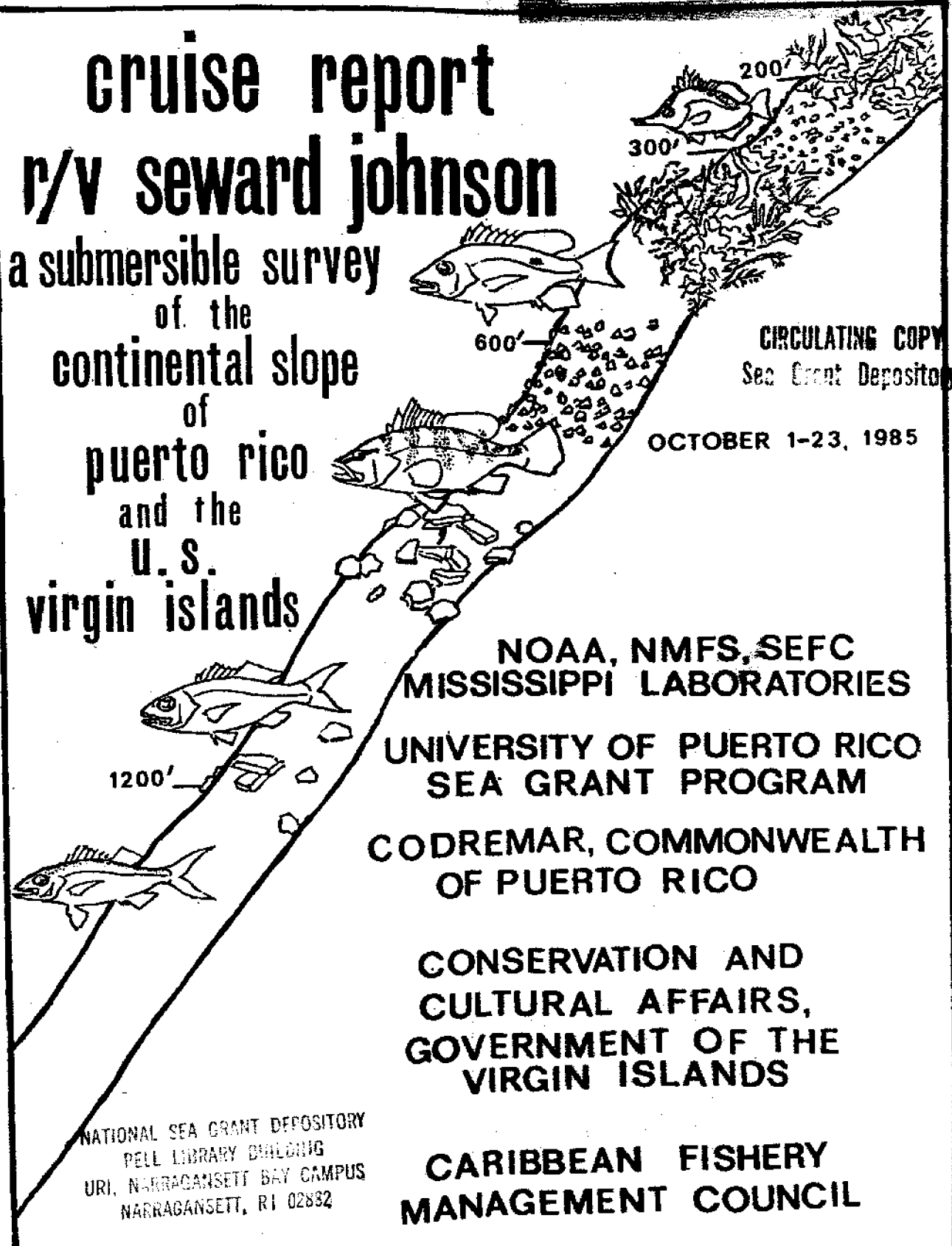


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CRUISE REPORT
R/V SEWARD JOHNSON
A SUBMERSIBLE SURVEY
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AND THE
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Submitted By:


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Co-Principal Investigator


Richard S. Appeldoorn
Co-Principal Investigator

Approved By:


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Southeast Fisheries Center


Director, Sea Grant Program
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Cruise Report R/V SEWARD JOHNSON
Puerto Rico and U.S. Virgin Islands
October 1-23, 1985

INTRODUCTION

A joint deepwater research cruise was conducted by the National Marine Fisheries Service, University of Puerto Rico Department of Marine Sciences and Sea Grant Program, CODREMAR of the Commonwealth of Puerto Rico, and the Department of Conservation and Cultural Affairs of the Government of the Virgin Islands. The cruise was based on an approved proposal for shallow-water submersible support submitted by NMFS and the University of Puerto Rico to the NOAA Office of Undersea Research entitled "Assessment of deepwater habitats and fauna and evaluation of passive assessment gears around Puerto Rico and the U.S. Virgin Islands." Support for the mothership R/V SEWARD JOHNSON and the research submersible JOHNSON SEA-LINK II of the Harbor Branch Foundation was provided by the NOAA Office of Undersea Research. The cruise was conducted in coordination with the NOAA Ship CHAPMAN with support provided by the Mississippi Laboratories of the National Marine Fisheries Service, the University of Puerto Rico, Sea Grant Program, CODREMAR of the Commonwealth of Puerto Rico, and the Caribbean Fishery Management Council. Thirty-one dives were made at 16 sites around Puerto Rico and the U.S. Virgin Islands in depths ranging from 758 m (2,500') to 36 m (120') to evaluate deepwater habitats and conduct transect and point counts on the reef fishes of commercial and recreational importance, to evaluate potential deepwater shrimp sites south of La Parguera, to evaluate effectiveness of deepwater fish and shrimp traps, to conduct bait attraction studies, to study deepwater corals and macroalgae, to evaluate fish attraction devices (FADs) deployed in May 1984, and to conduct shelf-slope calibration studies to relate ongoing work at the University of Puerto Rico to results from deepwater submersible transects. The NOAA Ship CHAPMAN made 5 traps sets and 4 bottom longline sets at each of 12 primary dive sites and deployed traps and longlines in support of the University of Puerto Rico deepwater trap and bait attraction studies.

OBJECTIVES

The purpose of this survey was to provide the first significant information on deepwater habitats, faunal assemblages and habitat associations of commercial and potentially commercial species around Puerto Rico and the U.S. Virgin Islands. Ultimate objectives were to provide information on the commercial potential of deepwater resources for the benefit of the Caribbean area fishing industry, to provide information on the impact of longlines and traps on those resources, and to aid the development of a deepwater resources management plan by the Caribbean Fishery Management Council. Specific objectives were to:

1. Categorize deepwater benthic habitats around Puerto Rico and the U.S. Virgin Islands in terms of bottom type, configuration, and cover.
2. Determine species complexes associated with each habitat type.
3. Provide quantitative abundance indices of commercial and potentially commercial fishes and invertebrates within each habitat.
4. Provide catch per unit effort data from trap and longline fishing for correlation with faunal indices within habitats and for historical comparison.
5. Determine effective fishing ranges of traps on deepwater fishes and invertebrates of commercial potential.
6. Evaluate the physical and biological factors which impact the effectiveness of fish traps in deepwater rocky and smooth habitats.
7. Compare stock densities, faunal components and biological characteristics between deepwater benthic habitats of the U.S. Caribbean, the U.S. South Atlantic coast and the northwestern Gulf of Mexico.
8. Evaluate fishing configurations and effectiveness of deepwater fish attraction devices deployed in 1984 off the U.S. Virgin Islands.
9. Provide an assessment of the abundance and distribution of deepwater black and bamboo corals and benthic macroalgae around Puerto Rico and the U.S. Virgin Island.
10. Add to the biological knowledge of the deepwater fishes and invertebrates in the Caribbean area.

SCIENTIFIC PERSONNEL

Walter R. Nelson	Co-Principal Investigator	NMFS, SEFC, Mississippi Laboratories
Richard S. Appeldoorn	Co-Principal Investigator	University of Puerto Rico, Department of Marine Sciences
David L. Ballantine	Investigator	University of Puerto Rico, Department of Marine Sciences
Ileana E. Clavijo	Investigator	Department of Conservation and Cultural Affairs,

Charles E. Cutress	Investigator	Government of the Virgin Islands
Carlos Goenaga	Investigator	University of Puerto Rico, Department of Marine Sciences
Elmer J. Gutherz	Investigator	University of Puerto Rico, Department of Marine Sciences
Dannie A. Hensley	Investigator	NMFS, SEFC, Mississippi Laboratories
Joseph J. Kimmel, III	Investigator	University of Puerto Rico, Department of Marine Sciences
David Nellis	Investigator	CODREMAR, Commonwealth of Puerto Rico
		Department of Conservation and Cultural Affairs, Government of the Virgin Islands
G. Michael Russell	Field Party Chief, NOAA Ship CHAPMAN	NMFS, SEFC, Mississippi Laboratories

ITINERARY AND ACTIVITIES

The R/V SEWARD JOHNSON arrived at Mayaguez, Puerto Rico on September 30 and was met by investigators from the NMFS and the University of Puerto Rico.

September 30 - Investigators Nelson, Gutherz, Hensley and Appeldoorn boarded the R/V SEWARD JOHNSON in Mayaguez and remained aboard until completion of the cruise on October 23.

October 1 - The R/V SEWARD JOHNSON departed Mayaguez at 6:00 am and proceeded to Site 1 (JOHNSON SEA-LINK II dives 1163 and 1164) which were population transect and point count dives (Fig. 1, Table 1).

October 2 - JOHNSON SEA-LINK II dives 1165 and 1166 were conducted at Site 2 for population transect and point counts (Fig. 1, Table 1).

October 3-12 - All dives during this time frame were conducted south of La Parguera, Puerto Rico at Site 3. A deepwater population transect and point count dive (#1167) was completed on the morning of October 3. Vessel problems terminated activities on the afternoon of October 3 and October 4. On October 5, one dive (#1168) was conducted to observe deepwater shrimp and fish traps. Severe weather terminated all activities through October 7 and the R/V SEWARD JOHNSON was forced to seek shelter in

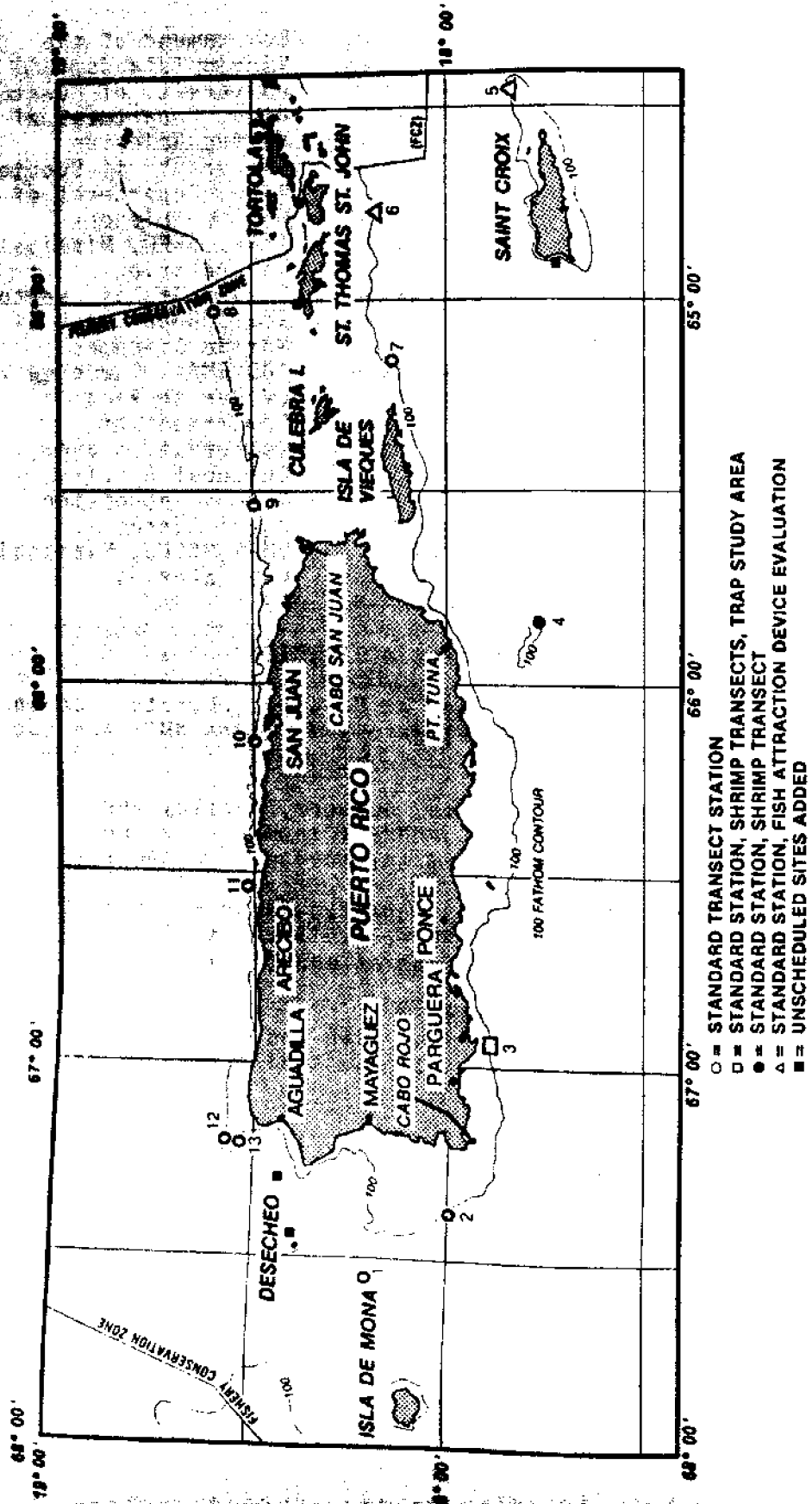


Figure 1. Sites for deep-water habitat and faunal studies with the Research Submersible Johnson Sea-Link II around Puerto Rico and the U.S. Virgin Islands, Oct. 1-23, 1985.

Table 1.

JOHNSON SEA-LINK II DIVE SUMMARY

Dive#	Date	Forward Pilot/Observer	Dive Chamber Diver/Observer	Depth Range in ft.	N. Lat.	W. Long.	Trans.	Photo.	Video	Traps, Seis.
1163	10-1-85	Hall/W. Nelson	S. Nelson/Hensley	1,290-985	18°13.66'	67°35.27'	X	X	X	
1164	10-1-85	Hall/Gutherz	S. Nelson/Appeldoorn	1,110-240	18°14.29'	67°36.16'		X	X	
1165	10-2-85	Askew/Hensley	Moore/Gutherz	1,325-270	17°59.58'	67°23.49'	X	X	X	
1166	10-2-85	Askew/W. Nelson	Moore/Appeldoorn	965-150	17°58.89'	67°23.80'		X	X	
1167	10-3-85	Hall/Gutherz	Sullivan/W. Nelson	2,208-1,785	17°52.73'	66°54.55'	X	X	X	
1168	10-5-85	Askew/Hensley	S. Nelson/Appeldoorn	800	17°53.86'	66°54.58'				X
1169	10-8-85	Askew/Hensley	Moore/Appeldoorn	1,580-1,390	17°53.65'	66°55.20'	X	X	X	X
1170	10-8-85	Hall/Appeldoorn	Moore/Hensley	1,740-1,425	17°53.59'	66°54.71'		X	X	X
1171	10-9-85	Hall/Hensley	Sullivan/Appeldoorn	2,505-2,390	17°52.82'	66°53.69'	X	X	X	X
1172	10-9-85	Hall/Hensley	Sullivan/Appeldoorn	2,475-2,325	17°52.67'	66°54.11'	X	X	X	X
1173	10-10-85	Askew/Appeldoorn	S. Nelson/Hensley	2,320	17°53.28'	66°53.62'		X	X	X
1174	10-10-85	Askew/Kimmel	S. Nelson/Ballentine	400-110	17°54.77'	66°53.21'	X	X	X	
1175	10-11-85	Hall/Ballentine	Moore/Goenaga	725-297	17°53.90'	66°54.71'	X	X	X	
1176	10-11-85	Hall/Kimmel	Moore/Goenaga	400-100	17°54.77'	66°53.21'	X	X	X	
1177	10-12-85	Askew/Goenaga	Sullivan/Ballentine	700-70	17°54.59'	66°53.52'	X	X	X	
1178	10-12-85	Askew/Hensley	Sullivan/Appeldoorn	2,398	17°52.74'	66°54.32'	X	X	X	
1179	10-13-85	Hall/W. Nelson	S. Nelson/Gutherz	1,590-200'	17°47.31'	65°54.54'	X	X	X	

Table 1 Continued

Dive#	Date	Forward Pilot/Observer	Dive Chamber Diver/Observer	Depth Range in ft.	N. Lat.	W. Long.	Trans.	Photo.	Video	Traps, Bait	Coll.
1180	10-15-85	Askew/Gutherz	S. Nelson/Hensley	1,730-140	18°10.65'	64°46.20'	X	X	X		
1181	10-15-85	Askew/Russell	S. Nelson/Clavijo	1,700-200	18°10.65'	64°46.20'		X	X		X
1182	10-16-85	Hall/Hensley	Moore/W. Nelson	1,425-100	17°49.88	64°25.60'	X	X	X		
1183	10-16-85	Hall/Clavijo	Moore/Russell	1,980-130	17°43.42	64°54.61'		X	X		X
1184	10-17-85	Askew/W. Nelson	Sullivan/Gutherz	1,515-150	18°06.72'	65°11.75'	X	X	X		
1185	10-17-85	Askew/Clavijo	Sullivan/Locke	140-100	18°23.76'	64°59.11'		X	X		X
1186	10-20-85	Hall/Gutherz	Moore/Hensley	1,675-950	18°31.47'	66°10.56'	X	X	X		
1187	10-20-85	Hall/W. Nelson	Moore/Appeldoorn	1,120-750	18°30.55'	66°10.47'	X	X	X		
1188	10-21-85	Askew/Hensley	S. Nelson/W. Nelson	1,170-300	18°35.42	67°14.14'	X	X	X		
1189	10-21-85	Askew/Appeldoorn	S. Nelson/Clavijo	2,490-2,260	18°26.82'	67°14.60'	X	X	X		
1190	10-22-85	Hall/W. Nelson	Sullivan/Costa	1,375-270	18°32.79'	67°13.64'	X	X	X		
1191	10-22-85	Askew/Gutherz	Sullivan/Roden	1,565-270	18°22.28'	67°29.68"	X	X	X		
1192	10-23-85	Hall/Hensley	Moore/Appeldoorn	1,280-350	18°29.50'	65°33.59'	X	X	X		
1193	10-23-85	Askew/Gutherz	Moore/Clavijo	1,500-300	18°35.27'	65°03.78'	X	X	X		

Guanica Harbor. At this time, the Managing Director of the Harbor Branch Foundation came to Guanica to assess the situation and provided an additional operations day for the loss of October 4. From October 8 to 10, 5 deepwater dives were made (#1169-1173) to conduct deepwater shrimp transects and shrimp and fish trap and bait attraction studies. An additional deepwater shrimp transect and bait attraction study dive (#1178) was run on the afternoon of October 12. Horizontal upper-slope fish transects were run on the afternoons of October 10 and 11 (#1174 and 1176). Algae and coral dives were made on October 11 and 12 (#1175 and 1177).

