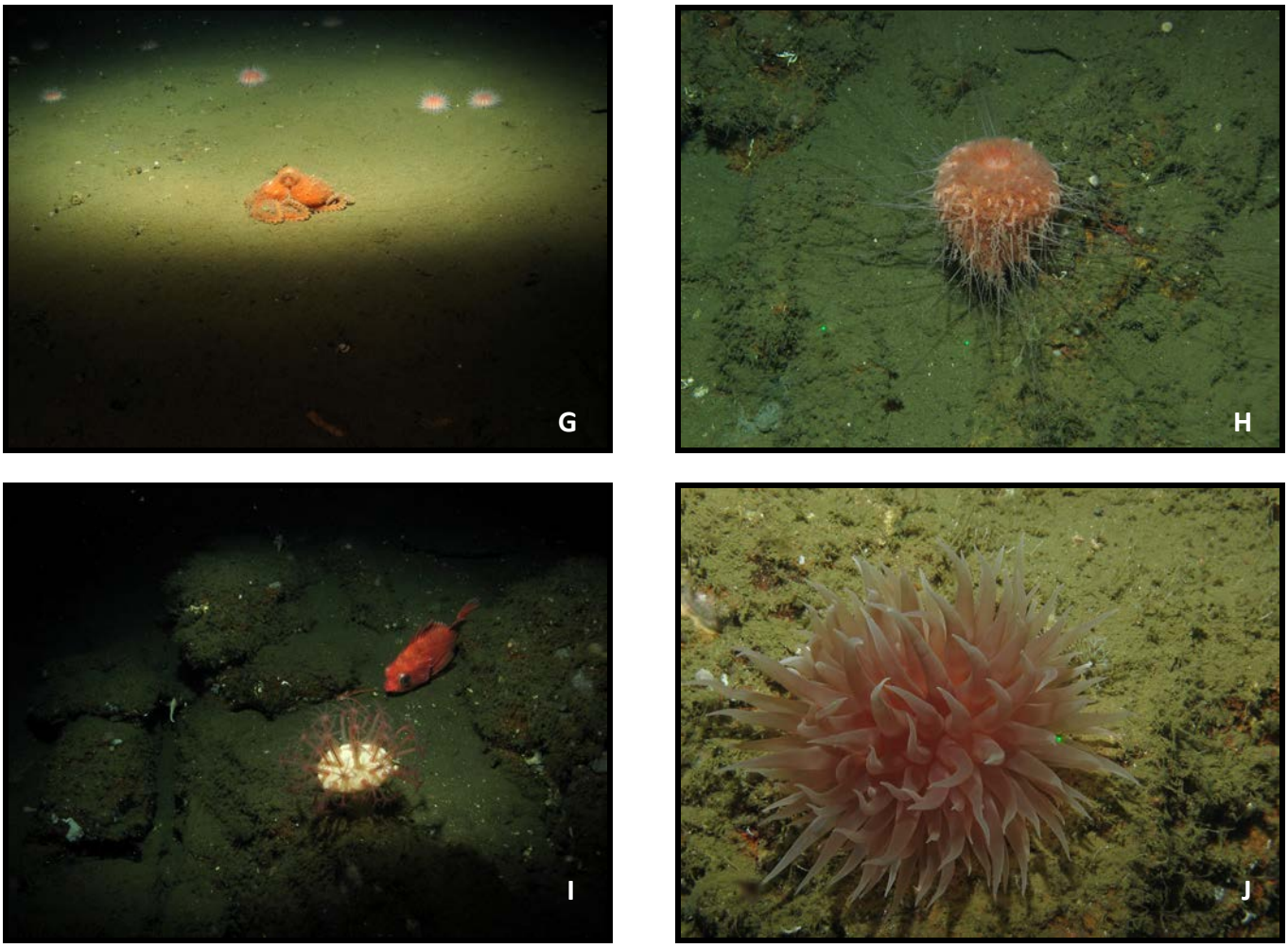

B


C


D


E


F



Dive 19 took place Southwest of Santa Cruz at Lauermann Ridge at depths ranging from 307 to 403 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) *Antipathes dendrochristos* with black coral crabs. B) *Plumarella longispina* with nudibranch. C) *Paragorgia* sp. on mixed substrate. D) California king crabs on cone-shaped sponge. E) *Swiftia* sp. on mixed substrate. F) Spot prawn with sea urchins on mixed substrate. G) Octopus on soft substrate with *Strongylocentrotus fragilis* (fragile sea urchins). H) Benthic siphonophore *Dromalia*. I) *Heteropolypus ritteri* with splitnose rockfish on hard substrate. J) *Liponema* sp. (pom pom anemone)

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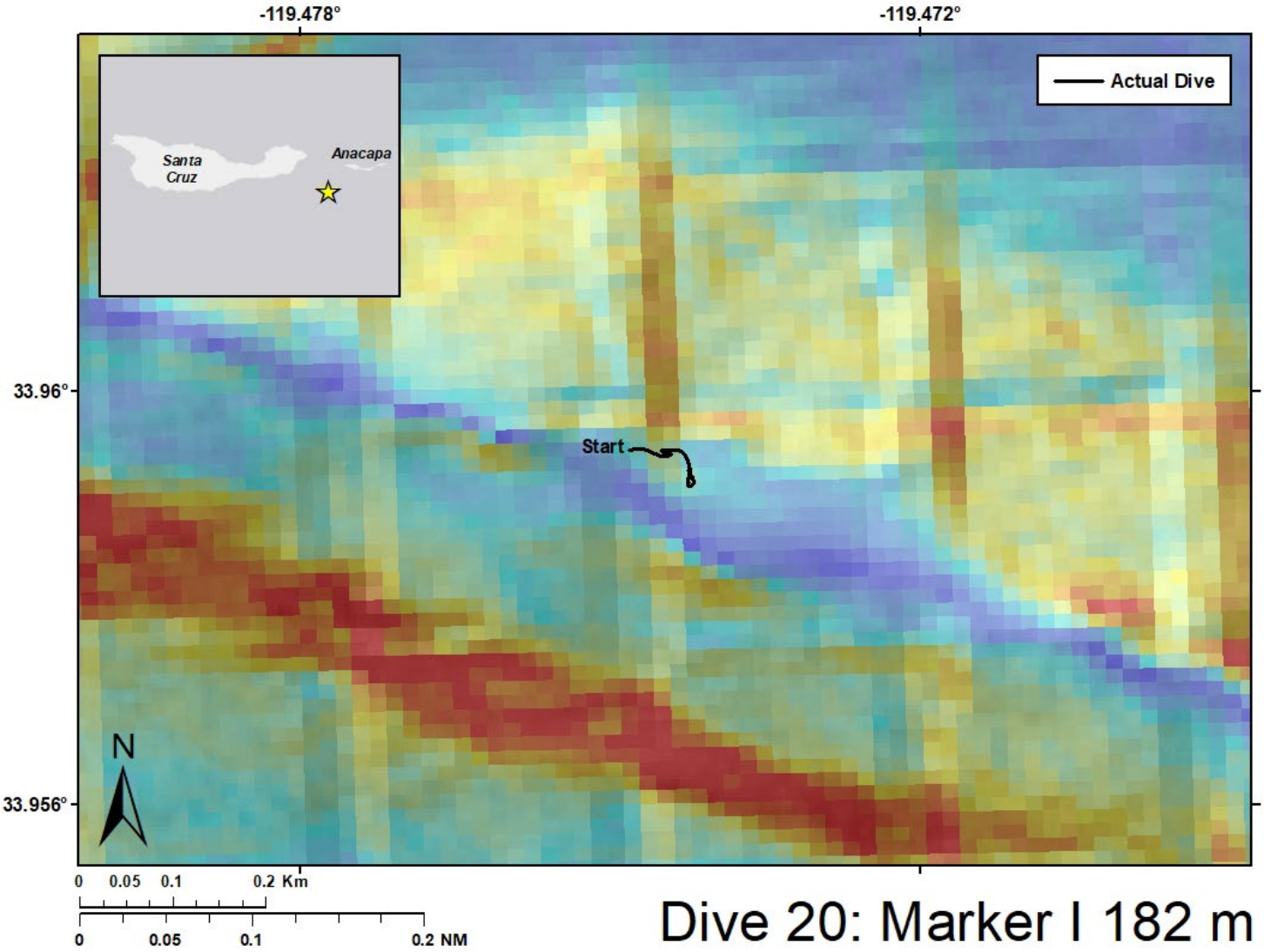
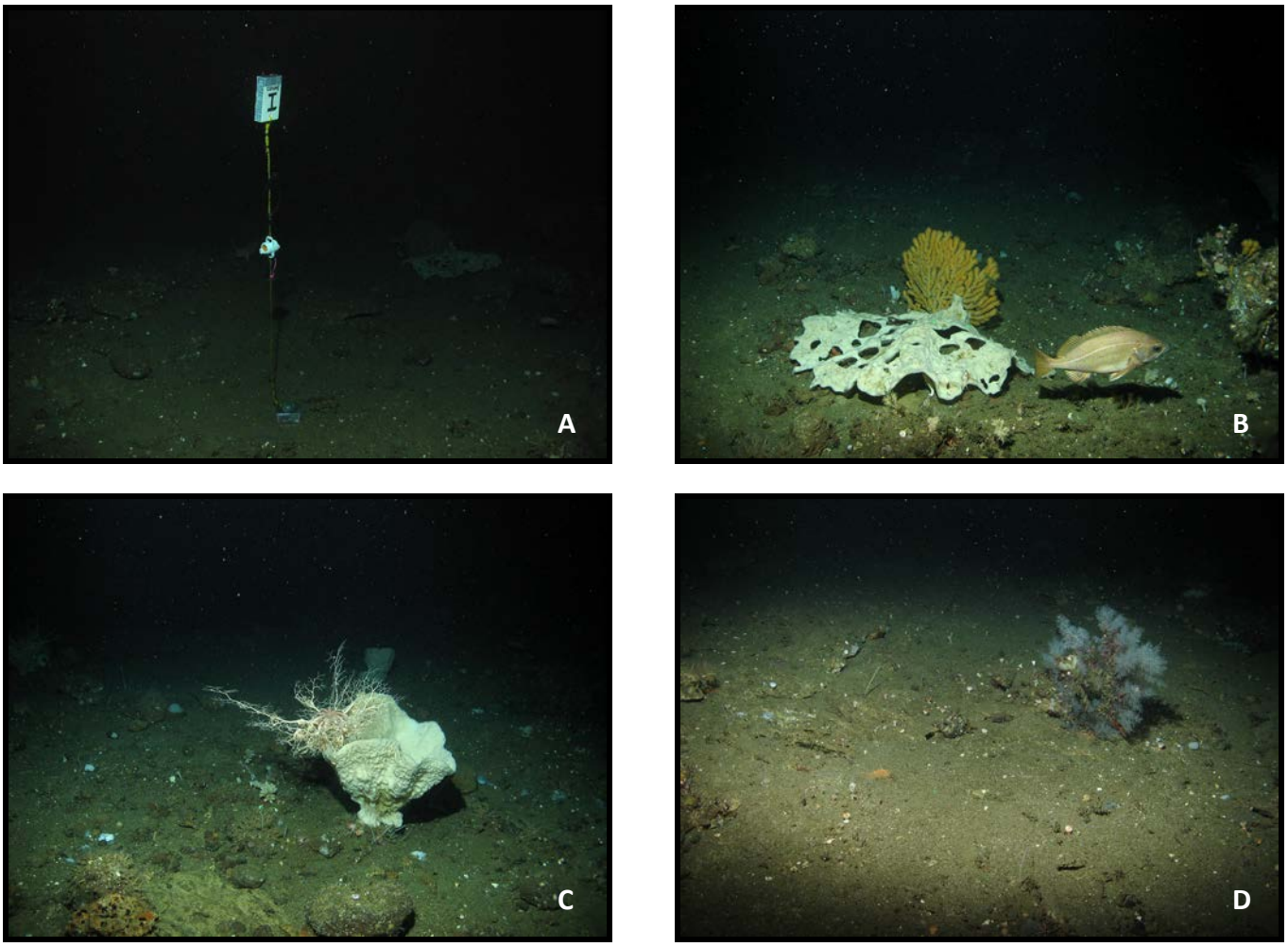
Dive 20
Start Coordinate: 33.95943, -119.47481
Depth Range: 176-182 m

SCS Site ID: Marker I (Footprint)
End Coordinate: 33.95923, -119.47424
Bottom Time: 0 hours 09 minutes



Map Caption. *The trajectory for ROV Dive 20 is shown as a black line. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