October 13-14 - One dive (#1179) was made on Grappler Seamount at Site 4 for population transects and point counts. The R/V SEWARD JOHNSON departed for a port call in Charlotte Amalie, St. Thomas, arriving there the evening of October 13, and staying in port through the night of October 14. Personnel from the Department of Conservation and Cultural Affairs of the Government of the Virgin Islands (Clavijo and Nellis) joined the vessel during this port call.

October 15-16 - Attempts to locate previously deployed FADs off of St. Thomas and St. Croix utilizing the scanning sonar aboard the NOAA Ship CHAPMAN were unsuccessful and that portion of the scheduled activities was not undertaken. Population transects and point counts and collection dives were made south of St. Thomas at Site 6 on October 15 (#1180 and 1181). Dive #1182 was made during the morning of October 16 at Site 5 for population transects and point counts on the east end of St. Croix. A scheduled afternoon dive (#1183) was shifted to the west end of St. Croix due to high winds.

October 17-19 - The morning population transect and point count dive (#1184) was made east of Isla De Vieques, at Site 7. A scheduled afternoon dive (#1185) was moved to a shallow area on the north shore of St. Thomas, again because of strong winds and high seas. Severe weather forced cancellation of scheduled activities on October 18 and 19 with the R/V SEWARD JOHNSON anchoring near Cabo San Juan on the night of October 18 and making a port call in San Juan on October 19.

October 20 - Two dives (#1186 and 1187) were made just northwest of the entrance to San Juan Harbor at Site 10 with the second dive terminated early because of poor visibility.

October 21-22 - Site 11 was not sampled because of lost time experienced earlier due to heavy seas. Transects and point counts (#1188) were taken at Site 12 on the morning of October 21. Dive #1189 was made on the afternoon of October 21 between Site 12 and Isla Desecheo to conduct deepwater shrimp transects for comparison with similar transects at Site 3. A population

transect and point count dive (#1190) was made at Site 13 on the morning of October 22. High seas were again experienced that afternoon and a population transect and point count dive (#1191) was made in the lee of Isla Desecheo. Following the afternoon dive, the R/V SEWARD JOHNSON and the NOAA Ship CHAPMAN steamed to Mayaguez to off-load specimens for the University of Puerto Rico and video tapes for transit to Pascagoula, Miss. aboard the NOAA Ship CHAPMAN. After a 3-hour period in port, the R/V SEWARD JOHNSON departed Mayaguez and proceeded along the north shore of Puerto Rico towards St. Thomas.

October 23 - A morning population transect and point count dive (#1192) was made at Site 9 and a similar afternoon dive (#1193) was made at Site 8 since those stations had been missed during previous inclement weather periods. Following completion of dive #1193 on the afternoon of the 23rd, the R/V SEWARD JOHNSON proceeded to port at Charlotte Amalie, terminating the mission.

RESULTS

A summary of results from each dive is given below. The investigator in the forward compartment of the JOHNSON SEA-LINK II was responsible for the write-up of each individual dive, and emphasis in the write-ups varies with the objectives and interest of the investigator. An attempt has been made to standardize the individual dive reporting format, but some variation in approach is expected. Conductivity values listed in the depth-temperature-conductivity profiles given for some of the dives are incorrect, but can be converted to correct readings when calibration standards are obtained from the Harbor Branch Foundation.

Dive #1163

General Locality - Twenty nm west of Mayaguez, Puerto Rico; Site I in proposal. The site was selected as one of a series of different habitat types to evaluate varying habitats and to estimate populations of fishes, principally commercial, by depth and habitat type around Puerto Rico and the U.S. Virgin Islands. See Table 1 for location and other station data.

Objectives - To conduct population transects and point estimate counts of fishes and invertebrates by depth and habitat type.

Depth - 391 m - 298 m (1,290' - 985').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Surface	29.80	-

100	29.10	78.78
200	26.70	81.05
300	24.91	80.48
400	24.18	80.01
500	23.40	79.67
600	20.49	78.70
700	19.24	76.39
800	18.93	75.74
900	18.43	75.61
1,000	17.00	74.56
1,100	16.04	73.73
1,200	15.08	72.68
1,290	14.73	72.21 Bottom

Visibility - Estimated by submersible pilot as 15 m (50') at 1,290', decreasing to about 7.5 m (25') at 1,000'.

Current - 0.1 kn at 1,290', increasing to 0.4 kn at 1,100' and decreasing to 0.1 kn at 985'.

Observations - JOHNSON SEA-LINK II reached bottom at 1,290' in an area that was extremely rocky and rugged. Large boulders and sheer walls of 20'-40' in height made transecting difficult because of the need to maneuver the submersible over and around the rocks and walls. Narrow channels between the rocks were filled with sand containing 3"-4" ripple patterns indicating at least periodic current flows up or down the steep slopes. Initial slope angle was 75°-80°, decreasing gradually to 10°-15° at the start of the dive (1,290'). The habitat changed from rugged rock boulders to a smoother sand-rock habitat at about 1,000'. Fauna at those depths was depauperate. Few commercial fishes were seen and the large number of small cryptic species usually found around tropical, rocky slopes was not sighted. Five population transects and six point counts were made between 1,290' and 985'. Few invertebrates were sighted. Two types of deepwater corals, along with numerous small, flat sponges were seen. The low biota at this site is supported by low catches made on NMFS vessels working this area over the past 5 years.

Dive #1164

General Locality - Same as #1163

Objectives - Complete population transects and point estimate counts between 900' and 240'; further documentation of habitat; and biological collections.

Depth - 336 m - 73 m (1,110' - 240').

Visibility - Estimated by submersible pilot as 15 m (50').

Current - 0.2 kn on bottom; increasing throughout the dive to 1.0 km on top of the wall.

Observations - This dive operated throughout its entirety along a wall face between 240' and 1,110'. No fish and few invertebrates were observed along the wall which appeared to be subjected to strong currents. Fishes were noted in crevices and indentations which formed plateau-like structures. Within these "plateaus" limestone-like rock was often seen in which smaller finfish were noted. Current was a problem throughout the dive; it prevented the collection of biological material and severely impacted our ability to obtain detailed video and photographic records.

Dive #1165

General Locality - In Mona Passage off Cabo Rojo, Puerto Rico; Site 2 in proposal. See Table 1 for location and other station data.

Objectives - Population transects and point estimate counts of fishes and invertebrates by depth and habitat type.

Depth - 402 m - 82 m (1,326' - 270').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
100	28.92	81.70
200	27.71	82.02
300	24.75	81.50
400	23.76	80.46
500	22.39	79.93
600	20.10	79.12
700	18.75	77.31
800	18.02	76.35
900	17.57	75.66
1,000	17.25	75.26
1,100	17.15	75.01
1,200	16.44	74.58
1,300	15.41	73.75
1,325	14.55	72.64 Bottom

Visibility - Estimated by submersible pilot as 15 m (50') at start of dive to 45 m (150') at shallower depths.

Current - Nil for most of the dive; some current noticeable near end of dive but not measured.

Observations - Six transects and seven point counts were made between 402 m (1,325') and 82 m (270'). Transect lengths were

determined by bottom habitat and contour. Bottom slope varied from 10° to 60°, with the greatest angle occurring along the last transect between 154 m (509') and 82 m (270'). Habitat varied from sand-mud on deeper transects to sand-rock and rocky-steep slopes between 177 m (583') and 82 m (270'). Invertebrate mounds and trails were observed on sand-mud bottoms. A bottom sample was taken at 402 m (1,325').

Argentinids were fairly abundant on the 364-m (1,200') to 303-m (1,000') transect. They were stunned by the submersible lights and one specimen was collected. Two lutjanid specimens were observed between 263 m (867') and 182 m (600'); they were also stunned by the submersible lights and began developing a color pattern of red bars. Xanthichthys ringens was the most abundant species observed during the dive and was first observed at ca. 177 m (583'); we continued seeing them to the shallowest depth, 82 m (270'). All individuals observed were closely associated with holes in the substrate. Caranx lugubris? showed a great deal of interest in the submersible from 364 m (1,200') to 82 m (270'). One individual ran into a light on the front of the submersible, suffering some injury and bending the light.

Specimens of a carrier shell, sea urchin, and sea whip were collected.

Dive #1166

General Locality - Same as #1165.

Objectives - Define habitat from 273 m (900') to 91 m (300') along the southwestern wall of Puerto Rico. Make scientific collections, develop species list, and document species and habitats with video and still cameras.

Depth - 292 m - 46 m (965' - 150').

Visibility - Estimated by submersible pilot as 15 m (50') to 21 m (70').

Current - No current at 292 m (965'); 0.2-0.3 kn at 152 m (500') and increasing to near 1.0 kn at 62 m (200'); current from the east.

Observations - The topography between 292 m (965') and 264 m (870') was sandy silt with scattered rocks which were then absent in the substrate until a depth of 245 m (810'). The initial slope was 10°-12°, gradually increasing to 35°-40° at a depth of about 212 m (700'). A rubble and dead coral zone extended from about 182 m (600') to 152 m (500') from which the rock wall rose almost vertically. Sea fans, and "typical" reef fishes were seen from about 152 m (500') to the termination of the dive at 46 m

(150'). No large corals were noted along the sheer wall, although both topography and current seemed ideal. Substantial numbers of the smaller reef fishes were seen, along with grouper, snapper, and jacks between 182 m (600') and 46 m (150'). All habitats and many dominant fishes were videotaped and photographed.

Dive #1167

General Locality - South coast of Puerto Rico off Guanica; Site 3 in proposal. See Table 1 for location and other station data.

Objectives - Population transects and point estimate counts of fishes and invertebrates by depth and habitat type.

Depth - 670 m - 541 m (2,208' - 1,785').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Surface	28.80	81.38
100	28.81	81.16
200	27.04	81.20
300	25.29	81.40
400	24.21	80.61
500	22.32	79.92
600	20.69	78.73
800	17.89	77.33
930	17.08	77.25
1,000	16.50	74.88
1,100	16.50	74.45
1,200	15.93	74.11
1,300	15.19	73.63
1,440	14.17	72.67
1,500	13.64	72.32
1,600	12.97	71.58
1,700	11.76	70.86
1,800	11.20	70.05
1,900	10.59	69.21
2,000	10.24	68.85
2,100	9.74	68.50
2,207	9.25	67.65 Bottom

Visibility - Estimated by submersible pilot as 18 m (60') throughout dive.

Current - Nil throughout dive.

Observations - This was a most interesting dive as we made one of the deepest dives of the trip. Starting at 670 m (2,208'), we

encountered a richer finfish and invertebrate fauna than anticipated. Not only was the benthic biota fertile, the water column below about 91 m (300') also displayed an abundance of marine organisms. This meso-pelagic fauna remained throughout the water column, then decreased in abundance about 61 m (200') above the bottom.

Five 100 meter transect and six point estimates were made during the dive. Several interesting and possibly a new fish species were videotaped along with many invertebrate species.

The bottom was of a mud-sand habitat upon which were numerous mounds, depressions, troughs, and burrows. "Finfish and invertebrate" burrows were observed throughout the dive and ranged from small to large, single to numerous. Invertebrate trails were noted throughout the dive with many produced by sea urchins.

Videotapes were made of unusual animals and their movements including: red lobsterette (Eunephropsis bairdii); giant isopod (Bathynomus giganteus); deepwater shrimp (Glyphocrangon sp.); crab (Parapagurus pilosimanus) with a colonial zoanthid (Epizoanthus paguriphilus) as its shell, deep sea shark (Etmopterus hilliianus); halosaurid eel clearly showing the whip-like action of the posterior, third of the body used in swimming; beard fish (Polymixia nobilis) showing the "walking" motion of the barbels as the animals swims; and an unrecognized Ophioform fish.

The Bathnomus, contrary to popular belief, was not nestled in the substrate nor was it sluggish in its movement. As the submersible approached the specimen it jumped several inches off the bottom and moving its pleuropods, it quickly swam off, away from the submersible. Many videotaped species appeared to be stunned by the lights from the submersible thereby allowing themselves to become video taped.

Throughout the dive the habitat was unchanged; however, the slope increased from 10° to 30°.

Dive #1168

General Locality - See dive #1167.

Objectives - Trap observations after a 3.5-hr soak; and a series of horizontal transects.

Depth - 242 m (800').

Visibility - Estimated by submersible pilot as 15 m (50').

Current - Appeared to be fairly strong to the west but was not measured.

Observations - The bottom was sand and silt with some small Invertebrate mounds and trails, and dead conch shells and echinoderm tests. Slope of the bottom was ca. 15°-20°. At ca. 226 m (745') some rock outcroppings and one very large boulder were seen.

We had some difficulty locating the pinger attached to the buoy line. Shortly after finding the traps, we became entangled in the floating mainline. We freed the submersible by maneuvering, but when attempting to follow the lines a second time, we again became entangled. This time, two lines were cut to free the submersible. After freeing the submersible, no forward thrust was available and the dive was aborted. Free segments of the cut line were found in three thrusters upon our return to the SEWARD JOHNSON.

The traps apparently were not set in a straight line on the bottom as much of the line between traps was tangled and floating. Only one shrimp trap was located.

Little biological activity was seen around the one shrimp trap found. It was burlap covered which prevented our seeing inside it.

While on the bottom there were always a few Seriola rivoliana? in sight. One lutjanid was seen which appeared to be stunned by the submersible lights and began displaying a color pattern of red bars.

No fishes were seen on the descent except the Seriola near the bottom. Near the surface on our ascent we observed about 14 Coryphaena hippurus which were ca. 1 m in length.

Dive #1169

General Locality - See dive #1167.

Objectives - Trap observations on shrimp and fish traps after ca. 30-hr soak; and a series of horizontal transects at ca. 425 m (1,394').

Depth - 479 m - 421 m (1,580' - 1,390').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Surface	28.13	80.76
40	28.21	80.85
75	28.29	81.03
100	28.48	81.10
150	28.47	80.87
200	28.47	80.31
300	24.78	80.62
400	23.10	80.39
500	21.83	79.52
600	19.53	78.58
700	18.42	77.27
800	17.60	76.25
900	17.12	75.44
1,000	16.89	74.93
1,100	16.24	74.59
1,200	15.88	74.10
1,337	14.21	73.32
1,400	13.36	72.24
1,421	13.57	72.26
1,476	12.86	71.14
1,500	12.90	71.24 Bottom

Visibility - Estimated by submersible pilot as 15 m (50').

Current - 0

Observations - The water was very murky and green from the surface to a depth of about 18 m (60').

At about 383 m (1,265') abundant midwater fishes (sternoptychids, paralepidids, and chauliodontids) began to appear and remained with us to the bottom. Gonostomatids and myctophids probably were present but could not be positively identified. A species of trichiurid (Benthodesmus) appeared near the bottom. Most individuals of this species were seen positioned (head up) vertically in the water column. Usually the only movements they made were periodic flicks of the caudal fin. Most individuals were ca. 18" in TL.

The bottom was silty sand (an occasional large rock was noted) with some invertebrate mounds, burrows, and trails. The slope was ca. 10°-15°.

During horizontal transects and searching for traps, the benthic fishes most commonly encountered were Polymixia nobilis, Poecilopsetta albomarginata, Chaunax sp., Cyttopsis roseus, Etmopterus hillianus, a species of Peristediidae, and a synodontid-like fish. Videotape footage was taken of a fish that was probably Epinnula magistralis. A paralepidid, peristediid and

a specimen of Cyttopsis roseus were collected. One Bathynomus was seen sitting on the bottom at 479 m (1,580').

Dive #1170

General Locality - See dive #1167.

Objectives - Observe bottom longline for bait preference experiment and documentation/collection of fauna and habitat.

Depth - 527 m - 432 m (1,740' - 1,425').

Visibility - estimated by submersible pilot as 15 m (50').

Current - No detectable current.

Observations - Surface waters had very poor visibility with much floating plant debris as a result of recent heavy rains and runoff. Water was clear at 30 m (100'). At 61 m (200') there was an increase in the amount of flocculant material suspended in the water. This condition remained throughout the descent. At 394 m (1,300') sternoptychids, small silver fishes, and small shrimps were noted. By 455 m (1,500'), gempylids were observed and biological activity increased until bottom was reached at 527 m (1,740'). Moving away from the area where we first reached bottom, the level of biological activity seemed to decrease.

The primary goal was to locate and observe a bottom longline with various types of bait; however, the bottom longline was not found. The remainder of the dive was spent documenting the habitat, characteristic species, filming shrimp and unusual fishes, and investigating burrows.

Bottom appeared to be a silt-clay flat with a slope of 15°, and characterized by a host of depressions, burrows of various types and sizes, and invertebrate mounds. Most burrows showed no signs of life, although some indicated recent excavation. One small eel-like fish was observed darting into a small burrow. Galatheid crabs were abundant, of which a few were seen backing down or sitting in small, finger-sized, vertical burrows. Several observations were made of Plesionika longipes standing in front of burrows, but there was no indication that they were responsible for their formation. A large Bathynomus surrounded by several Plesionika sp. was observed sitting in a channel leading to a large horizontal burrow. However, it did not appear that the burrow was constructed or used by the Bathynomus.

Several shrimp were documented on film: two Plesionika species, one tentatively identified as P. longipes, and two penaeid shrimps, one being Aristeus antillensis. These latter two species were prevalent on the bottom and were the

dominant shrimp caught in subsequent bottom trawls. They had not been observed in previous trap catches. One other very small, red penaeid shrimp, characterized by very long white antennae, was observed but not documented. This species was very abundant and usually observed swimming off-bottom. Film records were also made of a macrourid and a small red octopus, possibly a pelagic species, found curled up on the bottom.

Dive #1171

General Locality - See dive #1167.

Objectives - Trap observations after a 4 hr soak; horizontal transects at a depth of 727 m (2,400').

Depth - 760 m - 724 m (2,505' - 2,390').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Surface	28.39	82.11
100	28.55	81.72
200	27.32	81.04
300	25.16	80.41
400	23.40	80.18
500	21.80	79.53
600	19.79	78.41
700	18.70	77.40
800	17.87	76.43
900	17.34	75.76
1,000	17.68	75.31
1,100	17.30	74.90
1,200	16.66	74.45
1,300	15.73	74.07
1,400	13.22	73.48
1,500	13.89	72.82
1,600	12.92	71.83
1,700	12.69	71.11
1,800	11.98	70.22
1,900	11.25	69.80
2,000	10.72	69.29
2,100	10.25	68.67
2,200	9.75	68.32
2,300	9.45	67.89
2,400	9.34	67.49
2,505	8.88	66.81 Bottom

Visibility - Estimated by submersible pilot as 15 m (50').

Current - 0.3 kn

Observations - The layer of green water noted in dives 1169 and 1170 was not apparent on this dive. The bottom was sandy silt with numerous mounds, burrows, and tracks. The slope was 10°-15°.

On the descent, sternoptychids began appearing at 414 m (1,365'); and paralepids at 694 m (2,290'). Midwater fishes became more abundant and active at ca. 538 m (1,775'); this activity continued to the bottom. Sternoptychids were not as numerous near the bottom. Groups positively identified near the bottom were chauliodontids and paralepids.

General observations and transect counts indicated a species of halosaurid eel as the most abundant benthic species at this station. Other fishes encountered were Chaunax sp., peristediids, macrourids, argentinids, bathypteroids, and a fish that had the general appearance of a synodontid (maybe Parasudis). On two occasions an unidentified species of fish was observed to hang head down in the water column ca. 2 m (6.6') off the bottom. Several Bathynomus were seen.

Although a pinger had been placed on the buoy line, the traps could not be located.

Dive #1172

General Locality - See dive #1167.

Objectives - Trap observations after a 12-hr soak; make a vertical transect on descent; horizontal transects at ca. 727 m (2,400'); and collect and videotape organisms.

Depth - 750 m - 705 m (2,475' - 2,325').

Visibility - Estimated by submersible pilot as 15 m (50').

Current - 0

Observations - The bottom was sandy silt with numerous mounds, burrows, and tracks, with a slope of 15°-20°.

On the descent, midwater fishes began appearing at ca. 394 m (1,300'). Sternoptychids were first seen at ca. 545 m (1,800') and paralepids ca. 636 m (2,100'). From 606 m (2,000') to the bottom, midwater fish abundance and activity was highest. Chauliodontids were seen near the bottom.

The most frequently encountered benthic fishes were halosaurid eels and bathypteroids. Other fishes seen were squalid and hexanchid sharks and bathyclupeids. A fish that was identified as a bathyclupeid was seen to hang motionless in the

water column in a head down, vertical position. Other fishes seen in similar positions during previous dives may also have been bathyclupeids. One squalid shark (Centrophorus) was observed.

The traps were located on this dive but could not be observed due to interference by two large hexanchid sharks. One of these was ca. 2.5 m (8.2') in length. It was seen to attack and wrestle something in or near one of the traps. It showed some interest in the submersible and swam under its front end. A second hexanchid of ca. 5 m (15') in length was also seen swimming around the traps. It also showed interest in the submersible and approached the front chamber. This second shark may have been Hexanchus griseus. Due to the sizes of these sharks, their interest in the vehicle, and the fact that they were stirring up so much sediment, we abandoned further attempts to observe the traps.

During the time spent near the traps, many Bathynomus were seen moving or resting on the bottom.

The remainder of the dive was spent photographing and attempting to drive organisms out of burrows by injecting them with formalin. We saw no organisms leave burrows after the formalin injections.

Dive #1173

General Locality - See dive #1167.

Objectives - Observe bottom longlines for bait preference and bait-height experiments and documentation/collection of fauna and habitat.

Depth - 703 m (2,320')

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Surface	27.99	81.42
100	28.44	81.45
200	28.16	-
300	25.14	80.29
400	24.09	79.81
500	22.41	79.75
600	20.53	79.21
700	19.09	78.24
800	18.10	77.31
900	17.61	76.50
1,000	16.92	75.91
1,100	16.46	75.30

1,200	16.07	74.86
1,300	15.41	74.45
1,400	14.31	73.88
1,500	13.57	73.20
1,600	12.63	72.41
1,700	12.15	71.48
1,800	11.36	70.80
1,900	10.79	70.07
2,000	10.22	69.43
2,100	9.78	68.89
2,200	9.35	68.42
2,300	9.17	67.73
2,320	9.00	67.41 Bottom

Visibility - Estimated by submersible pilot as 15 m (50').

Current - 0.1 kn or less from 140°.

Observations - The Kali pole and bottom longline set was observed approximately 4 1/2 hr after being set. Observations were documented on videotape and 35 mm photographs. In general, the line was not straight, with much extra line curled on the bottom. Only 5 of 20 Kali poles were erect. The floats imploded on 14 poles while another was down due to the weight of a captured shark. Much bait was as yet untouched, but some empty hooks were observed. Observations were terminated after one complete pass due to snagging the line in a thruster. These difficulties resulted in weighting the line on future sets.

The experiment to test the effect of bait height off the bottom did not yield significant results due to the small number of erect Kali poles. Invertebrate feeding activity on off-bottom baits was not observed. The six sharks observed on the Kali poles, regardless of the position of the pole, were caught on one of the top two hooks.

The experiment to test the effect of bait type was ineffective because feeding activity was insufficient to determine bait preference.

The following species were observed around the longline either feeding or showing signs of being attracted to the bait: 12 sharks (11 of which were Squalus); giant isopods (Bathynomus giganteus) which were the dominant species present, their activity increased noticeably through the period of observation; 4 individuals of Heterocarpus laevis?; and 2 myxinids. The latter two species have been frequently caught in traps, but were observed at no other time at this depth.

Additional observations were made on isopods. They were seen to attack bait voraciously. One isopod ca. 30 cm (12") long was observed feeding on a piece of squid measuring roughly 3 x 7 cm. The bait was held by the first three legs as large pieces were torn away by the mouthparts. Almost the entire piece of squid was consumed during 2 minutes of observation. Another large isopod unsuccessfully tried to swim away with a large piece of barracuda about half its body size. Twice isopods were observed on the back of captured sharks resting motionless on the bottom. The sharks responded quickly with violent jerking motions, attempting to dislodge the isopods. Isopods were observed frequently swimming in and around the area of the longline. They swam using their flap-like pleuropods, which beat sequentially in a wave-like fashion with a pause between successive waves. The uropods were turned up while swimming. Isopods swam straight, steady, and even. The only exceptions noted were turns to avoid colliding with the submersible, and turns made just before touching bottom in the vicinity of the bait. Only once, and briefly, was an isopod observed "walking". This was near a bait, and consisted of a series of forward jerks as if it was about to swim. From the abundance of isopods observed around the longline in comparison to the number observed during transects, it was obvious that they were being attracted to the bait over a long distance.

Much time was spent investigating associations between organisms and burrows. The following observations were noted and recorded on film when possible. A shrimp (Heterocarpus laevis), while walking toward a piece of bait, encountered a small (finger-size) vertical burrow. It momentarily backed down the burrow, then proceeded on to the bait. A lobster (Eunephrops bairdii) was encountered in front of its burrow. The burrow was horizontal with a mound of recently excavated sediment in front. The entrance to the burrow was a little wider than the burrow itself, with steep sides. A different lobster (Acanthacaris caeca), characterized by long, thin chelae with rows of thin teeth, was encountered in the mouth of its burrow. The burrow was horizontal, the top of which was about 14 cm (5.6") deep. It had a fan-shaped entrance with a ridge of sediment 4-5 cm (1.5"-2") high in a 130° arc around the entrance forming the outer edge of the fan. Some recent excavation was evident. The lobster assumed what appeared to be a defense position in the burrow. Upon injecting formalin into the burrow, the lobster escaped out a back door located 1.5 m (4.9') away. This second opening did not appear as distinctive as the primary opening. A 10 cm (4") diameter vertical burrow was injected with formalin; a brittle star and a small galatheid crab emerged, both considerably smaller than the burrow. Two vertical burrows were found connected by a side chamber containing a brittle star. One burrow was injected with formalin; only the brittle star emerged. A small finger-sized burrow was injected with formalin with no response.

Other organisms observed and recorded on videotape were as follows: five red pelagic holothurians (Enypniastes eximia) of which two were noted ca. 9 m (29.5') off the bottom, then filmed to document their swimming behavior; a brown and white halosaurid eel; and a species of shrimp (Glyphocrangon sp.).

The following organisms were collected: 1 Chaunax sp., 3 pelagic holothurians (Enypniastes eximia), 1 benthic holothurian (Amphigymnas bahamensis), 1 galatheid crab (from a burrow).

Dive #1174

General Locality - See dive #1167.

Objectives - Count all fishes seen during 40-minute horizontal transects, to extend previously conducted shallow-water transects into deeper water; and to describe associated habitats.

Depth - 120 m - 33 m (400' - 110').

Visibility - Estimated by submersible pilot as 3 m (10') in 33-m (110') depth and 12 m (40') in depths of 70 m and 120 m (230' and 400').

Current - 0.3 kn in 33 m (110') depth with some surge from heavy seas; 0 current in 70 m and 120 m depths (230' and 400').

Observations - Due to poor visibility, the 33 m (110') transect was cancelled. A 40-minute census was made at both 120 m (400') and 70 m (230'). Horizontal transects were conducted in a west to east direction.

The slope at 120 m (400') was nearly vertical. The substrate was rock with an encrusting yellow sponge (Verongia (?) sp.) which was generally overlain within a thin veneer of silty sediment. "Sea whip"-type gorgonians (Ellisella sp.), often wrapped with basket stars, were common. The work face was scalloped so that small depressions with occasional crevices and holes provided the only hiding places for resident fishes. Between 100 m and 74 m (330'-244') the slope changed to about 60°, which remained constant to at least 33 m (110'). At 70 m (230'), the substrate was coarse coral rubble and boulders. Large basket stars and blade-like sponges were abundant. Highly branched soft and black corals added to the vertical relief. Relief provided by these substrates was as high as 2 m (6.6') but averaged 1 m (3.3').

Approximately 31 fish species were seen on both transects. Serranus lucipercanus and Chromis enchrysurus made up 38% and 15% of the total individuals seen in 120 m (400'). Fishes in the genus Serranus dominated the fauna in 70 m (230') and represented 54% of the total; Serranus tortugarum 25%; S.

Lucipercanus 19%; and S. tabacarius 10%; Chromis insolatus was also abundant at this depth and represented about 11% of the fauna.

Dive #1175

General Locality - See dive #1167.

Objectives - Search for macroscopic algae in deepwater habitats to further characterize algal flora at one site on the southern coast of Puerto Rico.

Depths - 220 m - 90 m (725' - 297').

Visibility - Estimated by submersible pilot as 11 m (35') at 220 m (725'); visibility improved to greater than 15 m (50') at 90 m (297').

Current - 0.1 kn at start of dive.

Observations - At 220 m (725'), the bottom was essentially silted over with very fine sediments, which was unsuitable for algal growth. The bottom at 130 m (430') and 140 m (475') was similar but with an increasing number of patches not silted over. No macroscopic algae and probably few or no filamentous forms were found at these depths. At 100 m (330'), the slope was almost vertical with an abundance of encrusting organisms; at 90 m (297') the slope decreased to about 30° and the bottom was coarse sediment with exposed dead corals. This substrate supported two varieties of gorgonians (Ellisella sp.), whip-like black corals (Stichopathes sp.), and sponges. Macroscopic algal species were absent.

A number of sponges were collected, primarily at 91 m (300'), as probable habitats for small, filamentous, primarily rhodophyte algae.

Dive #1176

General Locality - See dive #1167.

Objectives - Verification of fish species identified or seen on dive #1174; and collection of fish species to verify identity from video tapes.

Depth - 120 m - 30 m (400' - 110').

Visibility - Estimated by submersible pilot as 7 m (23') at 30 m (100'); and 18 m (60') at both 70 m and 120 m (230'-400').

Current - 0.2 kn at 33 m (110') decreasing to zero at 70 m and 120 m (230'-400').

Observations - Due to poor visibility, no transects were run at 33 m (110') on previous dives, therefore, no video documentation or rotenone collection was attempted at this depth. Approximately two hours were spent at 120 m (400') where 13 species were videotaped, 12 in sufficient detail to confirm identifications, and two species were collected. Dispersal of rotenone was successful from the sub using the manipulator arm, where appropriate overhangs, caves, and crevices were easily reached and sampled. Fish predators, which consumed most specimens before they could be collected, were Lutjanus buccanella, L. jocu, L. mahogani, Epinephelus cruentatum, Holocentrus rufus, Flammeo marianus, Caranx lugubris, and Sphyræna barracuda.

Dive #1177

General Locality - See dive #1167.

Objectives - Assess the precious coral potential in this area.

Depth - 212 m - 21 m (700' - 70').

Visibility - Estimated by submersible pilot as 12 m (40').

Current - Slight current, less than 0.1 kn.

Observations - An assessment of the precious coral abundance in 21 m to 212 m (70'-700') was made on the shelf margin south of Guanica Bay, Puerto Rico.

Five types of corals are considered of direct commercial importance (jewelry) in the world. Of these, only black corals (Antipathes) were observed. Two black coral species were observed which could be considered of commercial importance. Representative specimens of these were collected for identification. Black corals were absent above ca. 45 m (150') with their maximum abundance close to 54 m (180'); they then gradually diminished below this depth. None of the depths investigated appeared to contain commercial quantities of black coral. Their stem diameter never exceeded about 1 cm in diameter which is below the minimum recommended for collection (2.5 cm).

These observations suggest that black corals of the genus Antipathes are too small and sparsely distributed south of Guanica Bay to support an industry. A possible reason for the paucity of these organisms is the large amounts of silt on the wall.