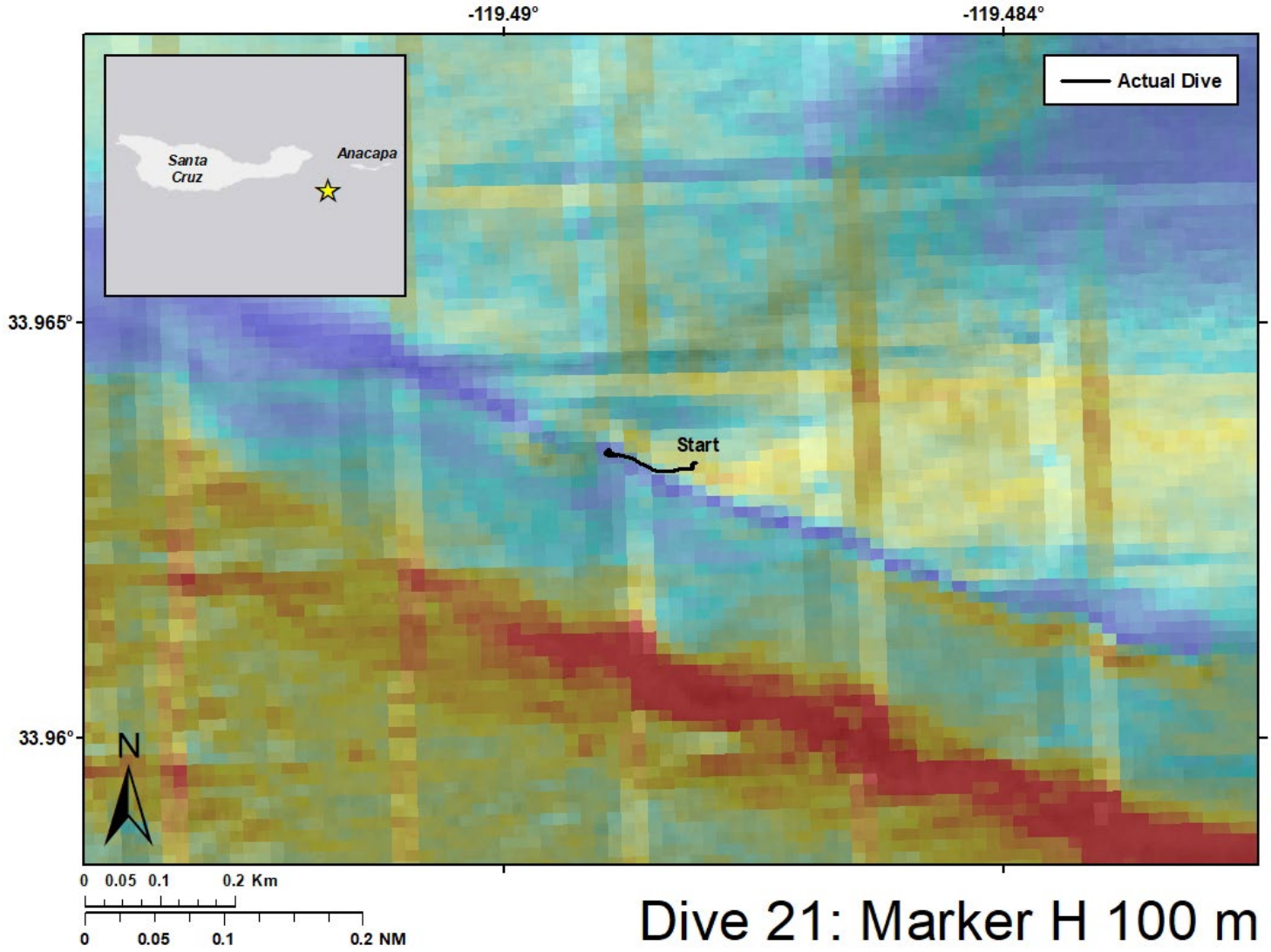
Dive Summary:
The twentieth dive surveyed the Footprint Ridge from mapping data collected by the United States Geological Survey (USGS) aboard the R/V *MacArthur* in 2003, to deploy temperature logger letter I (as in 'aye') at 181.7 m depth. The dive was on bottom at 22:16 on June 11, 2019 UTC at a depth of 176 m. Temperature was 8.6 °C. Dive duration was 9 minutes. The temperature logger was deployed (Latitude: 33.95936, Longitude: -119.47443) near a rocky ridge in the vicinity of a large vase sponge, a large *Acanthogorgia* sp., medium sized *Antipathes dendrochristos*, and small *Paragorgia* sp. All these were photographed for reference.



Dive 20 took place on Footprint Ridge at depths ranging from 176 to 182 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) Temperature logger I deployed at 181.7 m. B) *Acanthogorgia* sp., sponge, and speckled rockfish near temperature logger I. C) Sponge and basket star near temperature logger. D) *Antipathes dendrochristos* on hard substrate.

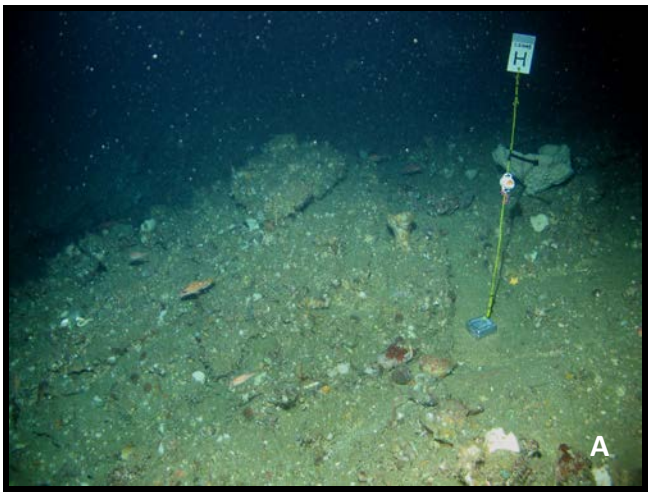
Dive 21
Start Coordinate: 33.96331, -119.48767
Depth Range: 106-111 m

SCS Site ID: Marker H 100 m (Footprint)
End Coordinate: 33.96342, -119.48867
Bottom Time: 0 hours 12 minutes



Map Caption. *The trajectory for ROV Dive 21 is shown as a black line. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

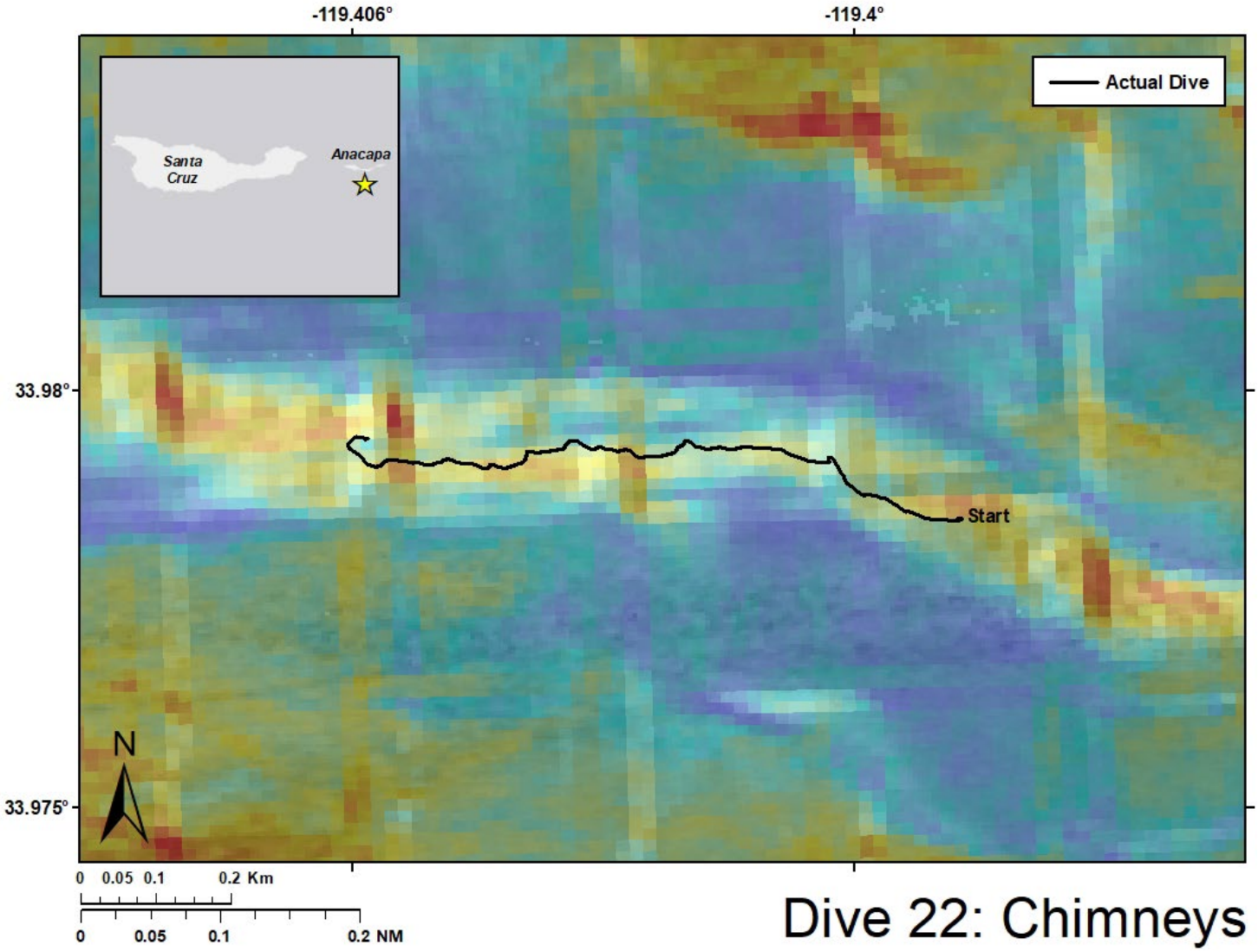
Dive Summary:
The twenty-first dive surveyed the Footprint Ridge from mapping data collected by the USGS aboard the R/V *MacArthur* in 2003, to deploy temperature logger letter H at 100 m depth. The logger came loose from the ROV when a zip tie snapped on deployment. The logger was found quickly and relocated to a new depth. The dive was on bottom at 22:59 on June 11, 2019 UTC and lasted 12 minutes. The temperature was 9.4 °C. The logger was deployed at 106 m (Latitude: 33.96346, Longitude: -119.48863) in the vicinity of *Lophelia pertusa*, a large vase sponge (now damaged), a small Plexauridae, and many scattered boulders. Rockfish species present included flag, bocaccio, and cowcod. The zip tie broke, so the manipulator is recommended for future deployments.



Dive 21 took place on Footprint ridge at depths ranging from 106 to 111 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) Temperature logger H deployed at 106 m. B) Benthic environment near temperature logger H including sponges and rocks with high live coverage.