A combination of the following factors is hypothesized as important in the reduced numbers of sessile organisms noted: a) high input of silt-laden waters from Guanica Bay, resulting from

heavy upland deforestation during recent decades; b) high organic content of these waters due to the presence of sanitary effluents within the bay; c) periods of reduced easterly water currents; and d) the closeness of this shelf margin to the coast. Consistent with this hypothesis is the apparent higher abundance of Antipathes on the shelf south of La Parguera, Puerto Rico.

Other observations unrelated to the assessment of precious corals were: 1) the presence of a geomorphological feature, "the wall," with its upper portion occurring from 10 m to 20 m (33'-66') deeper than other described walls in the Caribbean; 2) an abundance of stalked Crinoidea at 197 m (650') to 212 m (700') (the base of the wall); 3) the lower limit of hermatypic scleractinians was about 55 m (180'), shallower than other reported localities; 4) an abundance of ahermatypic scleractinian Madracis myriaster at 197 m (650') to 212 m (700'); 5) the most abundant sessile organism on the wall from ca. 197 m (650') to 91 m (300') was a yellow encrusting sponge; 6) spiral and non-spiral unbranched cnidarians were common but highly aggregated on the wall; 7) no Sclerospongia, which are common to abundant on other deeper reefs of the Caribbean.

Two five-minute photographic transects were made parallel to the 55-m (180'), 85-m (280') and 115-m (380') isobaths. A Benthos camera shot was made every six seconds. The relative abundance and spatial pattern of black corals, as well as other predominant benthos, will be determined by using each photograph as a quadrat.

Dive #1178

General Locality - See dive #1167.

Objectives - Horizontal transects at 2,390'-2,400' to collect and photograph fauna.

Depth - 727 m (2,398').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
100	-	-
200	29.44	82.45
300	26.69	82.06
400	25.41	81.20
500	24.20	80.29
600	22.63	79.70
700	20.25	78.64
800	19.55	77.51
900	18.58	76.68

1,000	17.88	75.85
1,100	17.40	75.27
1,200	16.91	74.75
1,300	16.26	74.21
1,400	15.68	73.82
1,500	14.85	73.32
1,600	14.16	72.80
1,700	13.29	72.30
1,800	12.68	71.52
1,900	11.90	71.01
2,000	11.53	70.39
2,100	10.73	70.02
2,200	9.92	69.34
2,300	9.56	68.78
2,398	9.01	68.00 Bottom

Visibility - Estimated by submersible pilot as 15 m (50').

Current - Nil

Observations - The bottom was sandy silt with numerous mounds, burrows, and tracks with a slope of 15°-20°.

Based on horizontal transects and general observations, halosaurid eels, bathypteroids, and macrourids were the most abundant benthic fish groups. Other fishes seen were Chaunax sp., a species of peristediid, a chimaerid, a neoscopelid, and a chauliodontid. One macrouid was collected. Several Bathynomus were observed.

One burrow was injected with formalin; a nephropsid (Acanthacaris caeca) was then seen leaving the burrow by a different opening shortly after the injection.

Several fishes and invertebrates were photographed for future identification.

Dive #1179

General Locality - Southeast corner of Grappler Seamount; Site 4 in proposal. See Table 1 for location and other station data.

Objectives - To conduct population transects and point estimate counts of fishes and invertebrates by depth and habitat type. Since this was the only dive at Site 4, additional objectives were to obtain thorough videotape and photographic coverage of habitat and dominant species.

Depth - 482 m - 61 m (1,501' - 200').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Surface	28.40	80.60
100	28.51	81.67
200	27.57	82.10
300	25.83	81.71
400	23.90	80.91
500	23.02	79.88
600	20.41	78.86
700	19.54	77.58
800	18.66	76.74
900	17.62	76.04
1,000	17.00	75.39
1,100	16.72	74.89
1,200	16.22	74.39
1,300	15.52	74.03
1,400	14.64	73.28
1,500	14.09	72.94
1,590	13.18	71.84 Bottom

Visibility - Estimated by submersible pilot as exceeding 15 m (50') at 61 m (200'), it was reduced to 9 m (30').

Current - 0.3 kn in 364 m (1,200') from east to west; 0.3 kn in 127 m (420') from west to east and nil in 73 m (240').

Observations - Bottom was reached at 482 m (1,590') at 8:15 am. The habitat was barren sand with almost no relief. Bottom sediment contained little silt and appeared slightly coarse. This habitat continued upwards on a slope of 20°-40° to 270 m (890'). Heart urchins and white, stalked crinoids were occasionally seen. A few widely scattered rocks were seen with attached crinoids at ca. 300 m (900'). One wenchman snapper (Pristipomoides) was seen by a small rock at 364 m (1,200'). A zone of widely scattered loose slab rock was viewed from 270 m (890') - 248 m (820'). Several silk snapper (Lutjanus vivanus), one blackfin snapper (L. buccanella) and one misty grouper (Epinephelus mystacinus) were seen in the area, along with numerous deepwater squirrelfish, and a moray (Lycodontis polygonius). Attached invertebrates were almost nonexistent. Above the slab rock zone, from 215 m (710') to 191 m (630') was an extensive area of small coral rubble that had fallen from the wall above. The rubble appeared loose and coarse and seemed to provide a poor habitat for both fishes and invertebrates. A near-vertical wall was found at 191 m (630'), with the lower 61 m (200') being extremely barren. Only a few small fishes were seen, but always hovering near the mouth of a small hole in the wall. Fracture lines appeared across the lower wall, from which slabs apparently broke off, forming the rubble-strewn slope below. At about 130 m (430') sponges and low corals appeared, and the number of small, reef fish increased. The slope

decreased at about 121 m (400') with dense rock rubble covering the bottom. Large numbers of deep-reef tropical fishes were seen from 121 m (400') to 91 m (300'). The bottom in depths less than 91 m (300') was rubble-strewn with encrusting sponges, various barrel and finger sponges and small circular sheets of algae. Several rock hinds were seen at 61 m (200'), along with large numbers of tropical reef fishes. Overall, the area appeared unproductive. A deep rubble strip about 109 m (360') wide, supported some snapper and grouper, but along the shelf-edge the best potential for commercial production was seen.

Species List, Dive 1179, Site 4: Grappler Seamount

Species	Transects							
	1 SS	2 SS	3 SS	4 SS	5 SR	6 SR	7 RRS	8 LW
<u>Polymixia nobilis</u>		X	X					
<u>Chlorophthalmus</u> sp.		X						
Lutjanidae								
<u>Pristipomoides</u> sp.			X					
<u>Lutjanus vivanus</u>					X	X		
<u>Lutjanus buccanella</u>						X		
Holocentridae								
<u>Ostichthys trachypoma</u>					X	X		
<u>Holocentrus rufus</u>					X	X	X	X
<u>Holocentrus ascensionis</u>							X	
<u>Flammeo marianus</u>								X
<u>Myripristis jacobus</u>							X	
<u>Plectrypops retrospinus</u>							X	
Serranidae								
<u>Epinephelus mystacinus</u>					X	X		
<u>Epinephelus fulvus</u>						X		
<u>Epinephelus guttatus</u>								
<u>Epinephelus striatus</u>							X	
<u>Holanthias martinicensis</u>						X	X	X
<u>Serranus lucipercanus</u>							X	X
<u>Serranus tabacarius</u>							X	
<u>Serranus tortugarum</u>								X
<u>Serranus</u> sp.							X	X
<u>Paranthias furcifer</u>							X	
Gobiidae								
Chaetodontidae								
<u>Chaetodon aya</u>						X	X	X
<u>Chaetodon aculeatus</u>								X
<u>Chaetodon sedentarius</u>								
Balistidae								
<u>Xanthichthys ringens</u>							X	X
<u>Balistes</u> sp.								X
<u>Balistes vetula</u>								
Pomacentridae								
<u>Chromis</u> sp.								X
<u>Chromis insolatus</u>								X
<u>Pomacentrus variabilis</u>							X	
Pomacanthidae								
<u>Holacanthus ciliaris</u>								
<u>Holacanthus tricolor</u>								
<u>Pomacanthus paru</u>								

<u>Centropyge argi</u>					
Others					
<u>Caranx lugubris</u>	X				
<u>Lycodontis polygonus</u>		X			
<u>Clepticus parral</u>		X			
<u>Lactophrys bicaudalis</u>			X		
<u>Priacanthus cruentatus</u>				X	
<u>Fristigenys alta</u>		X			
<u>Scomberomorus cavalla</u>					X
<u>Sphyraena barracuda</u>					X
<u>Acanthurus coeruleus</u>					X

SS = Sand silt 1,575'-995'
 SR = Sand rubble 995'-715'
 RRS = Rock rubble sand 715'-630'
 LW = Lower wall 630'-430'
 RWRT = Rock wall - reef top 430'-180'

Dive #1180

General Locality - Virgin Islands off St. John's south coast;
Site 6 in proposal. See Table 1 for location and other station data.

Objectives - Population transects and point estimate counts of fishes and invertebrates by depth and habitat type.

Depth - 525 m - 42 m (1,730' - 140')

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Surface	29.30	83.47
100	29.34	83.00
200	28.89	82.95
300	26.91	82.62
400	25.00	81.86
500	23.85	81.44
600	22.10	80.62
700	19.16	79.04
800	18.54	77.76
900	-	-
1,000	17.32	76.00
1,100	16.91	75.48
1,200	16.35	74.92
1,300	15.62	74.44
1,400	14.87	73.92
1,500	14.43	73.45
1,600	13.55	72.87
1,700	12.89	72.16
1,730	12.53	71.51 Bottom

Visibility - Estimated by submersible pilots 18 m (60').

Current - 0.1 kn at start of dive increasing to 0.2 kn.

Observations - Particulate material in water column again noted ca. 91 m (300'), and remained until ca. 485 m (1,600'). Population transects were run from 525 m (1,730') onto the reef proper. During the dive, three habitats were encountered. The rock rubble zone supports a limited number of fish or invertebrate species. At one site in the rock rubble habitat, which was associated with several very large boulders, about 18 snapper were counted in the periphery of the light. This notation prompts the question of whether these species are attracted to and follow the submersible, with a resultant

overestimate, or do they primarily remain in the outer reaches of the light, in which case we may underestimate the population. Externally, these rocks appear to provide good habitat, but few fish are recorded around them. Upon leaving the rock rubble at ca. 272 m (900'), a sheer rock wall was encountered which continued upward to about 61 m (200'). The slope was estimated at about 80°. There were two distinct habitats noted on the wall which may be related, in part, to a critical photic level. The lower wall, on which there were few sponges and corals, extended upwards to about 121 m (400'), at which point a marked increase in the amount of growth and species diversity was noted. The lower slope appeared to be terraced and undercut in places. These terraces were occupied by large numbers of snapper in depths of 227 m (750') to 152 m (500'). These fish swam freely along the terraces and showed limited movement up or down the slope. The upper slope displayed a greater ichthyofaunal diversity, similar to the reef top. After leaving the wall edge, a large number of schoolmaster snapper were observed. These fish showed an unusual amount of yellow on the fins and body. Video footage was somewhat disappointing as a high level of ambient light on the upper wall and reef top precluded good color. This was a spectacular wall with ambient light penetrating to ca. 272 m (900'). The light intensity increased as we ascended, providing some truly spectacular viewing.

Species List Dive 1180, Site 6, off south coast
of St. Johns Island, U.S. Virgin Islands

Species	Transect				
	1 RR	2 RR	3 RR	4 RR	5 W
<u>Chaunax pictus</u>	X				
<u>Sternoptychidae</u>	X				
<u>Polymixia nobilis</u>		X	X	X	
<u>Argentinidae</u>		X			
<u>Chlorophthalmidae</u>		X			
<u>Apogonidae</u>		X			
<u>Gobiidae</u>		X	X		
<u>Holocentridae</u>					
<u>Ostichthys trachypoma</u>		X	X		
<u>Holocentrus sp.</u>					
<u>Holocentrus ascensionis</u>					X
<u>Holocentrus rufus</u>					
<u>Flammeo marianus</u>					
<u>Plectropops retrospinus?</u>					
<u>Myripristis jacobus</u>					
<u>Holocentrus coruscus</u>					
<u>Lutjanidae</u>					
<u>Etelis oculatus</u>		X	X	X	X
<u>Pristipomoides sp.</u>				X	X
<u>Lutjanus sp.</u>				X	X
<u>Lutjanus buccanella</u>				X	X
<u>Lutjanus vivanus</u>				X	X
<u>Lutjanus apodus</u>					
<u>Lutjanus jocu</u>					
<u>Carangidae</u>					
<u>Caranx sp.</u>				X	X
<u>Caranx lugubris</u>				X	X
<u>Seriola sp.</u>					
<u>Chaetodontidae</u>					
<u>Chaetodon aya</u>					X
<u>Chaetodon aculeatus</u>					X
<u>Chaetodon capistratus</u>					
<u>Acanthuridae</u>					
<u>Acanthurus bahianus</u>					
<u>Acanthurus coeruleus</u>					
<u>Acanthurus sp.</u>					
<u>Serranidae</u>					
<u>Serranus lucipercanus</u>					X
<u>Serranus tortugarum</u>					
<u>Mycteroperca tigris</u>					
<u>Mycteroperca venenosa</u>					
<u>Epinephelus guttatus</u>					
<u>Epinephelus fulvus</u>					

<u>Epinephelus striatus</u>			X
<u>Paranthias furcifer</u>			X
Balistidae			
<u>Balistes sp.</u>	X	X	X
<u>Balistes vetula</u>		X	
Pomacentridae			
<u>Pomacentrus partitus</u>		X	X
<u>Chromis insolatus</u>		X	X
<u>Chromis multilineatus</u>		X	X
<u>Microspathodon sp.</u>			
Others			
<u>Clepticus parrai</u>		X	X
<u>Centropyge argi</u>		X	X
<u>Bullisichthys caribbaeus</u>		X	
<u>Malacanthus plumieri</u>			X
<u>Pomacanthus arcuatus</u>			X
<u>Holacanthus tricolor</u>			X
<u>Anisotremus virginicus</u>			X
<u>Anisotremus surinamensis</u>		X	
Labridae			
<u>Bodianus rufus</u>			X
<u>Sparisoma viride</u>			X
<u>Sparisoma sp.</u>			X
<u>Gramma linki?</u>			X

RR = Rock rubble 1,700'-900'
W = Wall 900'-300'
WRT = Wall, reef top 300'+

Dive #1181

General Locality - See dive #1180.

Objectives - Vertical transect from 212 m (700') to 91 m (300'); collect and photograph fauna and habitat.

Depth - 523 m - 61 m (1,700' - 200').

Visibility - Estimated by submersible pilot as 15 m (50').

Current - None

Observations - The bottom was sandy with medium-size rocks and a 20° slope. Numerous small fishes were present, but could not be identified.

The single vertical transect included observations of Ostichthys trachypoma, Holocentrus sp., Epinephelus mystacinus, Lutjanus vivanus, and L. buccanella which were the most abundant benthic fishes. Other observed fishes included Chaunax sp., Muraenidae, Apogon sp., and Balistes vetula. Several fishes and invertebrates were photographed and videotaped for future identification and reference.

One rock pile was injected with rotenone and a single fish collected, along with a sample of the rocks which resembled tree roots.

Dive #1182

General Locality - Virgin Islands off the east end of St. Croix; Site 5 in the proposal. See Table 1 for location and other station data.

Objectives - Population transects and point estimate counts of fishes and invertebrates by depth and habitat type.

Depth - 432 m - 30 m (1,425' - 100').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Near surface	28.39	83.56
150	28.74	83.33
200	28.78	83.38
300	24.92	82.63
400	23.35	80.97
500	21.94	79.95
600	20.93	78.92

700	19.36	77.96
800	18.22	76.83
900	17.81	76.35
1,000	15.95	75.68
1,100	15.33	74.52
1,200	14.88	74.16
1,300	14.36	73.80
1,425	13.54	72.77 Bottom

Visibility - Estimated by submersible pilot as 18 m (60').

Current - Variable from 0 to 0.6 kn.

Observations - Six transects and two sets of point counts were made. The bottom was sand in deeper areas, 432 m-182 m (1,425'-600') with a slope of ca. 35°-45°; from 182 m-105 m (600'-345') the bottom was a rock wall with a slope of 70°; at ca. 105 m (345'), the bottom composition became coral rubble and the slope decreased to about 5°.

In areas deeper than 105 m (600'), the only fishes seen were Seriola sp., argentinids, Peristedion sp., lophiids, Lutjanus sp., and a Ostichthys trachypoma. The holocentrid and one lutjanid were closely associated with a small rock cave. At 183 m-91 m (600'-300'), the diversity and abundance of fishes increased tremendously. Fish groups represented at these depths were typical of reef systems. General observations were continued to ca. 31 m (100').

Additional fishes seen were: Sphyræna barracuda; Chaetodon sedentarius; Caranx ruber; Pomacanthus arcuatus; Epinephelus fulvus; Holocentrus rufus; Haemulon sciurus; Acanthurus bahianus; Thalassoma bifasciatum; Chaetodon capistratus; Elagatis bipinnulata (near surface in school); Istiophoridae; Sparisoma aurofrenatum; and Sparisoma viride.

Dive #1183

General Locality - Virgin Islands off the west end of St. Croix, near Frederiksted.

Objectives - Habitat characterization collections and faunal description; photograph and videotape for species verification.

Depth - 600 m - 39 m (1,980' - 130').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
150	28.85	83.42
190	28.86	82.41
300	25.09	80.39
400	-	-
500	22.00	78.40
600	20.91	77.26
700	19.16	76.48
800	17.48	75.72
900	17.19	75.37
1,000	16.44	74.87
1,100	15.91	74.61
1,200	15.32	74.10
1,375	13.53	72.92
1,400	13.41	72.85
1,500	12.81	72.29
1,600	12.27	72.17
1,650	12.29	72.02
1,700	11.75	71.67
1,800	10.98	71.00
1,960	10.39	70.64
1,980	10.65	70.83 Bottom

Visibility - Estimated by submersible pilot as 12 m (40') from start of dive to 273 m (900'); decreasing rapidly at shallower depths.

Current - Negligible but increasing at reef top to 0.3 kn.

Observations - The bottom from 600 m - 152 m (1,980' to 500') was composed of white sand. Shrimp were seen at 576 m - 545 m (1,900' to 1,800'); burrows appeared to have double entrances with some secondary bioerosion around both entrances. Shrimp were filmed and tentatively identified as *Heterocarpus*. Carrier shells were common from 600 m - 364 m (1,980' to 1,200'), judging from the number of individuals seen and the abundance of their characteristic tracks. One specimen was collected at 455 m (1,500'). Several unidentified mesopelagic fish were seen in the water column. The most common benthic fish was *Polymixia nobilis*. At approximately 545 m (1,800'), an atelepodid-like fish and a macrourid with a distinctive round black spot on its pectoral fin were videotaped. Substrate for soft corals and their associated starfish was observed at 545 m (1,800'). Several small, 5 cm - 7.5 cm (2" to 3"), fish oriented with heads down were seen hovering near the starfish. One gorgonian with both a brittlestar and a red starfish and an ophidiid or brotulid, were collected.

At approximately 485 m (1,600') a small fish was filmed close-up; it had a distinctive black edge on the anterior portion

of the dorsal fin and very long veil-like, black-speckled pectoral or pelvic fins. Several scyliorhinid sharks were seen; one having brown saddle-like markings and spots was videotaped. Other unidentified fishes were filmed with good close-ups that may allow later identification.

Aggregations of two species of echinoderms were observed at 303 m (1,000') and 258 m (850') respectively. No fish were observed between 242 m and 152 m (800' and 500'). The slope at this depth was ca. 70°, and the bottom was still sandy.

At 152 m (500'), an 80°-90° wall was encountered with encrustations of different colored sponges. Some gorgonians were also present. No fish were seen until a depth of approximately 106 m (350'). Coral in the form of plate-like Agaricias was first observed at 58 m (190') at the reef crest. Other coral species were seen in shallower depths.

Identified fishes observed along the vertical wall between 106 m and 39 m (350' and 130') include: Liopropoma mowbrayi, Chaetodon aculeatus, Haemulon album, Holocentrus ascensionis, Chromis insolatus, C. enchrysurus, C. cyaneus, Flammeo marianus, Myripristis jacobus, Pseudupeneus maculatus, Synodontidae, Clepticus parrai, Holacanthus tricolor, Anisotremus virginicus, Acanthurus bahianus, Scarus taeniopterus, Xanthichthys ringens, Hypoplectrus nigricanus, H. puella, and Serranus tabacarius.

Dive #1184

General Locality - East of Isla de Vieques, Puerto Rico; Site 7 in the proposal. See Table 1 for location and other station data.

Objectives - Population transects and point estimate counts of fishes and invertebrates by depth and habitat type; and habitat documentation.

Depth - 495 m - 45 m (1,515' - 150').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Surface	29.00	83.75
100	28.32	83.56
200	27.71	83.51
300	26.55	83.24
400	24.80	82.56
500	22.62	81.82
600	19.87	80.29
700	18.52	78.97

800'	18.00	77.83
900'	17.45	77.07
1,000'	17.16	76.61
1,100'	16.88	76.15
1,200'	16.12	75.72
1,300'	15.60	75.31
1,400'	14.19	74.66
1,515'	13.68	73.22 Bottom

Visibility - Estimated by submersible pilot as 18 m (60').

Current - 0.0 kn at 459 (1,515').

Observations - As with previous sites visited, the slope and wall east of Isla de Vieques had some unique characteristics, although the general configuration was similar to other sites. A smooth sand bottom, sloping from 15° to 40°, existed between 459 m and 273 m (1,515' and 900'). An underlying hardpan was located under a thin veneer of sand. Echinoids and scattered hydroids were occasionally seen, but the bottom appeared generally depauperate. A *Chaunax* sp. was videotaped "walking" and then collected. At 273 m (900'), large boulders were found on part of the lower rubble zone which appeared as depauperate as the sandy area below. Coral rubble was widely scattered above and below the rubble zone, over the sand bottom. At 212 m (700'), small rounded coral pieces and small round structures, tentatively identified as rhotoliths (calcified algae balls), were very dense. Few commercial fishes were seen and almost no attached invertebrates were found on the low-relief rubble. The barren lower wall started at 182 m (600') and ascended at a slope of 80°-85° to a depth of 91 m (300'). Two ghost fishing traps were found on a small ledge at 121 m (400'). Both were arrow traps with iron rebar and wire mesh. A corner was torn open on one trap and the escape panel was open on the other. Neither trap contained fishes or invertebrates. As in other areas, at about 121 m (400'), the number of encrusting and standing sponges and corals increased dramatically. From 121 m (400') to 91 m (300') large numbers of tropical fishes were seen and the bottom had a rough, convoluted appearance. At 91 m (300'), the slope decreased to 65°-70° and the bottom was covered with the 1"-3" (2.5 cm - 5.0 cm) objects tentatively identified as rhotoliths. Another vertical wall extended from 76 m (250') to 45 m (150') and was marked by numerous small caves and crevices occupied by a rich tropical fauna. The top of the ledge was relatively barren, and appeared to be smooth cap rock. Efforts to survey the top were unsuccessful because an extremely strong current from the north prevented the JOHNSON SEA-LINK II from moving over the ridge top.

Overall, the site appeared very unproductive below ca. 121 m (400'). Although silk (*L. vivanus*) and blackfin (*L. buccanella*)

snapper were seen, they did not appear abundant. The upper slope was faunistically rich but few snapper or grouper were seen.

Species List, Dive 1184, Site 7, East of Isla de Vieques, Puerto Rico

Species	Transects							
	1 S	2 S	3 SR	4 SR	5 SR	6 SR	7 SR	8 SR
<u>Etmopterus</u> sp.	X							
<u>Scyliorhinus</u> sp.	X							
<u>Polymixia nobilis</u>	X		X					
<u>Chaunax</u> sp.	X	X						
<u>Argentinidae</u>	X		X				X	
<u>Synodus intermedius?</u>		X						
<u>Benthodesmus</u> sp.		X						
<u>Cyttopsis roseus</u>			X					
<u>Seriola</u> sp.			X		X	X	X	X
<u>Seriola dumerili</u>			X			X	X	X
<u>Chlorophthalmus</u> sp.							X	
<u>Lutjanidae</u>							X	
<u>Pristipomoides</u> sp.							X	X
<u>Lutjanus vivanus</u>								X
<u>Apsilus dentatus</u>								
<u>Serranidae</u>								
<u>Serranus</u> sp.								X
<u>Serranus lucipercanus</u>								
<u>Serranus tortugarum</u>								
<u>Epinephelus fulvus</u>								
<u>Epinephelus guttatus</u>								
<u>Paranthias furcifer</u>								
<u>Holocentridae</u>								
<u>Holocentrus rufus</u>								
<u>Holocentrus ascensionis</u>								
<u>Flammeo marinus</u>								
<u>Pomacentridae</u>								
<u>Chromis insolatus</u>								
<u>Chromis cyaneus</u>								
<u>Pomacentrus fuscus</u>								
<u>Pomacentrus partitus</u>								
<u>Microspathodon chrysurus</u>								
<u>Pomacanthidae</u>								
<u>Pomacanthus arcuatus</u>								
<u>Holacanthus tricolor</u>								
<u>Centropyge argi</u>								
<u>Chaetodontidae</u>								
<u>Chaetodon aculeatus</u>								
<u>Chaetodon ocellatus</u>								
<u>Chaetodon sedentarius</u>								
<u>Chaetodon striatus</u>								
Others								

Sphyræna barracuda
Xanthichthys ringens
Pristigenys alta
Priacanthus arenatus
Malacanthus plumieri
Acanthurus coeruleus
Clepticus parrai

X
X
X
X
X
X
X

S = Sand 1,515'-900'
SR = Sand, rock 900'-600'
W = Wall 600'-200'

Dive #1185

General Locality - North-northeast of St. Thomas. See Table 1 for location and other station data.

Objectives - Videotape fish and invertebrate species for identification and references.

Depth - 42 m - 32 m (140' - 100').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
90	28.51	83.64
105	28.45	83.58
140	28.43	- Bottom

Visibility - Estimated by submersible pilot as 1.5-3 m (5'- 10').

Current - Negligible, however, considerable surge noted at patch reef.

Observations - Sandy, muddy substrate extended from 42 m (140') to 35 m (117'). Eucinostomus were observed swimming rapidly about 1.5 m (5') above the bottom, and one Archosargus rhomboidalis was seen closer to the substrate. A Lutjanus analis estimated at 8 cm (20") long was briefly seen at 38 m (125'). Basket stars were noted tightly coiled around small gorgonians. Attempts were made to collect what was thought to be live Strombus gigas but they turned out to be large hermit crabs (Dardanus insignis) living in old shells.

A small patch reef approximately 46 m (150') long, was found at 35 m (117') with a depth on top of 27 m (90'). Some rubble and algae (Caulerpa and Penicillus) were observed around the base of this patch reef. Gorgonians were most abundant with corals (Diploria, Montastrea, etc.) next in abundance. Reef fishes were numerous on the patch reef, but seemed to avoid the approach of the submersible.

List of fishes observed during this dive included:

Eucinostomus, Archosargus rhomboidalis, Lutjanus analis, Canthigaster rostrata, Epinephelus cruentatus, E. guttatus, Scarus taeniopterus, Pseudupeneus maculatus, Pomacentrus partitus, Haemulon flavolineatum, H. sciurus, H. aurolineatum, Acanthurus coeruleus, A. chirurgus, Holacanthus tricolor, Chaetodon sedentarius, C. capistratus, Sparisoma viride, S.

aurofrenatum, Lachnolaimus maximus, Holocentrus rufus, Chromis cyaneus, Hypoplectrus chlorurus, Panulirus argus, and Scyllarid lobster.

Dive #1186

General Locality - Southwest of harbor entrance to San Juan, Puerto Rico; Site 10 in proposal. See Table 1 for location and other station data.

Objectives - Population transects and point estimate counts of fishes and invertebrates by depth and habitat type.

Depth - 508 m - 288 m (1,675 - 950').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Surface	28.17	81.91
100	28.47	82.96
200	28.43	83.39
300	26.10	83.60
400	23.71	82.62
500	21.96	81.40
600	20.72	80.38
700	19.50	79.15
800	18.12	78.10
900	17.51	77.32
1,000	16.90	76.59
1,100	16.34	76.02
1,200	15.90	75.62
1,300	14.93	75.19
1,400	14.25	74.58
1,500	13.15	73.93
1,600	12.89	73.34
1,675	10.97	71.75 Bottom

Visibility - Estimated by submersible pilot as 9 m (30').

Current - 0.2 kn from the north east (038°).

Observations - This dive operated from 508 m - 288 m (1,675' - 950') southwest of the San Juan, Puerto Rico, harbor. Bottom topography was smooth with only one small rock observed during the dive. Bottom composition was silty mud and sand which overlaid a mud bottom. The bottom was soft and extensive siltation occurred when the submersible slowed down or stopped. When capturing a Parasudis truculenta, the scoop settled ca. 30 cm - 45 cm (12"-18") into the bottom, verifying the soft bottom composition. Between about 424 m and 348 m (1,400' and 1,150'),

an extensive sponge/burrowing anemone forest was encountered. Few other species of invertebrates or fishes were noted during the dive. The anticipated fouling of the bottom was not encountered; however, more non-marine items were noted than on any other dive. Past catch rates in this area have been nonexistent, but the thought that these might be functions of fouling appears to be unfounded. There is simply no habitat for snapper-grouper species to reside in. Species diversity, as expressed on the species list, is much lower than on that of transects which surveyed the shallower depths. Diversity is greatest on the reef habitat which was not reached during this dive.

Species List, Dive 1186, Site 10, South West of San Juan Harbor Entrance.

Species	Transects							
	1 MSS	2 MSS	3 MSS	4 MSS	5 MSS	6 MSS	7 MSS	8 MSS
<u>Bramidae</u>	X							
<u>Chauliodus sloanei</u>	X							
<u>Chaunax</u>	X	X					X	
<u>Gonostomatidae</u>	X	X	X					
<u>Sternoptychidae</u>	X		X					
<u>Macrouridae</u>	X			X				
<u>Argentinidae</u>	X	X		X	X	X	X	X
<u>Benthodesmus</u>	X		X	X	X	X	X	X
<u>Parasudis truculenta</u>	X	X	X	X	X	X	X	X
<u>Polymixia nobilis</u>	X	X	X	X	X	X		X
<u>Myctophidae</u>	X				X	X		
<u>Poecilopsetta albomarginata</u>		X				X		
<u>Gobiidae</u>		X			X			
<u>Antigonia capros</u>					X			X
<u>Chlorophthalmidae</u>					X			
<u>Pristipomoides</u>							X	
<u>Synodontidae</u>								X

MSS = Mud, sand, silt 1,675'-950'

Dive #1187

General Locality - See dive #1186.

Objectives - Complete population transects and point estimate counts initiated on dive #1186. Evaluate deep habitat and impact of San Juan Harbor discharge on benthic organisms.

Depth - 340 m - 227 m (1,120' - 750').

Visibility - Very poor at start of dive; decreased to 2m-3 m (6'-10') at rock field, at a depth of 227 m (750').

Current - Very weak at 333 m (1,100'); increasing to 0.2 kn at 227 m (750').

Observations - This dive was a continuation of the population transects run at station 10 on dive #1186 and terminated at 227 m (750'). Upon reaching bottom at 340 m (1,120'), four transects were run. Visibility was poor and the bottom was the most barren seen to this point. A large rock seen at 300 m (990') had almost no attached invertebrates. The bottom slope was 20°-25° and the sediment was extremely silty. The area, just below the mouth of San Juan Bay looked depauperate and unproductive. Only one silk snapper (*Lutjanus vivanus*) and few other fishes of no commercial importance were seen from 340 m - 227 m (1,120'-750'). A longline was encountered at 236 m (780'), with the mainline and buoyline floating 3 m - 5 m (10' to 15') off of the bottom. The JOHNSON SEA-LINK II was forced to maneuver over the lines, which were difficult to see in the murky water. The submersible came down in a field of large boulders on the inshore side of the lines in 233 m (770'). Visibility at this point was only 2 m - 6 m (8' to 20'), and the close spacing of the rocks made maneuvering very difficult. The JOHNSON SEA-LINK II surfaced at this point and the dive was terminated. This dive site was selected to document the impact on resources of outflow from the San Juan Harbor. Unfortunately, the water was so silty, even at 227 m, (750'), that we were unable to complete the intended transect up to 91 m (300').

Dive #1188

General Locality - Off northwest corner of Puerto Rico; Site 12 in the proposal. See Table 1 for location and other station data.

Objectives - Population transects and point estimates counts of fishes and invertebrates by depth and habitat type.

Depth - 355 m - 91 m (1,170' - 300').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Surface	28.31	83.44
240	26.87	83.68
300	26.24	83.53
400	23.64	82.84
500	22.93	82.01
600	21.14	81.20
700	18.77	79.93
800	18.00	78.70
900	17.30	77.84
1,000	16.31	76.89
1,100	15.70	76.06
1,170	15.72	75.25 Bottom

Visibility - Estimated by submersible pilot as 15 m (50').

Current - 0.2-0.3 kn

Observations - Eleven transects and four sets of point counts were made. All transects were 100 yards in length. From 355 m - 205 m (1,170'-675') the habitat was characterized as sand-silt. However, when the submersible bumped the bottom, it became obvious that the sand-silt was a fairly thin veneer over a hard-rock or compacted basal layer. At ca. 315 m - 294 m (1,040'-970') breaks in these basal areas started appearing. The breaks formed small areas of rock rubble and shallow undercutting. Fish and invertebrate species were much more numerous and abundant at these breaks, compared to the surrounding areas. At ca. 205 m (675'), the bottom changed to one of rock rubble and remained so until ca. 136 m (450'), when the habitat started changing to hard-rock bottom with small holes and undercutting. At 91 m (300') the bottom was mainly rock and coral rubble. Slopes were 5°-10° at 355 m - 200 m (1,170'-660'), increasing to 25°-30° at 200 m - 91 m (660'-300'), and leveling off at 91 m (300').