Dive 22
Start Coordinate: 33.97847, -119.39875
Depth Range: 357-414 m

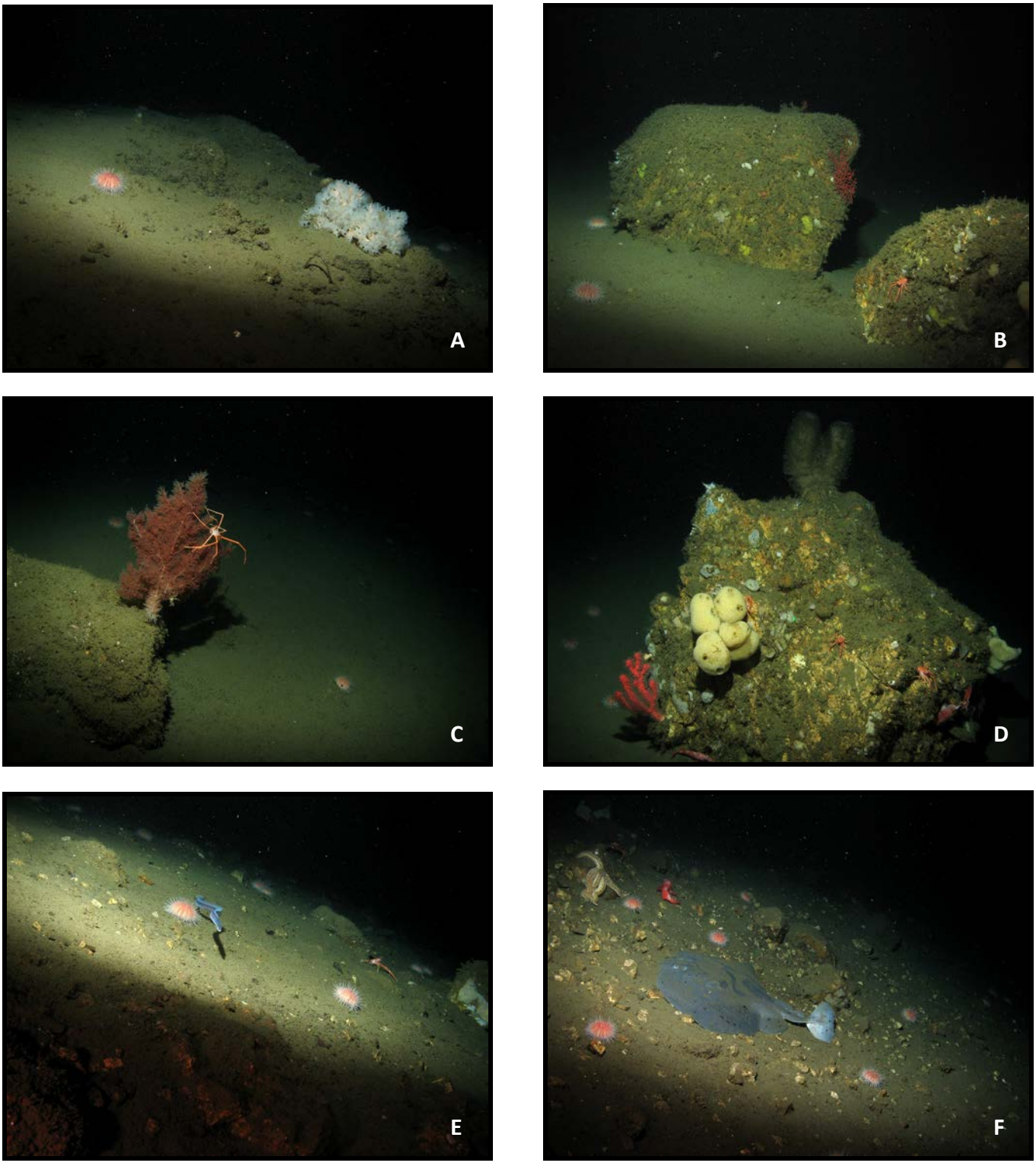
SCS Site ID: Chimneys (South Anacapa Deep Ridge)
End Coordinate: 33.97940, -119.40585
Bottom Time: 1 hour 04 minutes



Map Caption. *The trajectory for ROV Dive 22 is shown as a black line. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

Dive Summary:
The twenty-second dive surveyed a deep portion (> 400 m) of the South Anacapa Island Deep Ridge site known as Chimneys. A 2015 expedition provided information indicating that *Antipathes dendrochristos* corals were known to occur at this location. The area was mapped by the USGS aboard the R/V *MacArthur* in 2003. The purpose of the dive was to conduct reconnaissance for a planned sampling dive. Sampling was not possible on this dive due to a malfunctioning manipulator. The dive was on bottom at 1:01 on June 12, 2019 UTC at a depth of 414 m. Temperature was 7.6 °C. Dive duration was 1 hour 04 minutes. Two transects were completed, from 8 - 15 minutes in duration. The minimum depth was 357 m. The full line was completed, as planned. The ship briefly lost power at 1:27:00 due to a tripped breaker earlier in the day. The ship had been running on battery, unbeknown to the crew.

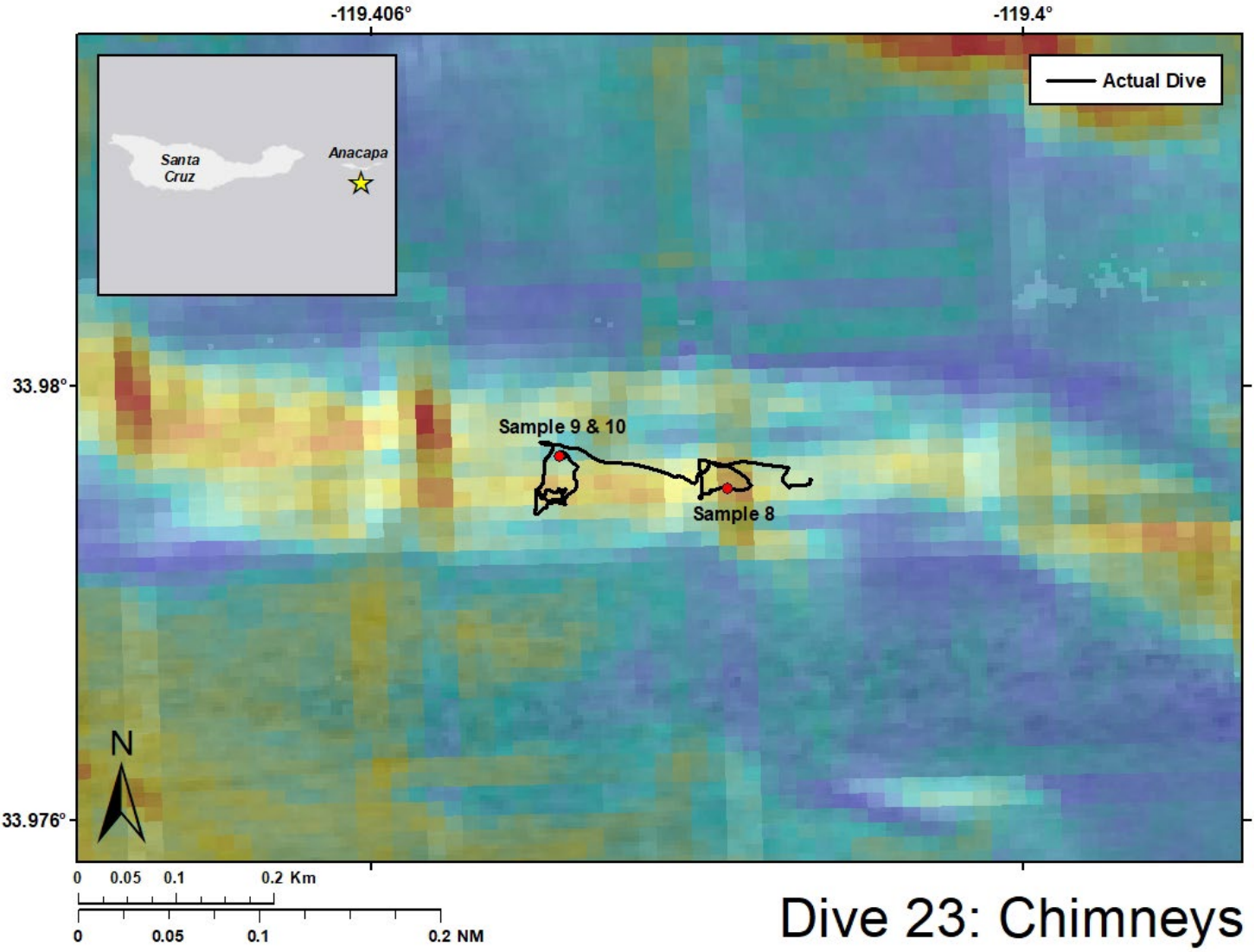
The geology consisted of a moderate slope draped with sediment, and interspersed by a few small to moderate boulders and rocky outcrops. Key species of corals were *Plumarella longispina*, *Antipathes dendrochristos*, *Paragorgia* sp., and *Swiftia* sp. on hard bottom, and *Halipteris/Funiculina* sp. and unidentified sea pens on soft bottom. Several large dead coral branches were seen. Sponges were common, including *Staurocalyptus* 'boot' sponges, *Farrea* spp. foliose sponges, orb sponges. The rockfish present were aurora and splitnose. Flatfish and poachers were present on sediment. Snailfish, dogface witch eel, and a torpedo ray were also seen. Mobile invertebrates were sea urchins, sea cucumbers, sea stars, black coral crabs, spot prawns, king crabs, red rock crabs, octopus, and a few of the benthic siphonophore *Dromalia*.



Dive 22 took place at South Anacapa Island Deep Ridge at depths ranging from 357 to 414 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) *Farrea* spp. foliose sponge with sea urchin on soft substrate. B) *Swiftia* sp. colony on rock with sea urchin and squat lobster. C) *Antipathes dendrochristos* colony with black coral crab on mixed substrate. D) *Paragorgia* sp. and unknown sponge on rock. E) Dogface witch eel with sea urchins and squat lobster. F) Torpedo ray over mixed sediment with sea stars and sea urchins.

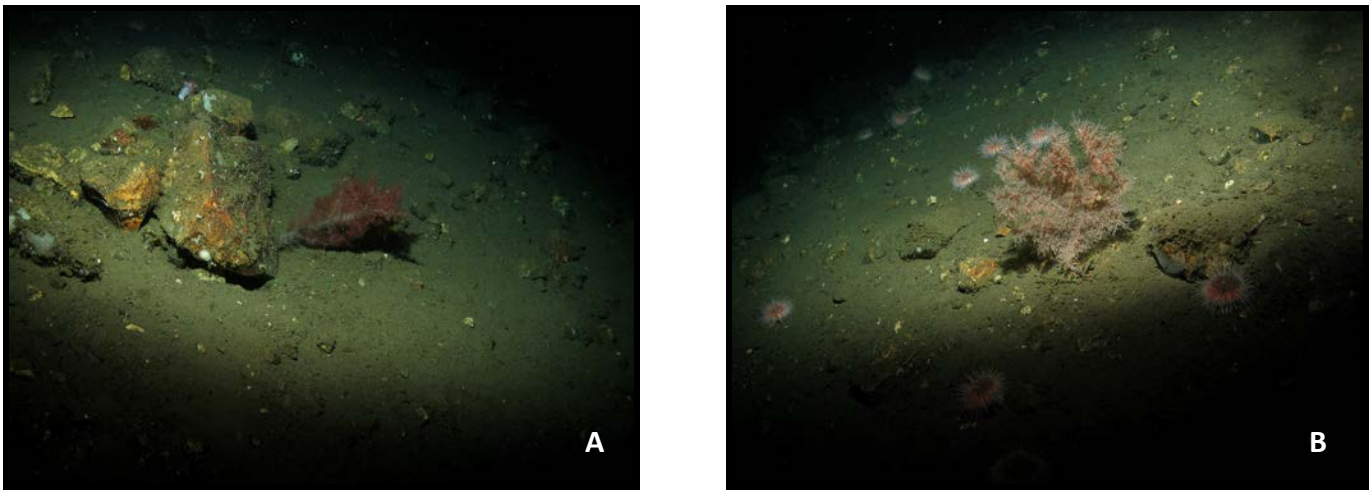
Dive 23
Start Coordinate: 33.97914, -119.40195
Depth Range: 362-389 m

SCS Site ID: Chimneys (South Anacapa Deep Ridge)
End Coordinate: 33.97934, -119.40426
Bottom Time: 0 hours 51 minutes



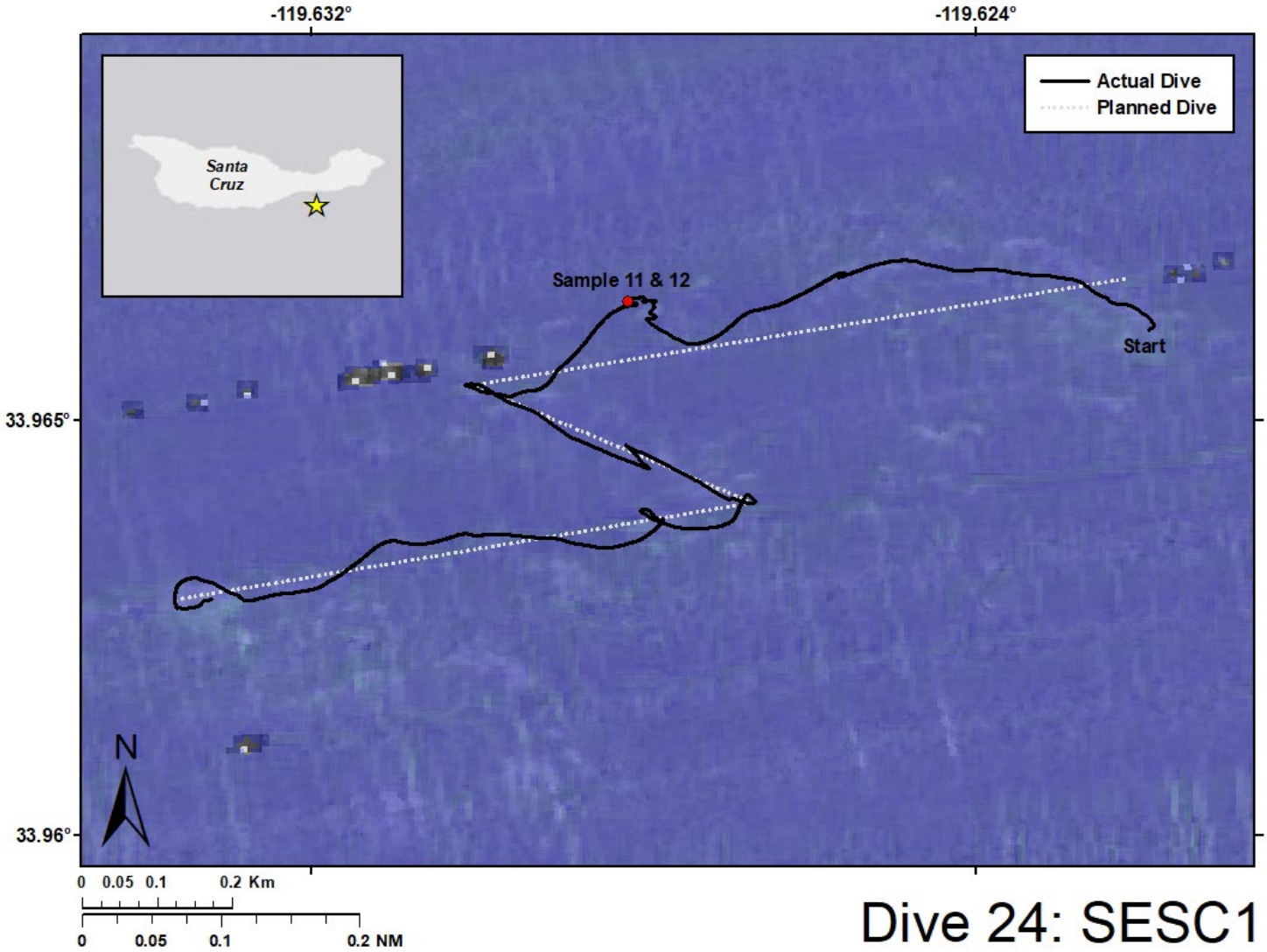
Map Caption. *The trajectory for ROV Dive 23 is shown as a black line, with sample locations as red dots. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

Dive Summary:
The twenty-third dive revisited the Anacapa Island Deep Ridge over area mapped by the USGS aboard the R/V *MacArthur* in 2003, to sample *Antipathes dendrochristos* for live husbandry at Monterey Bay Aquarium. The dive was on bottom at 15:54 on June 12, 2019 UTC at a depth of 389 m. Temperature was 7.7 °C. Dive duration was 51 minutes. The first *A. dendrochristos* sample was collected at 378 m (Latitude: 33.97920, Longitude: -119.40280). The second *A. dendrochristos* sample was collected at 364 m (Latitude: 33.97890, Longitude: -119.40410) and had a squat lobster associated with it. The geology and the species assemblage was similar to Dive 22.



Dive 23 took place at Anacapa Island Deep Ridge at depths ranging from 362 to 389 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) The first sample of *Antipathes dendrochristos* (SW1906_Dive23-Spec08). B) The second sample of *Antipathes dendrochristos* (SW1906_Dive23-Spec09) with an associated squat lobster (SW1906_Dive23-Spec10).

Dive 24 **SCS Site ID: SESC1**
Start Coordinate: 33.96607, -119.62192 **End Coordinate: 33.96284, -119.63318**
Depth Range: 71-73 m **Bottom Time: 1 hours 44 minutes**

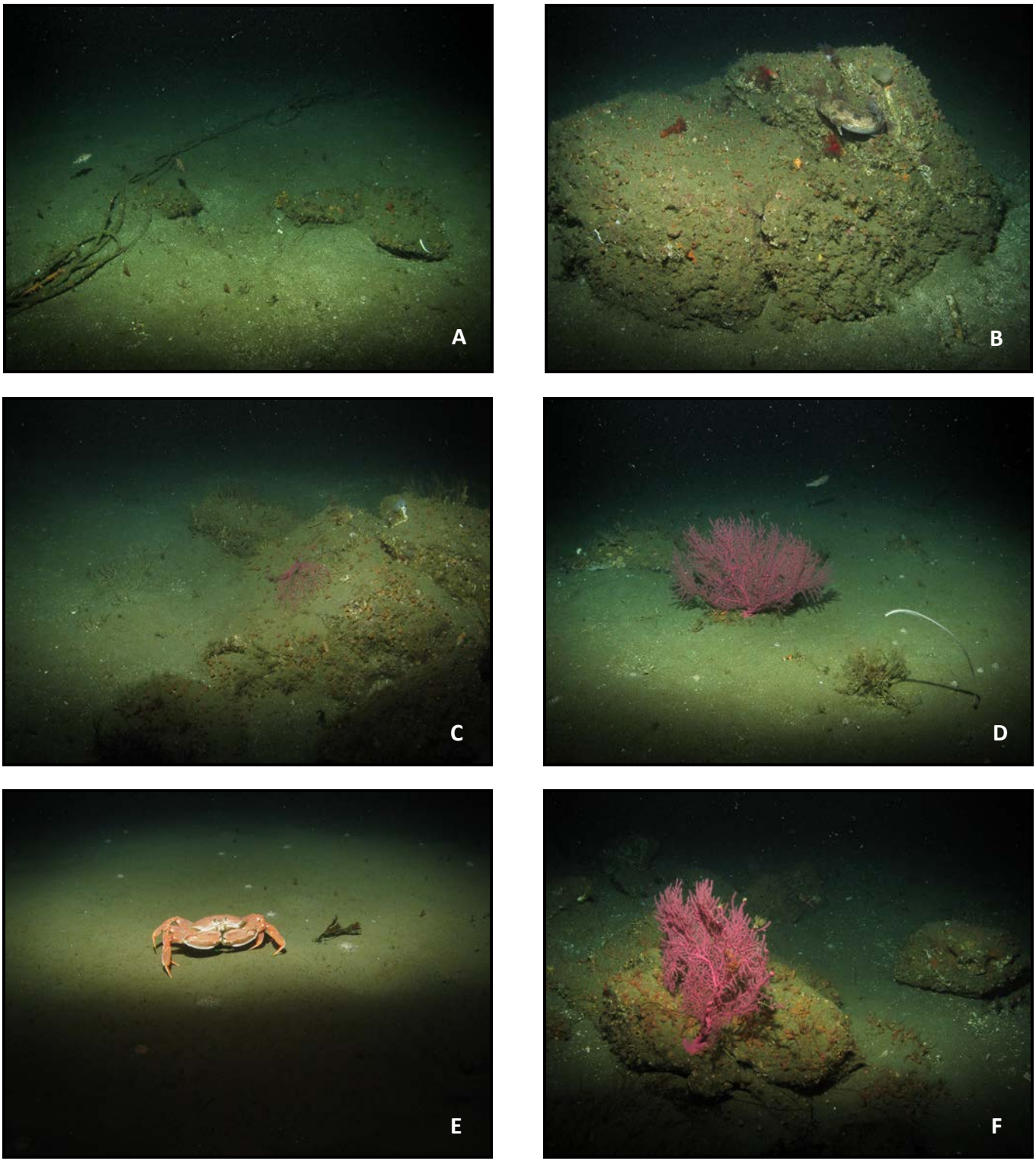


Map Caption. *The planned trajectory for ROV Dive 24 is shown as a gray dashed line, the actual trajectory in black, and sample locations as red dots. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

Dive Summary:
The twenty-forth dive revisited the SESC1 area mapped by the NOAA ship *Bell M. Shimada* in 2017, to sample *Adelogorgia phyllosclera* for live husbandry at Monterey Bay Aquarium. The dive was on bottom at 18:25 on June 12, 2019 UTC at a depth of 73 m. Temperature was 9.8 °C. Dive duration was 1 hour 44 minutes. The sonar was not working, but the backscatter appeared to be accurate. No transects were conducted, however a fair number of these could be derived from the video, including segments of soft bottom and hard bottom that were not previously annotated.

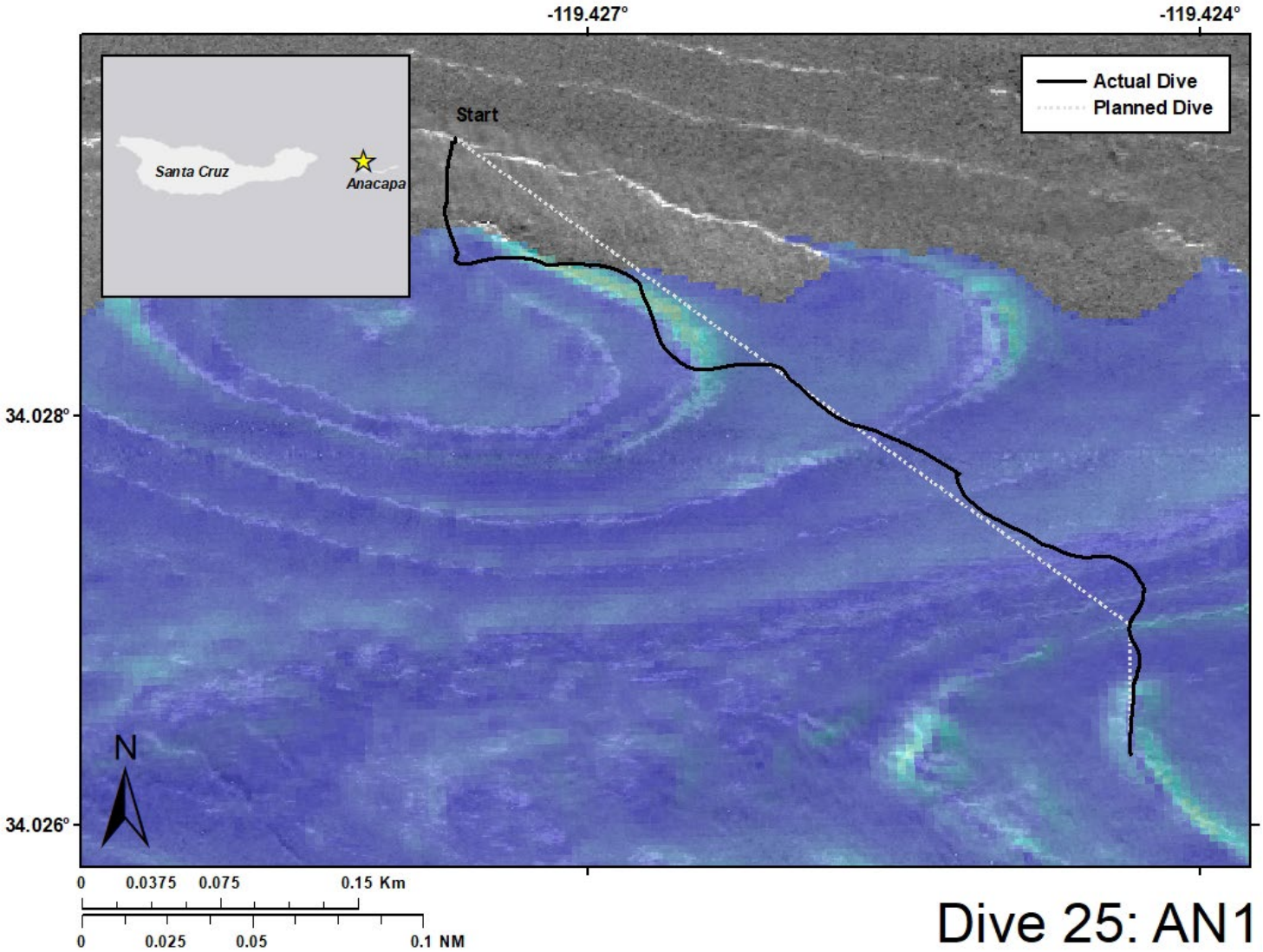
Adelogorgia phyllosclera was not found. A sample of *Eugorgia rubens* was collected at 19:06 UTC from 73 m (Latitude: 33.96640, Longitude: -119.62780). A small, white sea urchin was also collected with one of the corals. Two *Leptogorgia chilensis* were seen, one with zoanthid overgrowth, presumably *Parazoanthus*. The geology and the species assemblage was similar to Dive 7. Two fishing lines and two traps were observed during the dive. One highlight video clip was made at the end of the dive, which came off bottom at 20:09 UTC.

All samples from the expedition were maintained alive for experimental husbandry at Monterey Bay Aquarium. There were 12 total samples collected – including *Plumarella longispina* (n = 3), *Adelogorgia phyllosclera* (n = 2), *Eugorgia rubens* (n = 1), *Antipathes dendrochristos* (n = 2) and *Lophelia pertusa*. Associated species collected were *Desmophyllum* sp., a squat lobster, and a sea urchin.