On the deepest transects, 355 m - 315 m (1,170'-1040'), one fish tentatively identified as Cyttopsis roseus, was in much greater abundance than any other species encountered. However, this identification is by no means certain, as no specimens have been collected. The next most frequently encountered species along deep transects, 355 m - 283 m (1,170'-935') were Antignonia capros and a species we are calling "Symphysanodon or Pristipomoides" until an absolute identification can be made. Few fishes were observed from 283 m - 261 m (935'-860'). At ca. 261 m (860'), we began to encounter fishes more typical of shallow-water or reef areas. The first of these to appear was a specimen of Serranus (notospilus or phoebe). From 200 m - 136 m

(660' - 450'), many of the typical reef fish families started to occur. At 91 m (300'), the ichthyofauna was composed entirely of reef fish species.

Dive #1189

General Locality - West of Aguadilla, Puerto Rico. See Table 1 for Location and other station data.

Objectives - Horizontal transects and species/habitat documentation with emphasis on shrimp.

Depth - 755 m - 685 m (2,490' - 2,260').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Surface	28.89	82.58
100	28.46	83.55
200	27.48	83.78
300	25.90	83.64
400	20.81	82.80
500	20.64	81.13
600	20.05	80.49
700	19.35	79.51
800	18.53	78.71
900	17.03	77.92
1,000	16.24	76.97
1,100	15.89	76.32
1,200	15.50	75.87
1,300	14.51	75.31
1,400	13.93	74.77
1,500	13.28	74.27
1,600	12.51	73.83
1,700	12.13	73.30
1,800	11.80	72.88
1,900	11.12	72.32
2,000	10.58	71.81
2,100	10.03	71.28
2,200	9.45	70.73
2,300	9.28	70.28
2,420	9.07	70.07
2,490	8.53	69.60 Bottom

Visibility - Estimated by submersible pilot as 15 m (50').

Current - 0 at 755 m (2,490'); 0.2 kn at 718 m (2,370'); direction north northwest, upslope, from 335°.

Observations - Six horizontal, 100-yard transects in sets of two were made at the beginning, middle and end of the dive. The target species were shrimps, but all fishes were recorded. Comparison of the fauna observed on this dive to that observed off Guanica at a similar depth showed several obvious differences: 1) the shrimp species dominant in trawl samples and abundant during visual census off Guanica were not recognized during this dive; 2) the dominant species on this dive was a red pandalid with very long legs and a slight laterally-compressed body; this species was observed off Guanica but not in the abundance noted here; and 3) a nephropsid lobster (Acanthacaris caeca) characterized by thin claws with small teeth was fairly common here, but only occasionally observed off Guanica. During these transects, several species of galatheid crabs were also abundant. Two species of bathypteroids seen off Guanica were the dominant fish species observed. During transects, photographs were taken to study the distribution of burrows and the fauna.

Several species of fishes and invertebrates were filmed for subsequent identification and documentation. Among the fishes were two unknown eel-like species, a snipe eel (Nemichthyidae), and an unknown ray or skate. Documented invertebrates included a Venus flytrap anemone (Actinoscyphia saginaza), a large brittlestar or starfish characterized by long tube feet and rings around the arms, a common species of stalked crinoid, and several species of shrimp.

Collected on the dive were one flytrap anemone with an associated spider crab, a scaphopod shell with an anemone on it and a hermit crab in it, and a 90 cm (3') log which contained teredo worms, gastropods and amphipods. Small white isopods were observed leaving the log during its collection.

Dive #1190

General Locality - Approximately 5 nm northwest of Aguadilla on the northwest coast of Puerto Rico; Site 13 in the proposal. This site was paired with dive #1188 in anticipation that dive #1190 would be protected from the current while dive #1188 would be a similar site topographically, but subject to an alongshore current. See Table 1 for location and other station data.

Objectives - Population transects and point estimate counts of fishes and invertebrates by depth and habitat type.

Depth - 417 m - 82 m (1,375' - 270').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Surface	28.23	82.96

100	28.27	83.70
200	27.84	83.88
300	27.00	83.76
400	25.00	83.22
500	22.44	82.16
600	20.38	80.62
700	18.75	78.06
800	18.12	78.06
900	17.60	77.45
1,000	16.60	76.64
1,100	15.65	76.04
1,200	15.25	75.55
1,300	14.70	75.11
1,375	13.70	73.88 Bottom

Visibility - Estimated by submersible pilot as 15 m (50').

Current - 0 kn at 417 m (1,375'); 0.2 kn at 242 m (800'), decreasing to 0 kn at 91 m (300').

Observations - The dive site was typical of other slope sites around Puerto Rico. The bottom was sand and silt with few mounds or depressions at 417 m (1,375'). Its slope was approximately 10°. Scattered whitish sponges and anemones were the only protruding invertebrates seen. Several small gempylids and trichiurids were videotaped in a vertical position. Fish fauna was depauperate at 394 m - 273 m (1,300'-900') as at most of the other dive sites in these depths. Small white galatheid crabs were seen at the entrances to many small 1.3 cm - 2.5 cm (0.5" - 1.0") burrows.

The only decapods seen were two small porcellanid crabs 2.5 cm - 5.0 cm (1" - 2") in diameter. Benthic fishes in this area were Bembrops, Parasudis, Benthodesmus, two species of synodontids, Cyttopsis, Polymixia and Ostichthys, a deep-water squirrelfish. At 364 m (1,200'), small pieces of slab rock were occasionally seen, with crevices on the downhill side. One or two Pristipomoides (wenchman snapper) were generally associated with these slabs, along with an occasional boarfish (Antigonia). These slabs were widely scattered, with only six seen between 364 m (1,200') and 273 m (900'). At 273 m (900'), the slab rock areas became more numerous, along with fan and whip corals, colonial hydroids, white stalked crinoids, heart urchins, and robust, long-spined white urchins. Between 273 m and 197 m (900' and 650'), the slope increased gradually to 35°, with increasing numbers of slab rocks emerging from the sandy bottom. Numerous soft corals, hydroids, and sponges were seen, along with several Pristigenys alta and Serranus notospilus. Several unidentified scorpionfishes and searobins were videotaped, along with a long-snouted batfish, the "candy stripe" labrid; and a few silk snapper, Lutjanus vivanus, which were seen around large

outcroppings. At about 182 m (600'), bottom type gradually changed to continuous slab rock with a very low profile. Deepwater "tropical" fishes began to appear in small crevices at the lower edges of the slabs. The slope increased to 45° at 152 m (500') and the bottom had the barren appearance of lower wall areas seen at other sites. Dominant species through this area were Chromis insolatus, Holanthias martinicensis, and Xanthichthys ringens. Attached corals and sponges were widely scattered. At 121 m (400') the wall became steeper at 55°-60° with the slabs forming 12'-15' domes without exposed edges or high profiles. Corals and sponges increased in abundance at about 121 m (400'), but fish remained sparse and scattered. The wall remained relatively barren, compared to previous sites, with no large fishes being seen. The slope decreased to 15°-20° at 91 m (300'), with the bottom being covered with small, closely-packed rubble with few attached corals and sponges. A small, barren vertical wall extended from 86 m - 81 m (285' - 270') before leveling off at the depauperate reef top. A few small reef fish were noted around the low profile rubble, but no large commercial fish were seen.

This site was generally barren throughout the range of the dive, and was unproductive. Commercial fishes were found only around widely scattered small slabs of rock from 364 m - 242 m (1,200' - 800'). Although small fishing vessels were seen hand-lining near the dive site on the upper reef edge, no commercial fish were seen above 152 m (500').

Dive #1191

General Locality - Isla Desecheo, an island in the Mona Passage between Puerto Rico and Hispaniola, approximately 11.5 miles west of the westernmost Cape of Puerto Rico. See Table 1 for location and other station data.

Objectives - Transect counts, collections, and videotape fishes and invertebrates; general collections using rotenone.

Depths - 475 m - 82 m (1,565' - 270').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Surface	28.33	84.11
100	28.33	84.16
200	27.34	84.17
300	26.61	83.92
400	25.00	83.53
500	21.17	82.71
600	19.57	81.48

700	17.58	80.03
800	17.01	78.79
900	16.53	76.82
1,000	16.11	77.05
1,100	16.05	76.63
1,200	15.64	76.18
1,300	15.40	75.71
1,400	14.35	75.32
1,500	13.68	74.88
1,565	13.08	73.83 Bottom

Visibility - Estimated by submersible pilot as 15 m (50').

Current - 0

Observations - This dive was made along an extremely rough slope with many large rocks and boulders separated by interstitial sands which appeared as "sand rivers." The macroview, from the sphere, appeared as a mountain mockup with its ridges and valleys. Moving upslope, this picture changed to heavier boulders, "phosphorite" rock and less interstitial sand. On this habitat, approximately 50-60 myctophids were observed along the bottom, displaying benthic rather than mesopelagic behavior. Leaving the heavy boulder habitat, we encountered a rock wall at about 333 m (1,100'). Initially, the rock wall was somewhat bare with few invertebrates other than what appeared to be single-polyp corals. This portion of the wall was below the "critical photic zone" and few fish were noted. Ascending the wall, yellow encrusting sponges became abundant, followed by other sponges, corals, and algae as the "critical photic zone" was reached. Also noted were large and extensive crevices increasing in size and magnitude when ascending. Above approximately 121 m (400') an extensive profusion of sponges, corals, algae, hydroids, and gorgonians, along with an accompanying rich ichthyofauna, was observed. The greatest activity was again recorded near the wall edge, which was in association with a series of crevices which were deep, long, and extensively subdivided. Many smaller crevices were noted joining the main crevasse which appeared to run parallel to the wall edge. In association with these crevices were upwards of 100 blackfin snapper (*Lutjanus buccanella*) moving freely along the wall edge below the top of the reef. When looking directly into the crevasse, it appeared that within a few meters of the top, the profusion of invertebrates which characterized the upper "critical photic zone" became less abundant. Light penetrating into these crevices appears somewhat limited, ergo, the reduced invertebrates. Depths of the major crevasse was unknown, as when observed directly, no bottom was seen. This was an extremely interesting and pleasing dive over some very rough terrain.

Species List, Dive 1191, off Isla Desecheo, Puerto Rico

Species	Transects				
	1 RS	2 RS	3 RW	4 RW	5 RWRT
<u>Polymixia nobilis</u>	X				
<u>Halosaurid eel</u>	X				
<u>Chlorophthalmus sp.</u>	X				
<u>Myctophidae</u>		X			
<u>Ostichthys trachypoma</u>		X			
<u>Gonfoplectrus hispanus</u>			X		
<u>Lutjanus vivanus</u>				X	
<u>Mycteroperca interstitialis</u>				X	
<u>Caranx lugubris</u>				X	
"Candy stripe" labrid				X	
<u>Holanthias martinicensis</u>				X	X
<u>Apogonidae</u>					X
<u>Lutjanus buccanella</u>					X
<u>Paranthias furcifer</u>					X
<u>Clepticus parral</u>					X
<u>Holacanthus tricolor</u>					X
<u>Pomacentrus partitus</u>					X
<u>Chromis insolatus</u>					X
<u>Chromis enchrysurus</u>					X
<u>Holacanthus ciliaris</u>					X
<u>Holocentrus ascensionis</u>					X
<u>Flammeo marinus</u>					X
<u>Chaetodon sedentarius</u>					X
<u>Chaetodon aculeatus</u>					X
<u>Epinephelus fulvus</u>					X
<u>Serranus lucipercanus</u>					X
<u>Bodianus sp.</u>					X
<u>Centropyge argi</u>					X

RS = Rock sand 1,565'-1,100'
 RW = Rock wall 1,100'-400'
 RWRT = Rock wall/ridge top 400'-270'

Dive #1192

General Locality - North of east end of Puerto Rico; Site 9 in the proposal. See Table 1 for location and other station data.

Objectives - Population transects and point estimate counts of fishes and invertebrates by depth and habitat type.

Depth - 388 m - 106 m (1,280' - 350').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Surface	28.13	83.76
100	28.29	84.09
200	27.11	84.12
300	25.60	83.74
400	22.86	82.71
500	21.75	81.73
600	20.20	80.67
700	19.14	79.62
800	18.00	78.57
900	17.28	77.49
1,000	17.07	76.98
1,100	16.85	76.66
1,200	15.78	76.36
1,280	15.37	75.39 Bottom

Visibility - Estimated by submersible pilot as 15 m (50').

Current - 0-0.2 kn.

Observations - From 388 m - 182 m (1,280' - 600'), the bottom was basically sand-silt with some rocks. Very few invertebrates were encountered, although some burrows were present. Rocks were more frequently encountered as we moved upslope. At 182 m (600'), the habitat changed markedly to one of rock. Most of this rock was broken or boulder-like. The slope was 5°-10° from 388 m - 182 m (1,280' - 600'). At ca. 182 m (600'), it increased rapidly to 80°-85°. Invertebrate growth on rocks at depths of 182 m (600') or less was extensive.

At deeper transects, 388 m - 298 m (1,280' - 985'), the most frequently encountered fish was a species of Gempylidae (probably Epinnula). All individuals of this species were ca. 10.0 cm - 12.5 cm (4"-5") TL and positioned themselves vertically with head up and tail on or near the substrate. The caudal, soft dorsal, and anal fins were then vibrated rapidly. Other fishes seen at these depths were Polymixia, Etelis oculatus, Antigonia capros.

an unidentified lutjanid which may be a Symphysanodon or Pristipomoides, a peristediid, and a cynoglossid.

Many fishes seen at depths of 298 m - 186 m (985' - 615') could not be identified due to their small size and/or distance from the submersible. Individuals identifiable to family or below were species of Mullidae, Lutjanidae, and Carangidae. Most fishes at these depths were near rocks. At 186 m - 95 m (615' - 315'), fish groups typical of rocks or coral reefs (i.e., Pomacanthidae, Chaetodontidae, Serranidae, Lutjanidae, Holocentridae, Pomacentridae, Grammidae) were dominant.

Dive #1193

General Locality - The north coast of the Virgin Islands; Site 8 in the proposal. See Table 1 for location and other station data.

Objectives - Population transects and point estimate counts of fishes and invertebrates by depth and habitat types.

Depths - 455 m - 91 m (1,500' - 300').

Temperature and Conductivity Profile

<u>Depth in ft</u>	<u>Temp °C</u>	<u>Conductivity</u>
Surface	28.06	82.99
100	28.38	83.75
200	27.51	84.07
300	26.53	83.99
400	23.96	83.33
500	22.18	82.19
600	21.18	81.34
700	19.71	80.41
800	18.60	79.26
900	17.91	78.69
1,000	17.19	77.85
1,100	16.63	77.18
1,200	16.32	76.85
1,300	14.55	76.04
1,400	14.04	75.01
1,500	13.60	74.00 Bottom

Visibility - Estimated by submersible pilot as 15 m (50').

Current - 0

Observations - This dive off the north coast of the U.S. Virgin Islands was a highly productive dive in terms of population and habitat evaluation along the defined transects.

Queen snapper (Etelis oculatus) were observed in about 318 m (1,050') associated with several large isolated rocks. Snapper (Lutjanus) were first observed in about 227 m (750'), again associated with isolated rock outcroppings. They were then observed from 227 m (750') to the upper wall edge. Observed snapper included blackfin (L. buccanella), silk (L. vivanus), and dog snapper (L. jocu) with the possibility of a Caribbean red snapper (L. purpureus). No epinepheline grouper were noted, which was unfortunate as one of our target species was the misty grouper (E. mystacinus). However, several specimens of yellowmouth grouper (Mycteroperca interstitialis) were seen along the wall edge in about 91 m (300'). These grouper have the remarkable ability to dramatically vary color pattern almost instantaneously. This is a characteristic of most, if not all, grouper species. At the completion of this dive the submersible settled to the bottom and all lights were extinguished. In a short period of time (10 minutes or less), many snapper and grouper specimens gathered around the submersible. The video was turned on, followed by the submersible lights; within a few seconds after the lights were turned back on, those specimens which had gathered around the submersible quickly departed, leaving few specimens in the vicinity of the submersible. This response was similar to that noted for Anthias nicholsi off South Carolina. During the lights off experiment, the submersible used ambient light when maneuvering about. Fish distribution was greatest along the wall edge, for when the submersible settled down about 21.6 m (60') below the edge, fish were noted above the submersible, not around it. After moving up slope about, 10.8 m (30'), we were again surrounded by fish and the light experiment was replicated with the same end results.

Species List, Dive 1193, Site 8, North Coast of St. Thomas Island, U.S Virgin Islands.