Dive 24 took place at Southeast Santa Cruz at depths ranging from 71 to 73 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) Fishing line over mixed substrate with halfbanded rockfish. B) Lingcod over rocky substrate. C) Injured colony of *Eugorgia rubens*. D) *Eugorgia rubens* and sea pen on mixed substrate. E) Crab on soft substrate with sea urchins. F) *Eugorgia rubens* sample (SW1906_Dive24-Spec11) collected with associated sea urchin (SW1906_Dive24-Spec12).

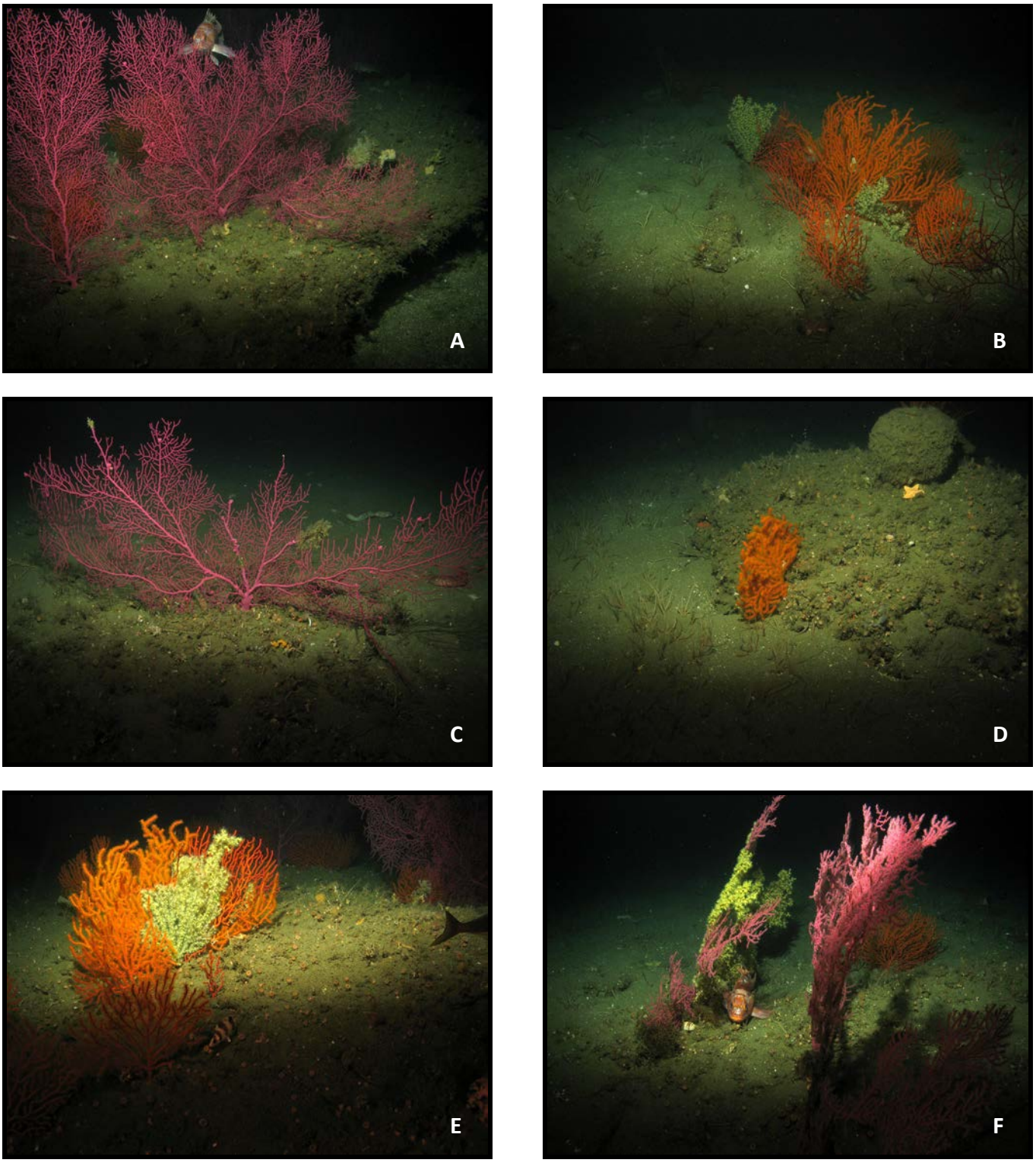
Dive 25 **SCS Site ID: AN1**
Start Coordinate: 34.02935, -119.42764 **End Coordinate: 34.02635, -119.42434**
Depth Range: 77-81 m **Bottom Time: 0 hours 36 minutes**



Map Caption. *The planned trajectory for ROV Dive 25 is shown as a gray dashed line, with the actual trajectory in black. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and side-scan imagery (in grey-scale).*

Dive Summary:
The twenty-fifth dive of the expedition surveyed Northwest Anacapa Island during a day trip by MARE on June 14, 2019 UTC over multibeam bathymetry (4 m) from the NOAA ship *Rainier* in 2017. The dive was on bottom at 18:03 UTC for a duration of 36 minutes. Bottom temperature was 10.4 °C at a maximum depth of 81 m. One 15-minute transect was completed.

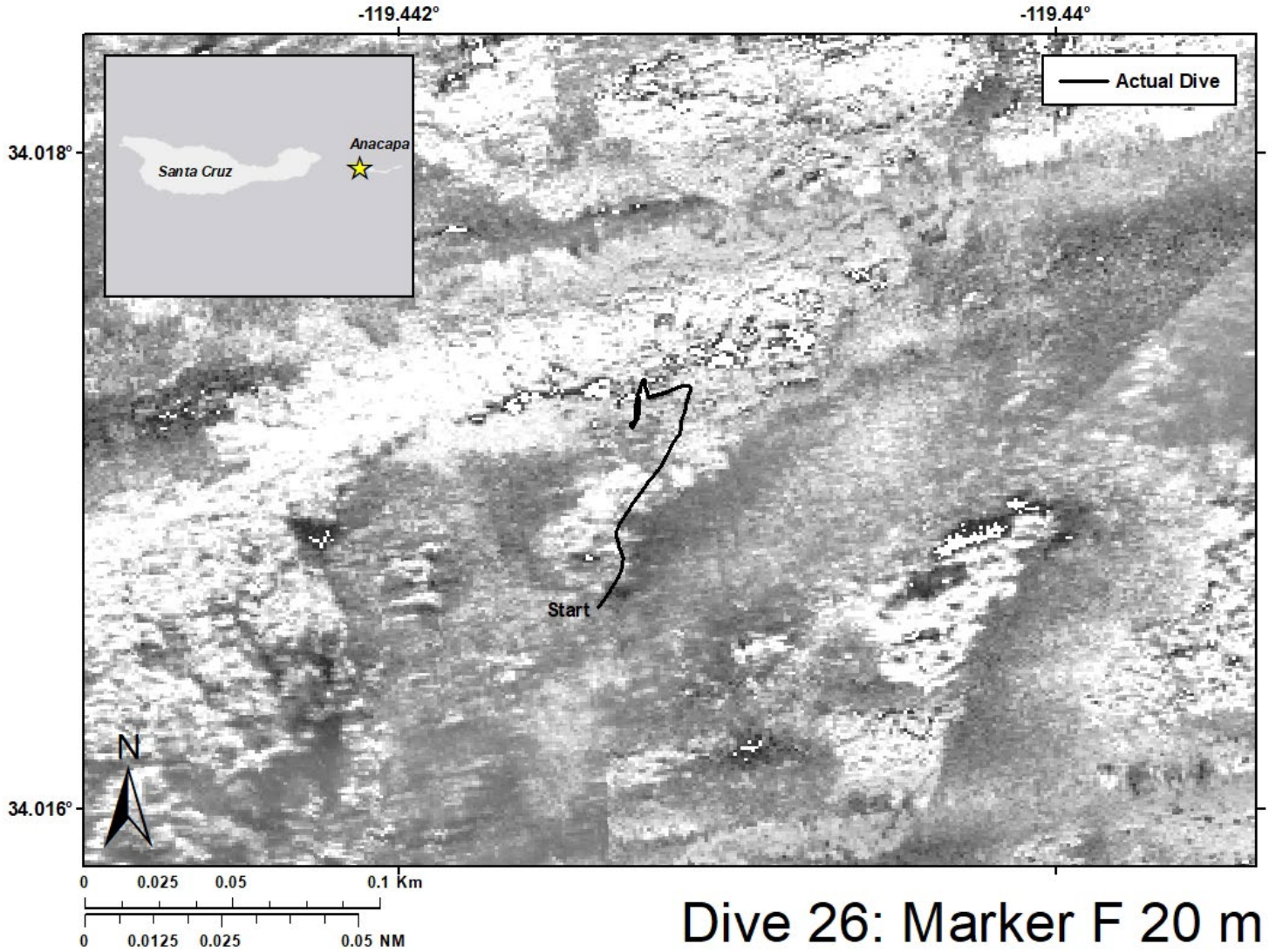
The dive alternated between areas of flat, soft bottom and rocky outcrops. In general, the relative abundance of fish was high on the rocky outcrops and boulders that also had a relatively high abundance of gorgonian corals. Key coral species observed included *Adelogorgia phyllosclera*, *Eugorgia rubens*, and *Leptogorgia chilensis.* Several of these gorgonian corals were injured and had some zoanthid overgrowth. The rockfish included halfbanded, rosy, flag, honeycomb, speckled, copper, and vermilion. A lingcod and a skate were also observed. Mobile invertebrates present included sea urchins, sea cucumbers, sea stars, and brittle stars.



Dive 25 took place Northwest of Anacapa Island at depths ranging from 77 to 81 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) Colonies of *Eugorgia rubens* with copper rockfish. B) *Adelogorgia phyllosclera* colonies, some with zoanthid overgrowth. C) Injured colony of *Eugorgia rubens*. D) *Adelogorgia phyllosclera* on mixed substrate. E) *Adelogorgia phyllosclera* with zoanthid overgrowth. F) *Eugorgia rubens* colonies, one with zoanthid overgrowth and copper rockfish.

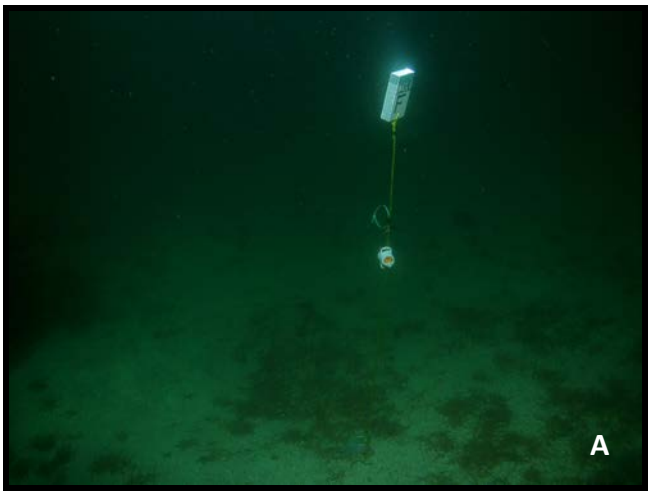
Dive 26
Start Coordinate: 34.01661, -119.44139
Depth Range: 18-20 m

SCS Site ID: Marker F 20 m
End Coordinate: 34.01726, -119.44126
Bottom Time: 0 hours 12 minutes



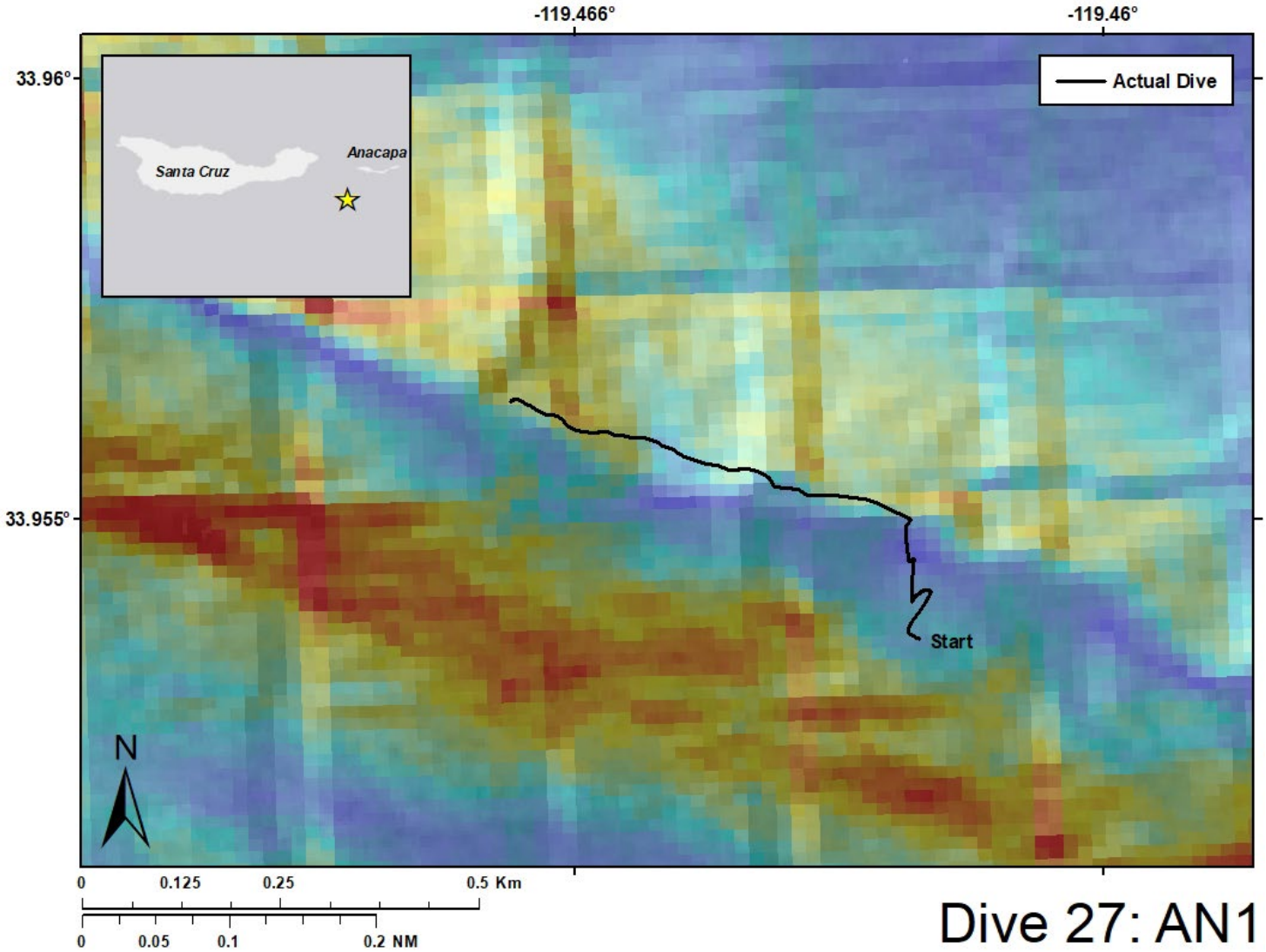
Map Caption. *The trajectory for ROV Dive 26 is shown as a black line. The map background is side-scan imagery (in grey-scale).*

Dive Summary:
The twenty-sixth dive surveyed Northwest Anacapa Island over multibeam (4 m) from the NOAA ship *Rainier* in 2017 to deploy temperature logger letter F at 20 m. The dive was on bottom at 19:02 on June 14, 2019 UTC for a duration of 12 minutes. Temperature was 15.9 °C. The logger was deployed at a depth of 20 m (Latitude: 34.01717, Longitude: -119.44128). It was deployed on flat bottom with shell hash and numerous brittle stars near a rocky outcrop. There was some trouble getting the temperature logger off the hook and it was dragged before being released.



Dive 26 took place Northwest of Anacapa Island at depths ranging from 18 to 20 meters, using the ROV *Beagle* aboard the R/V *Shearwater*. A) Side view of temperature logger F at 20 m on unconsolidated sediment. B). Front view of temperature logger F at 20 m on unconsolidated sediment.

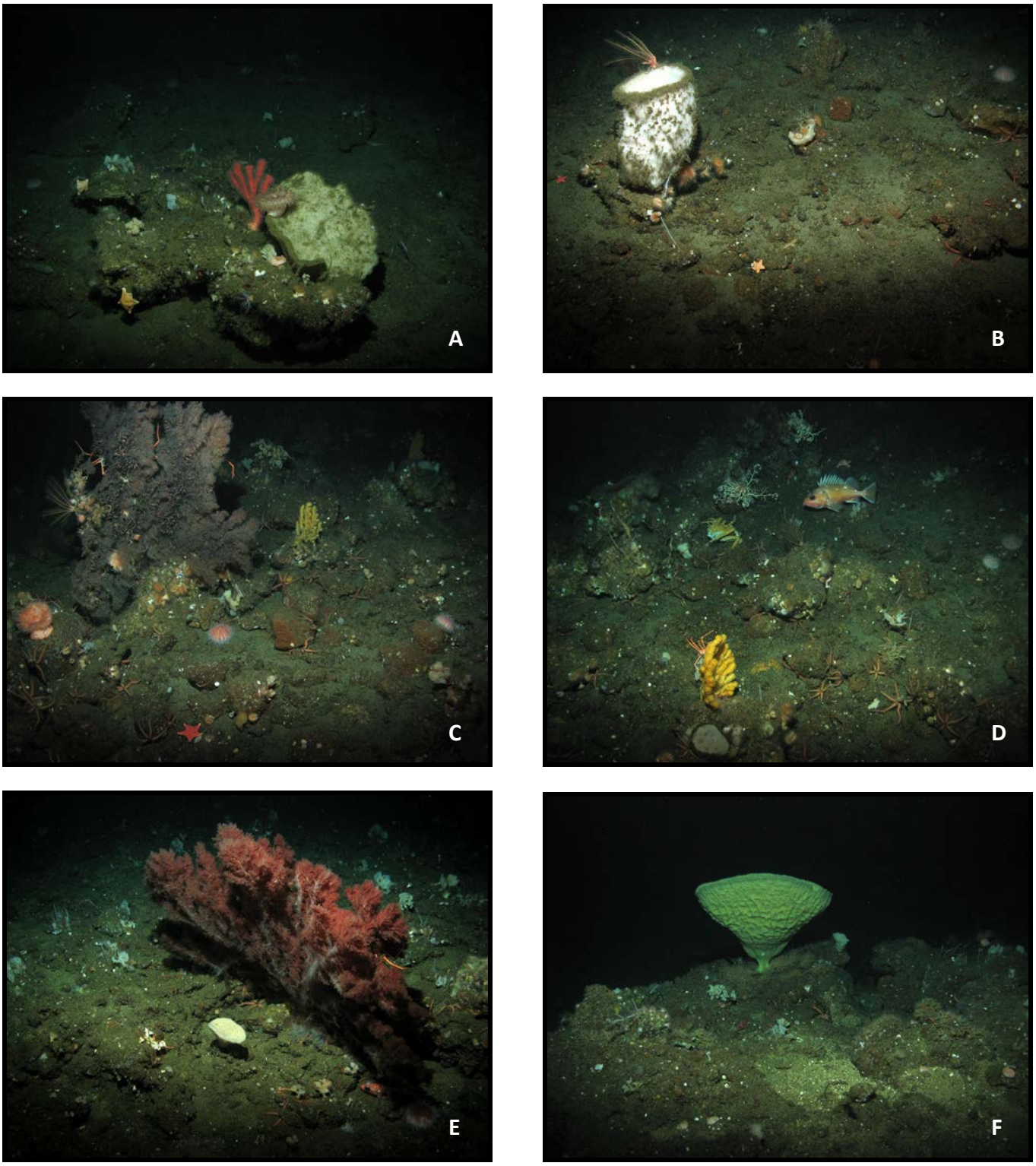
Dive 27 **SCS Site ID: AN1**
Start Coordinate: 34.95364, -119.46208 **End Coordinate: 33.95633, -119.46672**
Depth Range: 192-260 m **Bottom Time: 0 hours 37 minutes**



Map Caption. *The trajectory for ROV Dive 27 is shown as a black line. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and backscatter (in grey-scale).*

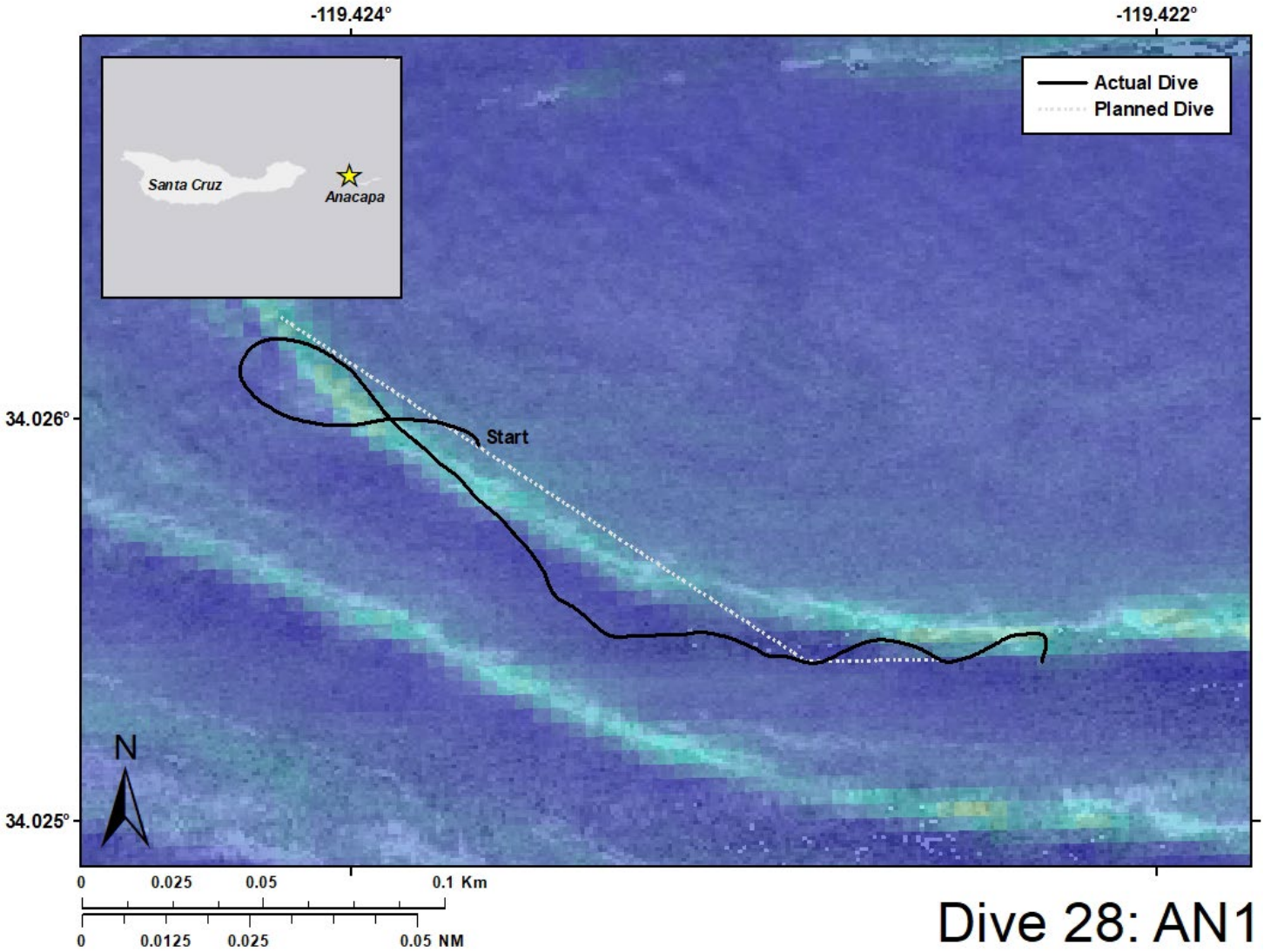
Dive Summary:
The twenty-seventh dive surveyed a deep site around Northwest Anacapa Island over multibeam bathymetry from the NOAA ship *Rainier* in 2017, during a day trip by MARE. The dive was on bottom at 20:29 on June 14, 2019 UTC at a depth of 260 m and temperature of 8.4 °C. Dive duration was 37 minutes and had a minimum depth of 192 m. One transect was completed that was 28 minutes long but was ended early due to a camera malfunction at 21:05 UTC.

The geology was comprised of hard, rocky substrate on a moderate slope. Key species of corals were *Antipathes dendrochristos*, *Paragorgia* sp., *Swiftia* sp., many *Acanthogorgia* sp., several genera of cup corals, and *Lophelia pertusa*. Sponges were common, including *Staurocalyptus* 'boot' sponges, orb sponges, and white foliose sponges. The rockfish observed during the dive were starry, greenspotted, bank, and vermilion. Lingcod, Spotted ratfish, and skates were also observed. Invertebrates observed during the dive were sea urchins, sea cucumbers, sea stars, squat lobsters, anemones, basket stars, and crinoids.