Species	Transects						
	1 SMS	2 SMS	3 SMS	4 SMS	5 SMS	6 RW	7 RW
<u>Myctophidae</u>	X						
<u>Chlorophthalmus sp.</u>	X						
<u>Epinnula orientalis</u>	X						
<u>Polymixia nobilis</u>	X						
<u>Gemplyidae</u>							
<u>Parasudis truculenta</u>		X		X			
<u>Cyttopsis roseus</u>		X					
<u>Etelis oculatus</u>		X		X			
<u>Lutjanus sp.</u>							
<u>Lutjanus vivanus</u>							
<u>Caranx lugubris</u>							
<u>Seriola dumerili</u>							
<u>Synodontidae</u>							
<u>Holanthias martinicensis</u>							
<u>Pristigenys alta</u>							
<u>Labridae</u>							
<u>Chaetodon guayenensis</u>							
<u>Chaetodon aculeatus</u>							
<u>Serranus lucipercanus</u>							
<u>Serranus tortugarum</u>							
<u>Paranthias furcifer</u>							
<u>Mycteroperca interstitialis</u>							
<u>Chromis insolatus</u>							
<u>Pomacentrus partitus</u>							
<u>Centropyge argi</u>							
<u>Liopropoma mowbrayi</u>							
<u>Pomacanthus paru</u>							
<u>Kyphosidae</u>							
<u>Malacanthus plumieri</u>							
<u>Caranx ruber</u>							
<u>Gobiidae (burrowing)</u>							

SMS = Sand mud silt 1500' - 700'
 RW = Rock wall 700' - 300'
 RT = Reef top 300' -

HABITAT CHARACTERIZATION AND FAUNAL DENSITIES

A major objective of the submersible studies was to document habitat types between 300 and 1,500 feet and to document the presence and density of commercial species in relation to habitat type and depth category. This was accomplished through vertical submersible transects from the lower slopes and rock walls to the shelf break at 270-200 feet. Dives were initiated at the offshore transect to insure that the forward observation bubble would be facing the slope or wall as the submersible ascended. Because of strong surface currents and the steep slope at some sites, it was difficult to deploy the JOHNSON SEA-LINK II and have it reach bottom at precisely 1,500 feet; therefore, starting depth varied between 1,300 and 1,700 feet. The NOAA Ship CHAPMAN surveyed each site prior to the arrival of the R/V SEWARD JOHNSON, providing dive coordinates and insuring that a full range of depths was available. Distance per dive was limited to no more than 1 nautical mile, as greater distances could not be covered in a 3-hour dive upslope. When the vertical distance to be covered exceeded 1 mile, the offshore starting point was moved inshore to 1,200-1,300 feet to insure that the upper slope and wall could be reached.

Description of Habitats - Two basic kinds of slope-shelf were viewed. One was a rugged rocky habitat at all depths, which was seen at both sites in the Mona Passage. At Site 1 and Desecheo, large rocks and boulders formed an extremely rugged jumble that was unrelieved from the start to the end of each dive. These areas consisted of large rock piles, with little or no level areas. Site 1 was characterized by strong currents, even in depths exceeding 1,000 feet. Small depressions in and between the large boulders were filled with sand with 3- to 4-inch current ripple patterns. Small "rivers" of sand were found between the boulders and there were apparently occasional cascades of sand down the nearly vertical rocky faces. The ruggedness of the areas makes them appear to be excellent habitat for deepwater fishes, but the sites, below 400 feet, were surprisingly depauperate. Few attached invertebrates were seen at depths below 400 feet, with only a few small hard corals and small sponges attached to the myriad rock faces. Above 400 feet at Desecheo, the habitat became extremely productive, with a profusion of hard and soft corals, sponges, and colonial hydroids. Numerous tropical reef fishes were seen, along with a moderate number of blackfin snappers and a few groupers. This rich habitat is extremely limited, however, and is undoubtedly confined to the upper slope and edge of the dropoff. The balance of rocky habitat in the Mona Passage area is below the photic zone and is probably similar to deep areas viewed at Site 1 and Desecheo.

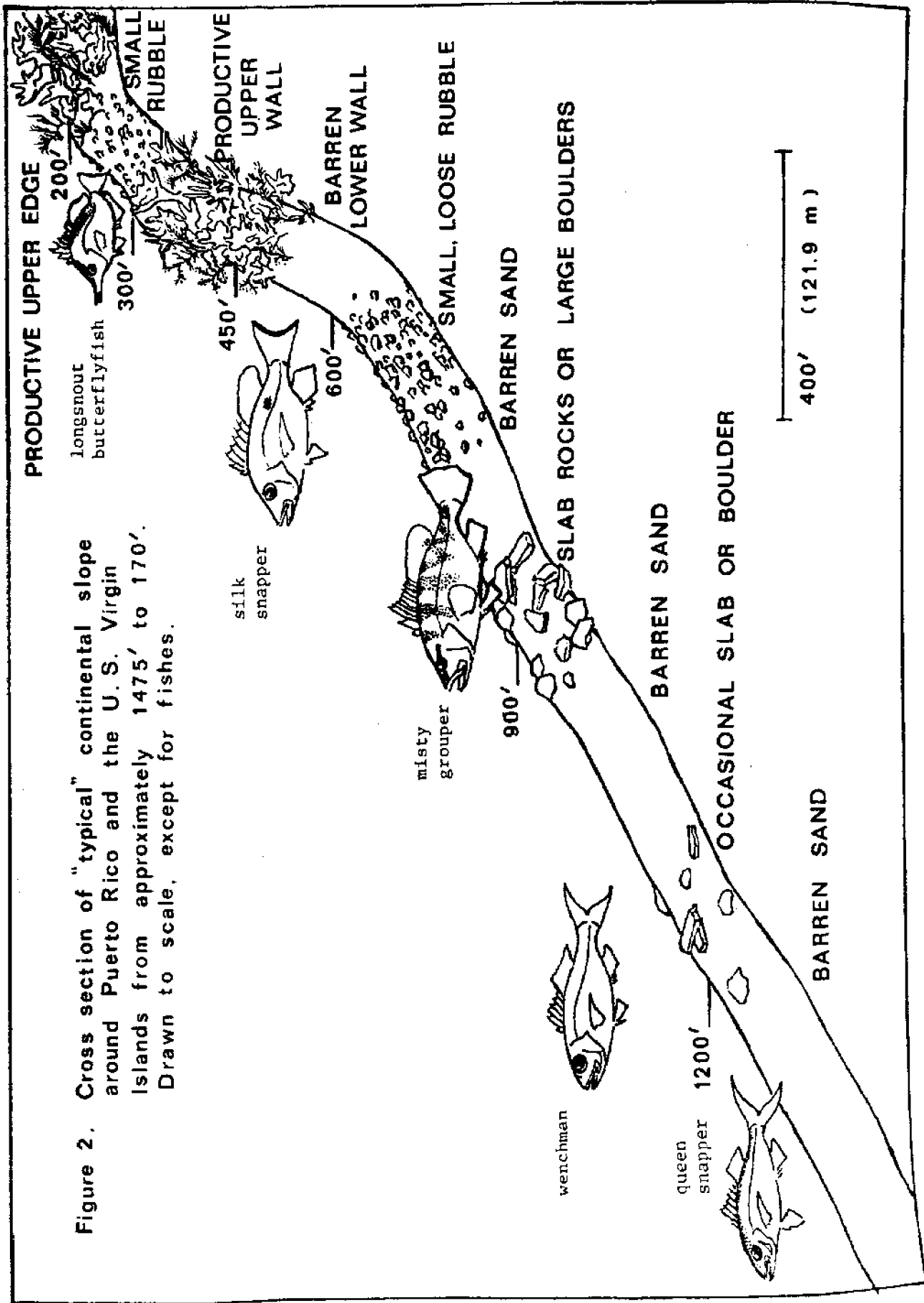
The second type of slope-shelf areas viewed during the study appears to be "typical" around Puerto Rico and the U.S. Virgin Islands (Fig 2). Although some variation was seen at each site, a basic pattern was always present. Bottom composition at about 1,500 feet was sandy, with some overlying silt. The slope was gentle, ranging from 5 to 15 degrees, depending on the particular site. Rocks or small, grade-level slabs were seldom seen and the habitat was extremely unproductive. Occasional emergent sponges, soft corals, or crinoids were seen, but were widely scattered. Fishes were widely scattered, usually consisting of noncommercial deepwater species such as gempylids and myctophids. The predominant impression is one of smooth, barren sand unrelieved by topographic features.

Between 1,500 and 1,200 feet, the bottom remains unchanged, marked only by a few emergent invertebrates. The slope increased gradually to 15 to 20 degrees between 1,500 and 1,200 feet, with rare large boulders or emergent slab rocks sighted. Very few attached invertebrates were seen on the hard substrate, except for occasional groups of crinoids on small slabs. Wenchman snappers (Pristipomoides spp.) were occasionally seen around these small emergent slabs. Queen snapper (Etelis oculatus) were also seen in this habitat but appeared to be highly mobile and not associated with any particular rock outcrop.

Little change in habitat type was noted between 1,200 and 900 feet, except that the slope gradually increased to 25 to 30 degrees. Some increase was noted in the number of rock outcroppings and slabs sighted. Basically, the area remained sandy and unproductive, with occasional sponges, hydroids, soft corals, hard corals, crinoids, and gorgonians attached to the rocky substrate. With the modest increase in small, emergent slab rocks in this depth stratum, there was some accompanying increase in the abundance of wenchman snapper, blackfin snapper (Lutjanus bucanella) and silk snapper (Lutjanus vivanus). The emergent slabs were not abundant at any site, however, the overall abundance of both commercial and noncommercial fishes remained low.

A rubble zone was encountered at about 900 feet, with relief and density of the rubble dependent on the particular site. In general, the rubble appeared to be predominately slab rock on the south side of Puerto Rico and the U. S. Virgin Islands, and large boulder outcrops on the north side. The large boulders appeared to be igneous in origin and were 3 to 20 feet in diameter. These large boulders were also characteristic of the slope found east of St. Croix and both north and south of St. Thomas and St. John. The slab rock rubble was loose, and several flat 2-to-3 feet slabs were occasionally found piled together, forming crevices for deepwater squirrelfishes, and numerous lesser serranids. The large misty grouper (Epinephelus mystacinus) was seen only in

Figure 2. Cross section of "typical" continental slope around Puerto Rico and the U. S. Virgin Islands from approximately 1475' to 170'. Drawn to scale, except for fishes.



this rubble zone, as were moderate numbers of silk snapper and occasional wenchman and queen snappers. Width of the rubble zone varied greatly between sites and ranged from very narrow (one rock wide) to 300 to 400 feet wide. Like lower depths, there were few attached invertebrates and the area appeared generally unproductive, despite the increased density of rocky substrate.

Above the upper end of the rubble zone (900 to 700 feet) the slope increased to 30 to 50 degrees, with sand or very small loose rubble being the predominant bottom type. This area was even more unproductive than the rubble zone below, with almost no suitable areas for the attachment of invertebrates. The small, loose rubble provided no niches for concealment and large fishes, except for occasional jacks, were rarely seen. Large boulder outcrops or larger slab rocks were sometimes seen in this depth stratum, but the bottom was generally unbroken, sloping up to the lower edge of a wall at 600 to 650 feet.

The depth at which the steep wall started varied according to site, but it was generally marked by a vertical or near vertical expanse of barren, reasonably smooth rock. The lower wall, from about 600 to 450 feet, had few attached invertebrates and a depauperate fish fauna. Dominant fishes were small, with triggerfishes and lesser serranids generally hidden in small burrows or in the few crevices along the lower wall. Large cracks or "gullies" down the lower wall were filled with sand and small rubble that has cascaded down from upper reaches. Occasional small schools of silk or blackfin snapper were seen along the lower wall, as was an occasional solitary grouper.

At about 450 feet, ambient light was noticeable and overall productivity increased markedly. Large numbers of typical tropical reef fishes were associated with an increase in abundance and diversity of hard and soft corals, sponges, and hydroids as depth decreased to about 300 feet. Small to large schools of blackfin snapper were occasionally seen along the upper wall as were isolated individuals of black snapper (Apsilus dentatus), dog snapper (Lutjanus jocu), and Caribbean red snapper (Lutjanus purpureus). At most sites on the south side of the Islands, the upper slope was nearly vertical, so the effective area of higher productivity is extremely narrow. Site 6, south of St. John was of particular interest in that the vertical wall consisted of a series of overhanging ledges with schools of blackfin and silk snapper moving back and forth under the overhangs in 300 to 600 feet of water.

The north wall, based on Sites 8, 9, and 12, is not as steep as the south wall. A slope of 50 to 70 degrees was typical, with the wall ascending as a series of slabs or rock outcrops instead of smooth rock. Individual rock ledges, 10 to 15 feet high, ascended like stairsteps at some sites up to a depth of 300 feet.

Attached invertebrates appeared similar in diversity and abundance at comparable depths on both sides of the Islands.

At about 300 feet, the slope decreased markedly to 20 to 30 degrees as the upper edge of the wall was reached. This sudden change in slope angle was marked by a band of unproductive, relatively barren small rubble. This band extended upwards to a depth of 270 to 250 feet, and contained few attached sponges and corals, and a depauperate fish fauna. Occasionally, vertical outcroppings and walls 10 to 15 feet in height protruded from this upper rubble zone, but at most sites only a gentle, rubble-covered slope was found. At the top of this slope, the bottom flattened out with a typical, tropical reef finfish and invertebrate fauna associated with the upper edge and reef top.

No attempt was made to develop quantitative estimates of abundance of fishes above the 300-foot depth. Classifications of habitat type were also not undertaken once the edge of the insular shelf was reached. The abundance and diversity of tropical reef faunal assemblages and habitats was too complex to adequately detail, with the limited amount of time available at each site. Great amounts of ambient light also changed effective viewing distances from the submersible, making comparisons with observations from greater depths difficult without re-standardization of the assessment techniques. A detailed evaluation of the shelf-top fauna and habitats would have required several days at each site and would have jeopardized our primary objective to evaluate the deepwater habitats and fauna around Puerto Rico and the U.S. Virgin Islands. In addition, large seas on the open shelf areas caused a bottom surge that, along with strong currents, and greater turbidity made operation of the submersible difficult in depths less than 200 feet.

Our reason for including Site 10, just west of the mouth of San Juan Harbor, was to evaluate the vertebrate and invertebrate fauna and habitat characteristics to determine the impact of outflow from San Juan. A considerable amount of siltation was seen in deeper areas, but depths greater than 700 feet seemed no more depauperate than most of the other deep areas surveyed. However, the sediment was so heavy in the water column that the dive was terminated at 700 feet, when visibility was reduced to 10 feet or less. One dive off the western end of Saint Croix, just north of Frederiksted, showed very heavy sediment on the bottom throughout the full range of the dive. Very few sponges or corals were seen at any depth. Only a few small fishes were seen at depths of 1,980 to 450 feet, and the expected large number of tropical reef fishes found above that depth was not present. Shallow dives for coral and algae were conducted at Site 3, just east of the entrance to Guanica Harbor. Although the current was flowing to the west, the upper wall area was heavily sedimented, reducing the abundance and diversity of attached invertebrates

and limiting the depth at which macroalgae was found. This site was sampled shortly after the tropical wave that devastated Puerto Rico with high winds and heavy rains in early October, and sedimentation may have been higher than normal due to extensive flooding and runoff from southern Puerto Rico. Other than these three sites, no evidence of heavy siltation or other effluent was noted in the dives that were spaced around the islands. In general, waters to the upcurrent end of the islands (Sites 5, 6, and 7) were exceptionally clear, whereas sites downcurrent showed increased sedimentation and higher levels of turbidity in the water column.

Faunal Transects - Vertical transects and point counts to estimate faunal densities were run with the submersible at each of the 13 primary sites, except for Site 11, which was dropped because of a shortage of time. Transects were also run at Desecheo, a site added during the survey. Transects over the full depth range intended (1,500 to 300 feet) could not be run at Site 1 (Mona Passage) because of strong currents and at Site 7 (west of San Juan) because of poor visibility. Transects were started at 1,500 feet, where possible, and were 100 yards in length when habitat type was constant. Transects were broken at each change in habitat type and a new transect was begun. Transects were also broken at 1,200-, 900-, 600-, and 300-foot contours, and new transects were initiated. Plans to make 3 one-minute point counts at the beginning and end of each transect were not rigorously followed. Generally, the run upslope from 1,500 to 600 feet involved long distances over barren sand and required a considerable portion of the 3- to 3 1/2-hr dive. Actual positioning of the submersible and replication of the point counts, with one-minute intervals between each count, took 10 to 12 minutes, and would have added 1 to 2 hours to each dive. Documentation of habitat types and distribution of fishes throughout the slope was of high priority, and point counts were frequently omitted. This was particularly true after several days were lost to weather and the number of dives dedicated to each of the remaining sites had to be reduced from two to one.

Density data were obtained on all fishes seen between 1,500 and 300 feet, but most were small and not of commercial potential. These will be addressed in scientific publications and are not included in data summarized for this cruise report. Number of fishes sighted, by species, was recorded for each transect and standardized to number per 1,000 square yards. The area covered by each transect was based on the length of the transect, the visibility (effective sighting distance) and viewing angles from the forward and rear observer compartments. Transect data from the forward and rear compartments were treated separately. Data for the commercial species were summarized by depth category and habitat type.