Dive 27 took place around Northwest Anacapa Island at depths ranging from 192 to 260 meters, using the ROV Beagle aboard the R/V Shearwater. A) *Paragorgia* sp. and sponge on rocky substrate. B) White vase sponge with crinoid. C) *Antipathes dendrochristos* and *Acanthogorgia* sp. with various benthic invertebrate. D) *Acanthogorgia* sp. with greenspotted rockfish, basket stars, California king crab, and squat lobster. E) *Antipathes dendrochristos* and small white sponges on rocky substrate. F) Cone shaped yellow sponge on rocky substrate.

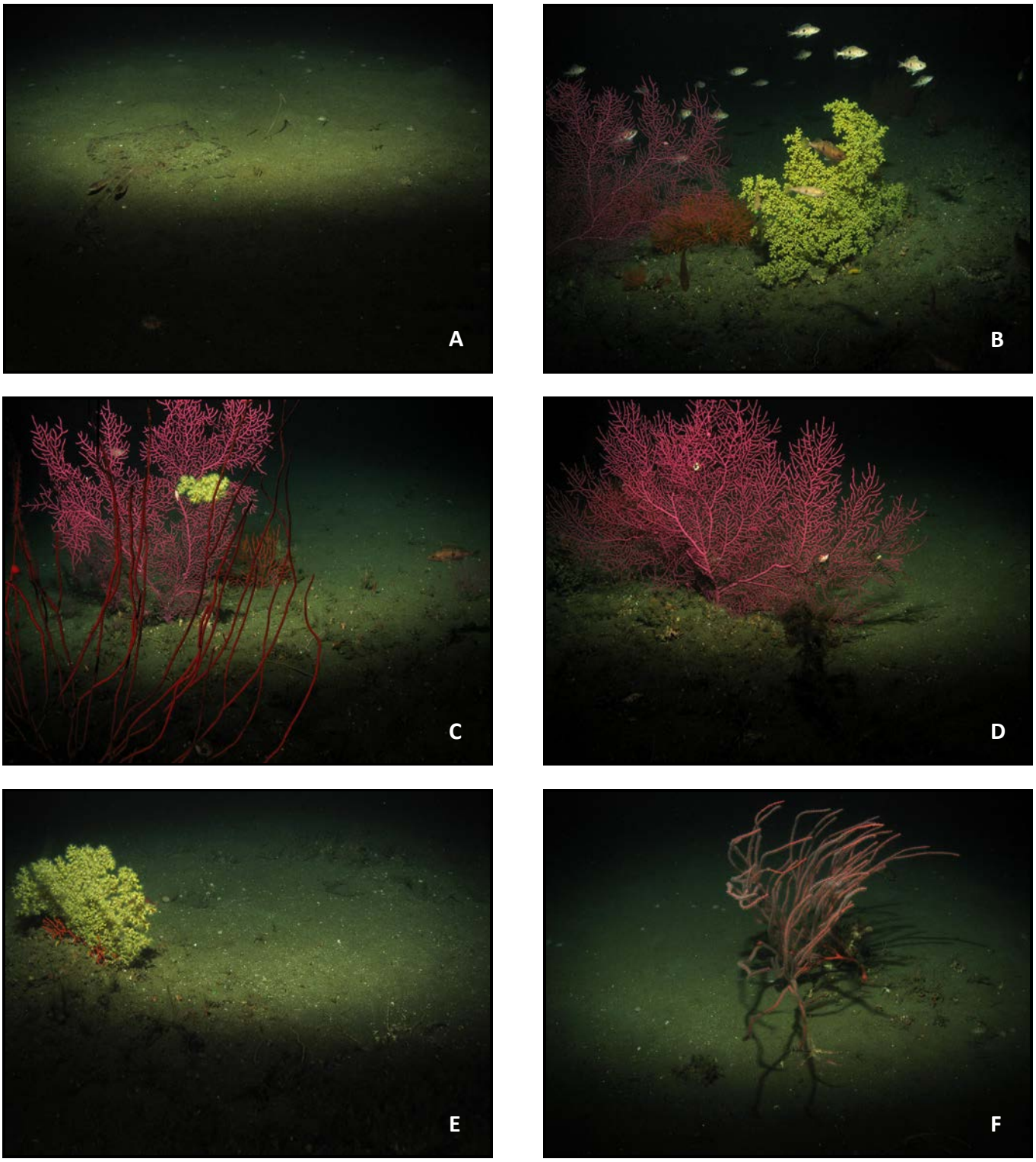
Dive 28 **SCS Site ID: AN1**
Start Coordinate: 34.02593, -119.42368 **End Coordinate: 34.02539, -119.42264**
Depth Range: 70-77 m **Bottom Time: 0 hours 18 minutes**



Map Caption. *The planned trajectory for ROV Dive 28 is shown as a gray dashed line, with the actual trajectory in black. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and side-scan imagery (in grey-scale).*

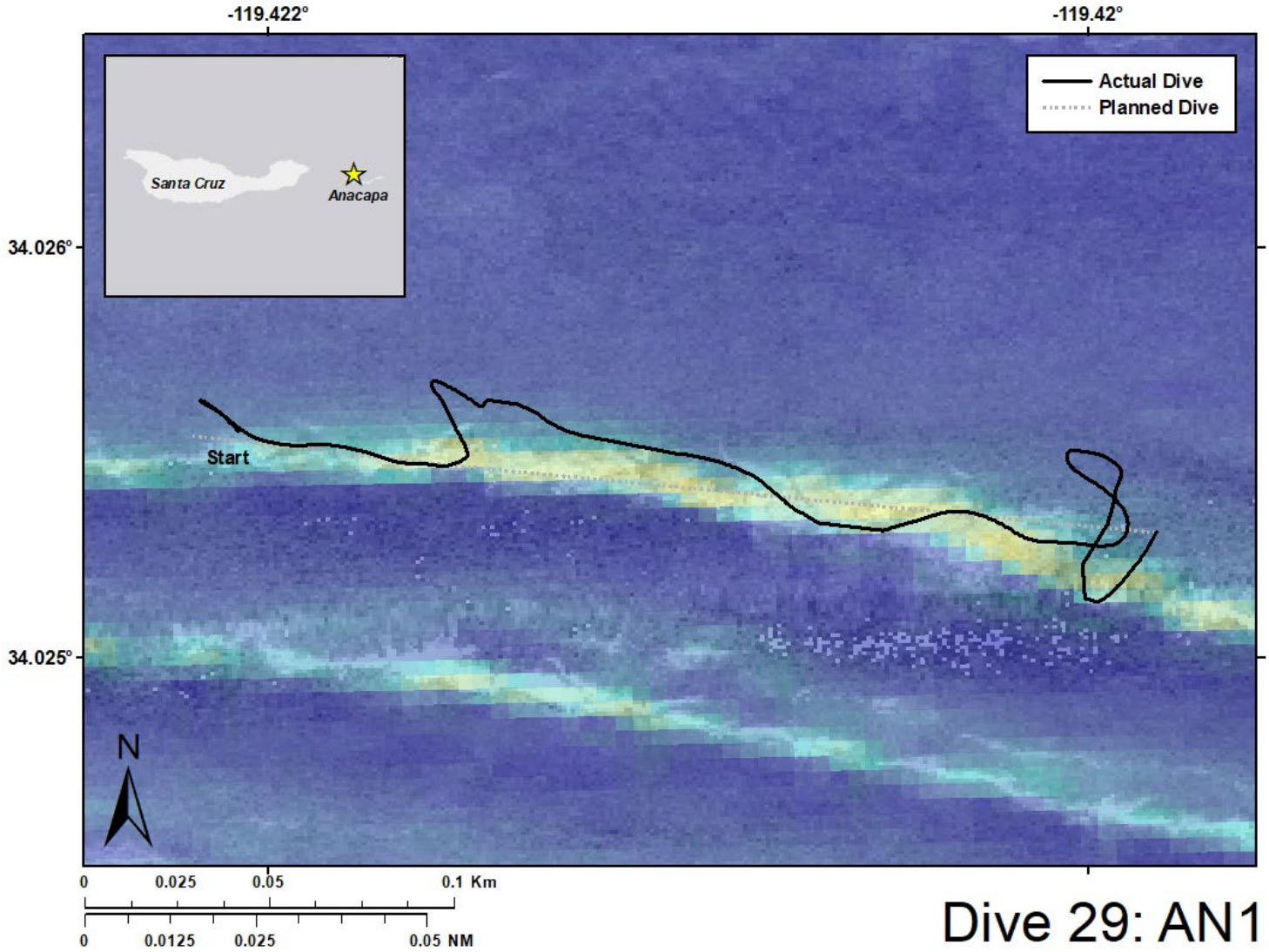
Dive Summary:
The twenty-eighth dive surveyed a site around Northwest Anacapa Island during a day trip by MARE over multibeam bathymetry from the NOAA ship *Rainier* in 2017. The dive was on bottom at 17:47 on June 14, 2019 UTC at a depth of 75 m and temperature of 10.2 °C. Dive duration was 18 minutes and had a minimum depth of 70 m. One transect was completed that was 12 minutes in duration.

The geology was comprised of sandy flat bottom alternating with periods of rocky bottom. Key species of corals included *Funiculina*/*Halipteris* sea pens, *Adelogorgia phyllosclera*, *Eugorgia rubens*, and *Leptogorgia chilensis.* Several of the *A. phyllosclera* and *E. rubens* colonies had zoanthid overgrowth and some of the *E. rubens* were observed with predatory snails. Flatfish, skates, lingcod, and flag and halfbanded rockfish were observed. Mobile invertebrates observed during the dive included sea urchins, sea cucumbers, sea stars, and brittle stars.



Dive 28 took place around Northwest Anacapa Island at depths ranging from 70 to 77 meters, using the ROV Beagle aboard the R/V Shearwater. A) Black skate on soft substrate with sea pen. B) Halfbanded rockfish with *Adelogorgia phyllosclera* colony and two *Eugorgia rubens* colonies, one of which is completely overgrown with zoanthids. C) *Leptogorgia chilensis* and *Eugorgia rubens* with zoanthid overgrowth. D) *Eugorgia rubens* with predatory snails on the colony. E) *Adelogorgia phyllosclera* with majority of colony covered in zoanthid overgrowth. F) *Leptogorgia chilensis* on mixed substrate with sea urchins.

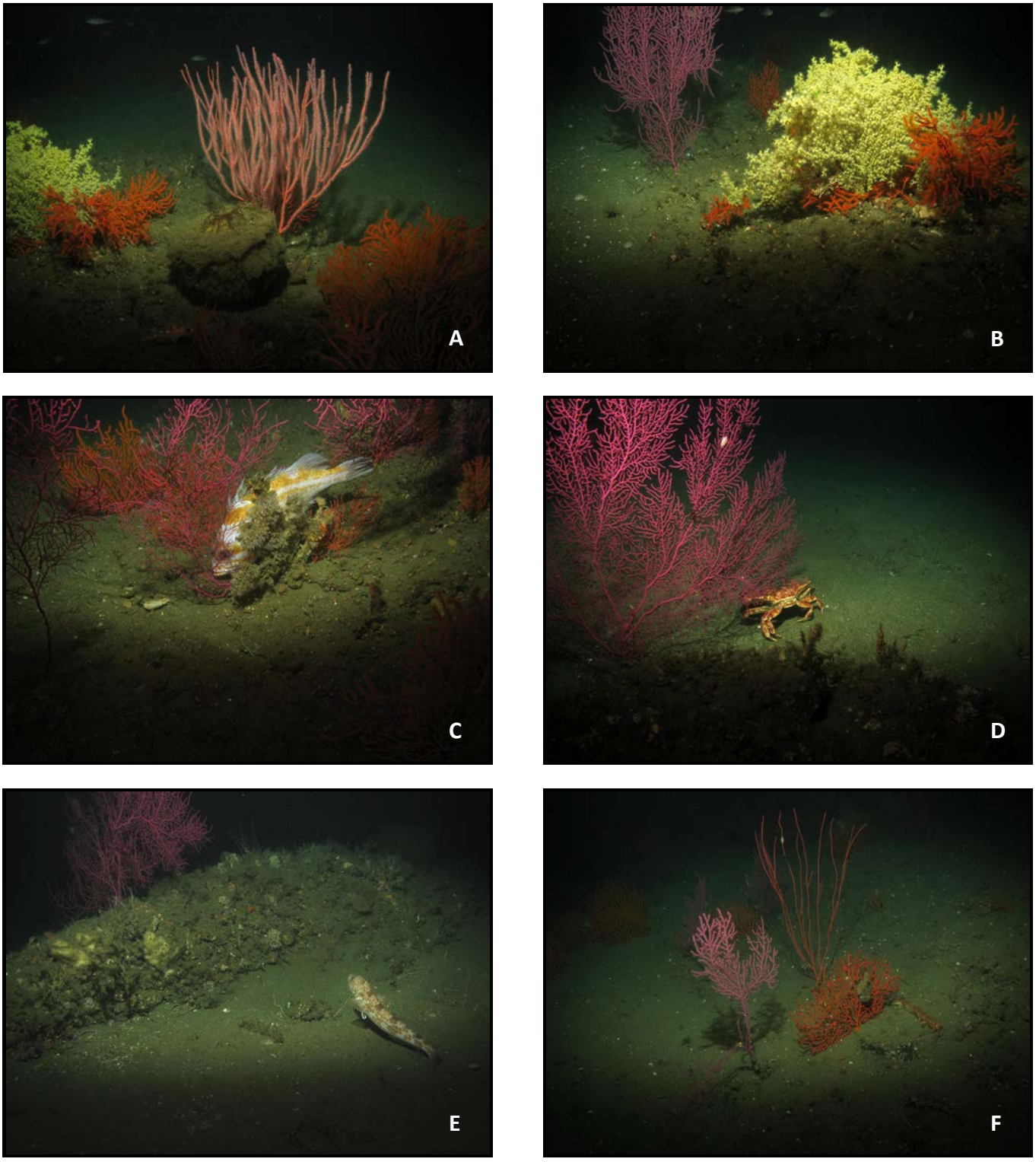
Dive 29 **SCS Site ID: AN1**
Start Coordinate: 34.02555, -119.42207 **End Coordinate: 34.02530, -119.41983**
Depth Range: 72-77 m **Bottom Time: 0 hours 33 minutes**



Map Caption. *The planned trajectory for ROV Dive 29 is shown as a gray dashed line, with the actual trajectory in black. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and side-scan imagery (in grey-scale).*

Dive Summary:
The twenty-ninth dive surveyed a site around Northwest Anacapa Island during a day trip by MARE over multibeam bathymetry from the NOAA ship *Rainier* in 2017. The dive was on bottom at 18:39 on June 14, 2019 UTC at a depth of 72 m and a temperature of 10.4 °C. Two transects were completed that were 15 and 16 minutes in duration.

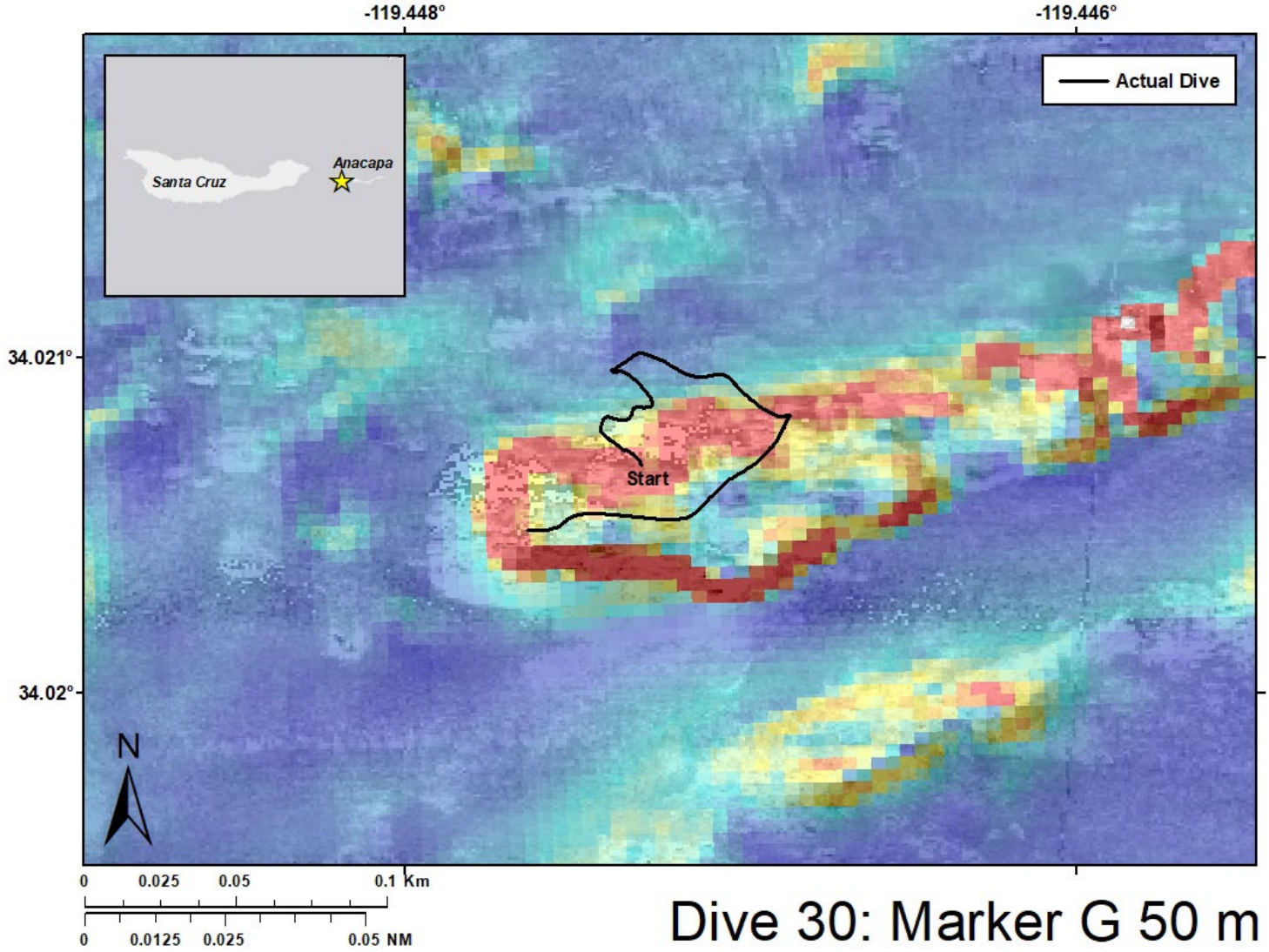
The geology consisted of flat bottom with periodic patches of rocky outcrops and boulders. Key species of corals were *Leptogorgia chilensis*, *Eugorgia rubens*, *Adelogorgia phyllosclera*, and cup corals on hard bottom, and *Funiculina/Halipteris* sp. on soft bottom. Several *E. rubens* and *A. phyllosclera* colonies had zoanthid overgrowth and some *E. rubens* colonies were observed with predatory snails. The rockfish present were halfbanded, honeycomb, copper, and flag. Other fishes included flatfish, lingcod, and California lizardfish. Mobile invertebrates observed during the dive included sea urchins, sea cucumbers, brittle stars, sea stars, red rock crabs, and squat lobsters.



Dive 29 took place around Northwest Anacapa at depths ranging from 72 to 77 meters, using the ROV Beagle aboard the R/V Shearwater. A) *Adelogorgia phyllosclera* colonies, one of which has zoanthid overgrowth and a *Leptogorgia chilensis* colony. B) *Adelogorgia phyllosclera* colony with zoanthid overgrowth and *Eugorgia rubens* colony. C) *Adelogorgia phyllosclera* and *Eugorgia rubens* with copper rockfish. D) *Eugorgia rubens* with a predatory snail on the colony and an adjacent crab. E) *Eugorgia rubens* on mixed substrate with lingcod. F) *Leptogorgia chilensis*, *Eugorgia rubens*, and *Adelogorgia phyllosclera*.

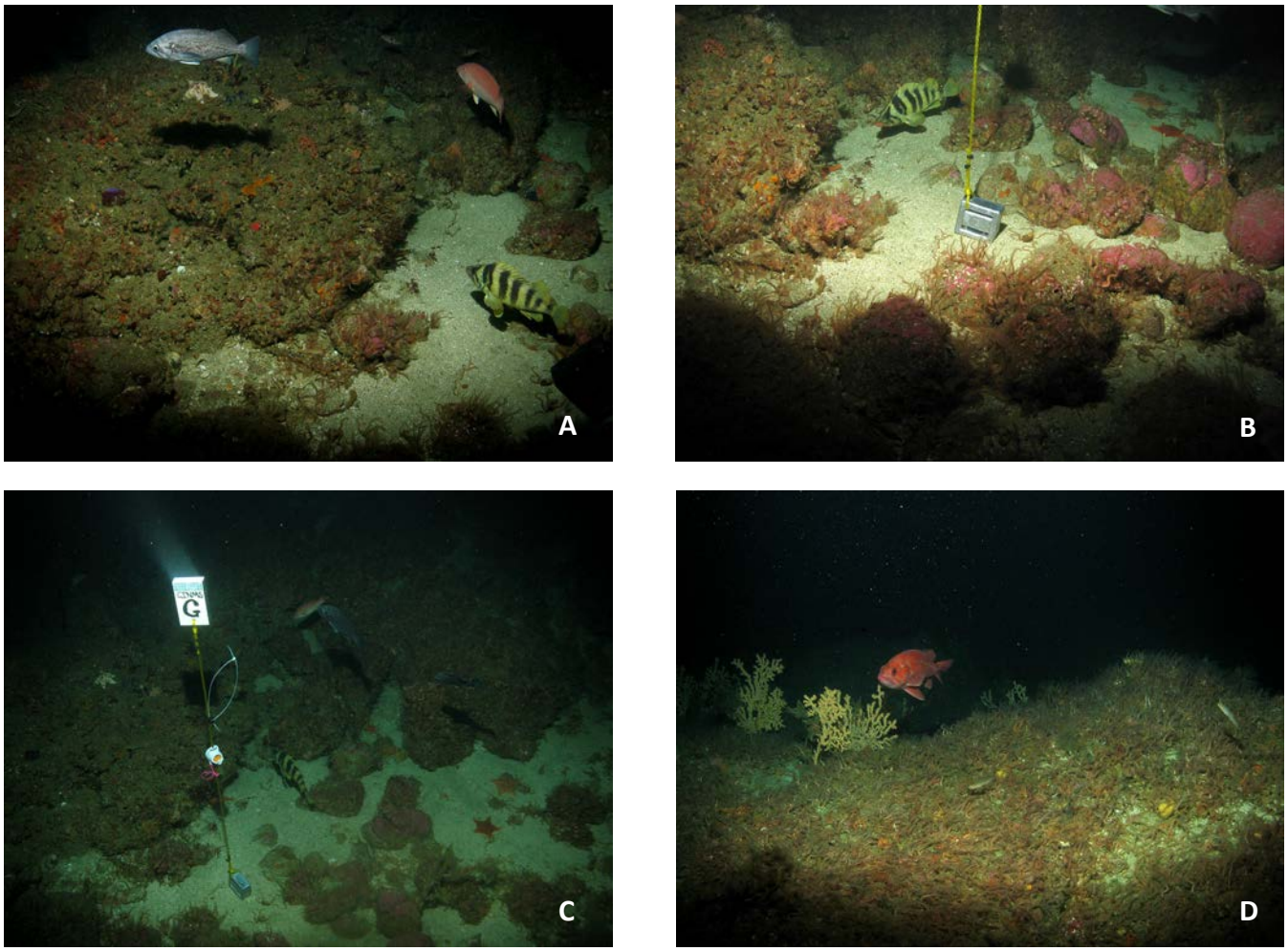
Dive 30
Start Coordinate: 34.02067, -119.44729
Depth Range: 39-50 m

SCS Site ID: Marker G 50 m
End Coordinate: 34.02048, -119.44763
Bottom Time: 0 hours 13 minutes



Map Caption. *The trajectory for ROV Dive 30 is shown as a black line. The map background is three layers- slope (in color, partially transparent, red = high slope), hillshade (in grey-scale, partially transparent), and side-scan imagery (in grey-scale).*

Dive Summary:
The thirtieth dive surveyed Northwest Anacapa Island over multibeam bathymetry from the NOAA ship *Rainier* in 2017 to deploy temperature logger G at 50 m depth. The ROV was on bottom at 20:15 on June 15, 2019 UTC at 39 m with a temperature of 13.0 °C. The dive was 13 minutes in duration. Temperature logger G was deployed at a depth of 50.8 m at 20:33 UTC (Latitude: 34.02093, Longitude: -119.44702) on soft substrate comprised of shell hash and sand next to a rocky outcrop. Only one key coral species, *Acanthogorgia* sp., was observed near the end of the dive. Rockfish species present were flag, treefish, vermilion, gopher, and blue. A California sheephead was also observed. Some marine debris was seen during the survey including a small metal hand net, a crab trap, and fishing line.



Dive 30 took place around Northwest Anacapa Island at depths ranging from 39 to 50 meters, using the ROV Beagle aboard the R/V Shearwater. A) Treefish, blue rockfish, and sheephead over mixed substrate. B) Temperature logger G weight and line deployed at 50.8 m next to treefish. C) Full view of temperature logger G deployed in an area of mixed substrate. D) Gorgonian with zoanthid overgrowth and vermilion rockfish.

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