Density by depth - A total of 176 transects was run over four depth categories (Table 2). The distribution of transects is reasonably proportional to the amount of bottom within each of the depth categories from 1,200 to 300 feet. The 1,500- to 1,200-foot depth is undersampled, in that several of the dives started at depths of less than 1,500 feet, while most transects of 100 yards in length could be run in the greater depth categories, because of the gentle slope, while shallow areas (600 feet to 700 feet) were generally covered in one or two transects because of the steepness of the slope (i.e., if the wall was vertical, one 100-yard transect would cover the 600- to 300-foot depth contours).

The variety and density of groupers seen were surprisingly low (Table 2). None were sighted in the 1,500 to 1,200- and 1,200- to 900-foot depth categories, where misty and yellowedge groupers have been taken on past longline surveys. The only misty grouper seen (3) were in the 900- to 600-foot rubble zone. Only a very small percentage of the deep area around the islands was surveyed by submersible, but the lack of sightings may be indicative of a very low population size. Unlike deepwater large snowy and yellowedge grouper surveyed off South Carolina and Texas with a submersible, misty grouper did not appear curious and swim around the submersible. Instead, they were seen under or behind rock slabs and were reluctant to leave hiding places. The only other groupers seen below 600 feet were coney (Epinephelus fulvus), which are small and only marginally commercial. Coney also dominated sightings in the 600- to 300-foot depth category, although Nassau (E. striatus), red hind (E. guttatus), and several unidentified groupers were recorded on these transects. Most groupers sighted were above the 300-foot depth contour, and are not included in the density estimates.

Snappers were more abundant than groupers in all depth categories, although never in high densities (Table 2). Queen snapper occurred in low but equal densities from 1,500 feet to the lower edge of the wall. Blackfin snapper increased in abundance from 1,200 feet to 300 feet and were the dominant snapper seen along the upper wall. Silk snapper were found from 1,200 feet to about 400 feet, and were most abundant in the 900- to 600-foot depth interval. Wenchman snapper were found from about 1,350 feet to about 700 feet and were widely scattered throughout the entire area, despite their low overall abundance. However, they were generally sighted as individuals, instead of in schools as was characteristic of the other snappers. The variety and abundance of snappers increased as depth decreased, with black snapper, dog snapper, Caribbean red snapper, and vermilion snapper being found in the 600- to 300-foot depth range. The number of unidentified snappers (Lutjanus sp., Table 2) was fairly high because snappers were frequently seen from the

Table 2. Number of commercial groupers and snappers seen by depth category per 1,000 sq. yards on submersible surveys around Puerto Rico and the U.S. Virgin Islands, Oct. 1-23, 1985. Number of transects in parenthesis.

Species	1500-1200' (45)	1200-900' (66)	900-600' (40)	600-300' (25)
Serranidae	-	-	-	0.113
<u>Epinephelus fulvus</u>	-	-	0.007	0.617
<u>Epinephelus guttatus</u>	-	-	-	0.078
<u>Epinephelus mystacinus</u>	-	-	0.007	-
<u>Epinephelus striatus</u>	-	-	-	0.012
<u>Apsilus dentatus</u>	-	-	-	0.064
<u>Etelis oculatus</u>	0.031	0.030	0.034	-
<u>Lutjanus sp.</u>	0.036	0.033	0.702	0.632
<u>Lutjanus bucanella</u>	-	0.004	0.033	0.928
<u>Lutjanus jocu</u>	-	-	-	0.012
<u>Lutjanus purpureus</u>	-	-	-	0.021
<u>Lutjanus vivanus</u>	-	0.038	0.350	0.242
<u>Pristipomoides sp.</u>	0.004	0.069	0.042	-
<u>Rhomboplites aurorubens</u>	-	-	-	0.012

submersible at distances too great for identifying characteristics to be observed. Snappers, particularly those at shallower depths, displayed an avoidance reaction to the submersible, and there is a possibility that this avoidance led to an underestimate of the densities of snappers.

Density by habitat type - A wide variety of permutations in habitat type was seen and a large number of types could be identified by considering small differences in sediments, in rock structure or frequency of outcrops, in wall steepness, or in other minor factors that made no two sites nearly identical. However, we have summarized habitat type into four general categories:

- ° Sand - Barren, without rocky outcroppings, and frequently with a thin veneer of silt.
- ° Sand Rubble - Mostly sand with scattered boulders or slab outcrops.
- ° Rugged Rock - Large, closely-packed boulders with little or no sand. Primarily in Mona Passage.
- ° Rock Wall - The upper slope, usually sheer, although occasionally a series of stepped rock ridges or smooth lapstrake rock caps.

The distribution of transects by habitat type is reasonably indicative of the relative percentage of habitat types seen around Puerto Rico and the U.S. Virgin Islands (Table 3). Since the full depth range from 1,500 to 1,200 feet was not covered at each site, and since the deeper sites were mostly barren sand, that habitat type is probably undersampled. Groupers were not found on the barren sand or on the rugged rock habitat. Lack of grouper on the rugged rock habitat was surprising, and may be due to the low stock size and limited number of transects in that habitat. Large misty grouper were found only in the sand rubble habitat while red hind were found on both the sand rubble and the rock wall habitats. The coney were found frequently on shallower rock walls, but, along with the red hind, were seen in some abundance only above the 300-foot depth limit imposed for this study. A number of other groupers, such as tiger, yellowmouth, and Nassau, were also seen on the shelf edge or reef top above 300 feet.

Snappers were seen in all areas but were in low abundance on barren sand and sand rubble (Table 3). Queen, silk, and wenchman snapper were occasionally seen over barren sand, but there were undoubtedly small rock outcrops or slabs nearby. Silk snapper was the most abundant species sighted on the sand rubble

Table 3. Number of commercial groupers and snappers seen by habitat types per 1,000 sq. yards on submersible surveys around Puerto Rico and the U.S. Virgin Islands, Oct. 1-23, 1985. Number of transects in parenthesis.

Species	Sand (100)	Sand Rubble (35)	Rugged Rock (18)	Rock Wall (23)
Serranidae	-	-	-	0.123
<u>Epinephelus fulvus</u>	-	0.008	-	0.670
<u>Epinephelus guttatus</u>	-	-	-	0.084
<u>Epinephelus mystacinus</u>	-	0.008	-	-
<u>Epinephelus striatus</u>	-	-	-	0.013
<u>Apsilus dentatus</u>	-	-	-	0.070
<u>Etelis oculatus</u>	0.020	0.017	0.121	-
<u>Lutjanus sp.</u>	0.079	0.031	1.271	0.688
<u>Lutjanus bucanella</u>	0.004	0.017	0.032	1.009
<u>Lutjanus jocu</u>	-	-	-	0.013
<u>Lutjanus purpureus</u>	-	-	-	0.023
<u>Lutjanus vivanus</u>	0.026	0.105	0.570	0.263
<u>Pristipomoides sp.</u>	0.045	0.041	0.032	-
<u>Rhomboplites aurorubens</u>	-	-	-	0.013

and rugged rock habitats, while blackfin snapper dominated on the 300- to 600-foot deep rock walls. Species such as black, dog, and Caribbean red snappers were associated with the upper wall, starting at about 450 feet where the density of attached invertebrates increased markedly.

Densities of snappers and groupers combined indicated very low numbers of commercial fishes per 1,000 square yards, regardless of depth or habitat type (Table 4). Averaging the mean for each depth category into an overall unweighted mean for the entire area around Puerto Rico and the U.S. Virgin Islands from 300 to 1,500 feet provides estimates of 0.83 and 0.24 snappers and groupers, respectively, per 1,000 square yards. Eliminating the small coney grouper from the "commercial fish" estimates provides overall means of 0.83 and 0.05 snappers and groupers, respectively, for a combined estimate of 0.88 fishes per 1,000 square yards. Based on the average weight of 3.5 pounds per fish of all snapper and grouper combined that were taken on bottom longlines during the cruises, a commercial potential of 3 lb per 1,000 square yards exists in this area.

Submersible-Longline Comparisons

One of the objectives of the study was a comparison of longline catches with actual observations from the submersible. Based on work done with submersibles and bottom longlines by the Mississippi Laboratories and the Texas Division of Coastal Fisheries on golden tilefish and yellowedge grouper off of Texas in 1984, an effective fishing width of the longline was determined to be approximately 40 feet. All fishes within a 40-foot swath are not caught, but the longline catches some fish attracted to it from beyond the 40-foot swath and the overall effect of this catch is estimated to be similar to that if all fish within the 40-foot swath were removed. Based on this removal rate, populations of commercial fishes available to longlines can be extrapolated.

A test of this hypothesis, comparing projected longline catch rates, based on calculated densities from submersible transects against actual catch rates made by the NOAA ship CHAPMAN, provides support for the validity of both assessment techniques (Table 5). A 1,200-foot bottom longline set, assuming the 40-foot wide fishing area, covers approximately 5,333 square yards. Multiplying the mean number of commercial snapper and grouper per 1,000 square yards based on submersible counts in the 1,500- to 300-foot depth range by the area covered per set (5.3 thousand square yards) provides a projection of numbers that should have been taken per set. Mean catch rates and submersible-derived densities were calculated for each of the four depth categories and an overall unweighted mean for each method is used in the comparison. A small grouper, Epinephelus

Table 4. Total number of commercial groupers and snappers seen by depth category and habitat type per 1,000 sq. yards on submersible surveys around Puerto Rico and the U.S. Virgin Islands, Oct. 1-23, 1985. Number of transects in parenthesis.

Depth category (ft.)				
	1500-1200 (45)	1200-900 (66)	900-600 (40)	600-300 (25)
All groupers	0.000	0.000	0.014	0.820
All snappers	0.071	0.174	1.161	1.923
Total commercial	0.071	0.174	1.175	2.743

Habitat Type				
	Sand (100)	Sand Rubble (35)	Rugged Rock (18)	Rock Wall (23)
All groupers	0.000	0.016	0.000	0.890
All snappers	0.174	0.211	2.026	2.067
Total commercial	0.174	0.227	2.026	2.957

Table 5. Actual catch rates of snapper and grouper per set of a 1,200-foot longline compared with projected catch rates based on snapper and grouper densities estimated from submersible surveys around Puerto Rico and the U. S. Virgin Islands, Oct. 1-23, 1985 (46 sets from 300-1,500 feet).

	Actual Catch No./Set	Projected Catch No./Set
Commercial Snappers	3.5	4.4
Commercial Groupers	0.3	0.3
Total	3.8	4.7

fulvus, listed as commercial in Tables 2 and 3, is rarely taken on longlines (none were caught between 300 and 1,500 feet) and was therefore not included in the calculations. A considerable amount of variation is found within individual species and within individual depth categories, requiring a detailed analysis, but for purposes of this cruise report, overall results are given and serve as indicators of the validity of the two methodologies and of the overall level of abundance of snappers and groupers in the deepwater (300- to 1,500 foot) slopes around Puerto Rico and the U.S. Virgin Islands.

Trap and Bait Studies and Deepwater Shrimp and Fish Transects - Seven dives were dedicated to trap and bait studies and faunal characterization along a transect off Guanica (Site 3) from 225 m to 725 m and one off Aguadilla (near Sites 12 and 13). Observations of fish and shrimp traps were unsuccessful, partially due to difficulty in locating traps. When traps were located, faunal observations had to be cut short due to fouling of lines in thrusters or obscured visibility. One longline set was located for observations on bait-type preference and the effect of bait height off the bottom. The latter experiment was unsuccessful as the Kali-pole floats imploded (depth was 725 m) so that most poles rested on the bottom. At the time of observation (four hours after set), there was too little activity among the invertebrates of interest to determine bait preference. Abundance around the bait appeared to be related to size, mobility and ability to respond. Sharks were already abundant, and isopod (Bathynomus) activity increased during the period of observation. Of particular note was the observation of Heterocarpus shrimp and a hagfish (Myxine). These are common species in trap catches but were not observed during visual census. Isopods were observed to be numerous and nonselective feeders, capable of rapid response to bait, and swimming in from long distances.

Faunal characterizations through visual census (horizontal transects) and photography/collections were made at 425 m and 725 m and compared to trap catches. Off Guanica, the dominant invertebrates at both depths were penaeid shrimps, several of which were videotaped for later identification. The pandalid shrimps that dominated trap catches were either absent or recorded in low abundance. The only invertebrate commonly observed visually and in trap catches was the giant isopod, Bathynomus giganteus. Other common crustaceans were galatheid crabs and nephropsid lobsters.

Principal fishes in deep traps have been moray eels and hagfishes. This contrasts with visual observations, where characteristic species were Chaunax, peristediids, and macrourids. Polymixia dominated at 425 m and halosaurid eels and bathypteroids dominated at 725 m. Small sharks, Etmopterus spp., were observed visually and caught on longline. An observation of note at 725 m was the documentation of chimaera swimming behavior.

Off Aguadilla, some differences were noted in the 725-m fauna. The dominant invertebrate species was a pandalid shrimp, whereas one of the dominant penaeids off Guanica was not recorded. Bathypteroids were the dominant fishes, and halosaurid eels were not recorded.

Comparison of visual observations with trap catches shows traps to be highly selective. Either the majority of species do not detect at distance and/or utilize large benthic food sources (bait), or their activity is curtailed by the behavior of more voracious species (hagfish, eels, isopods, pandalid shrimp). Deepwater shrimp and fish transect data from Guanica and Aguadilla are currently being analyzed by personnel of the University of Puerto Rico Department of Marine Science.

Upper Slope Fish, Coral, and Algae Studies - Horizontal, visual census transects at 70 m and 120 m were run to characterize the deep reef fauna off Guanica. An additional census at 33 m, designed to calibrate with shallower scuba transects, could not be done due to poor visibility and wave surge. A subsequent dive documented species with videotape, photographs and collections. At 120 m, 14 species were recorded, with Serranus lucipercanus and Chromis enchrysurus dominant. Collections at this depth were hampered by high predatory activity on fishes affected by rotenone. Principal species observed were Serranus tortugarum, S. lucipercanus and S. tabacarius, with serranids forming 61% of the fauna. Principal predatory species were Lutjanus spp., Holocentrus spp. and others. The horizontal transect data are currently being analyzed by personnel from CODREMAR.

The Guanica area was also surveyed for algae and corals. Siltation was very high in this area, possibly due to runoff from Guanica Bay. From 220 m to 120 m, siltation was complete; no macroscopic algae were observed. At 90 m there was less siltation, but no algae were seen. At this depth sponges were collected as possible substrates for microscopic rhodophytes and returned to the laboratory for subsequent analyses. Corals were observed during a series of horizontal transects at selected depths, and collections were made. Stylasterin and black corals were recorded as well as other species of soft and hard corals. (See writeup on dives #1175, #1177). Coral and algal finding are being described by personnel of the University of Puerto Rico Department of Marine Science.

CONCLUSIONS

1) The potential for a deepwater shrimp fishery has not been fully defined, and continued work is necessary to determine the extent of deepwater shrimp distributions and their density.

2) Trap efficiency and bait attraction studies were inconclusive, and additional effort is needed to determine appropriate trap design and bait preference to optimize catchability.

3) Additional effort will be required to provide quantitative fish density estimates of outer shelf areas to

relate diver estimates on the inner shelf to upper and lower continental slope submersible-derived estimates of faunal density.

4) Coral and algae studies were hampered by heavy sedimentation at the sites selected, and additional sites in sediment-free areas should be surveyed to provide a better summary of species distribution and abundance around Puerto Rico and the U.S. Virgin Islands.

5) A majority of the habitat around Puerto Rico and the U.S. Virgin Islands was barren sand, followed by deep sand-rubble, a 300- to 400-foot steep wall at the upper edge of the continental slope, and limited areas of rugged rock.

6) The barren sand, rock-rubble and wall area below 450 feet were extremely unproductive, with few attached invertebrates and a depauperate fish fauna.

7) Above 450 feet, productivity increased sharply with sponges, corals and associated fishes becoming more abundant and diverse as the upper edge of the continental slope was approached at 200 to 300 feet.

8) A number of commercial species were associated with the upper slope and shelf edge and were not found below the 450-foot depth where substantial ambient light was first noted.

9) Dominant deepwater species were silk, blackfin, wenchman, and queen snappers, but none were found in abundance.

10) Grouper abundance was very low, even along the upper shelf edge and reef top where the greatest number and variety were seen.

11) Overall estimates of abundance of commercial snappers and groupers combined for the 300- to 1,500-foot depth-range studied are approximately 0.88 fishes and 3 pounds per 1,000 square yards.

12) Both submersible and bottom longlines proved effective tools for estimating the abundance of deepwater snappers and groupers, with projected catch rates based on submersible-derived density estimates being similar to actual bottom longline catch rates made at the same locations surveyed by the submersible.

13) The upper shelf edge and reef top were highly productive, but the complexity of vertebrate and invertebrate fauna will require assessment and analytical techniques of a higher degree of sophistication than those employed for the

deepwater studies conducted in the past by the National Marine Fisheries Service.

14) Longlines will be ineffective in assessing stocks on the flat, tropical reef top and shelf edge because of excessive fouling of longline gear and rapid bait loss due to large numbers of small, tropical reef fishes.

15) Several unidentified deepwater fishes were observed and collected, and unique information was obtained on behavioral, color, and swimming patterns of a number of deepwater species.

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