continental shelf off the Guianas during eight cruises of the MV *Calamar* (Kleijn 1974). Fishing during daylight was done by handlining, a small trawl for catching bait, and at night with one or two sets of steel-cable bottom setline.

Over 4,600 sharks of 25 species, weighing over 165,000 pounds (74,820 kg) were caught. Nearly half were caught during 245 hours of handlining with 1-8 lines and about the same number were caught with 105 sets or 1,212 hours of steel-cable setlines with 100-175 hooks. Sharks were most abundant between 15 and 20 fathoms during November and December and off the mouths of the Iracoube and Coppename Rivers. The more common species were blacktip shark (*Carcharhinus limbatus*), smalltail shark (*C. porosus*), bull shark (*C. leucas*), and tiger shark (*Galeocerdo cuvieri*).

The whole area off the coast of the Guianas will yield an average of 3,000 pounds (1,360 kg) of dressed shark meat (about 60 percent of round weight) per 24 hours of fishing, i.e., 1,000 pounds (458 kg) with two steel-cable sets during the night and 2,000 pounds (907 kg) with handlining during the day alternated with required trawl hauls.

Because the catch rate of shark is initially high, and the stock rather small, overfishing could easily result from any intensive fishing efforts.

CONCLUSIONS

The results of explorations by project vessels, as well as others, coupled with analyses of ongoing fisheries indicate that fishery resources available to participating countries in the project are not vast, but several offer potential for expansion. Foremost is the trawl resource on the continental shelf off northeastern South America. The second most promising latent resource awaiting greater use is that of snappers, jacks, and groupers. The keys to development of these resources by project countries are training of fishermen in trawling, handlining, and reel and pot fishing for snappers, and the operation of fishing vessels of the size and endurance necessary for these offshore operations. Resources of shark and bait fishes, as well as various pelagic fishes available to live bait fishing and to trolling, are of insufficient magnitude to offer large-scale commercial development, but when and where they are abundant they could be important in increasing the supply of animal protein for local residents. Based on project experience, there appears to be little hope of development of a tuna fishery by the longline or live bait methods by participating countries in the project.

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MFR PAPER 1083

Handline and Longline Fishing Explorations for Snapper and Related Species in the Caribbean and Adjacent Waters

KYOTARO KAWAGUCHI

ABSTRACT — Explorations for snapper and related demersal species have been conducted in the Caribbean and adjacent waters by vessels of the Caribbean Fisheries Development Project. This report presents the results of those explorations which used the handline and bottom set longline methods on the under- or unexploited shelves and banks within the project region.

Three project vessels spent a total of 382 days conducting exploratory and simulated commercial type production fishing for snappers, groupers, and jacks. They produced about 291,000 pounds of fish which averaged about 760 pounds per fishing day or about 14.6 pounds/line/hour of fishing. The species composition of the overall catch was 51 percent snapper (Lutjanidae), 34 percent jacks (Carangidae), 6 percent groupers (Serranidae), and 9 percent other mixed species. The daily catch rates ranged from 0 to 137 pounds/line/hour. Fishing efficiency and catch rates are discussed.

Catch results as related to fishing ground, water depth, bottom type, fishing season, and species composition are examined. Results of experimental use of the bottom set longline method are given.

From exploratory fishing results it is estimated that annual production of snapper could be increased from two to four times by utilizing under- or unfished grounds.

INTRODUCTION

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The United Nations Caribbean Fisheries Development Project became operational in August 1965. The purpose, stated in the Project Plan of Operations (FAO 1965), was: To provide, through exploratory fishing, marketing study and demonstration, and training, a basis for the further growth of the fisheries of the Caribbean Region, by: (a) indicating the most promising ways in which the productivity of the fisheries can be increased; (b) setting up a nucleus of trained fishermen and fishery officers; and (c) demonstrating the most economic ways of developing domestic and export markets and defining those fields in which future capital investment can most fruitfully be applied.

Within these limitations, the Exploratory Fishing portion of the Project performed diverse exploratory and demonstration fishing for all major pelagic and demersal fish resources in the Caribbean and adjacent waters of interest to countries participating in the project. A variety of recognized successful fishing techniques were applied in order to conduct the most effective operation within the limited period available. The fishing efforts were typically directed toward areas unexploited or underexploited by local fishermen of those areas. Some work was carried out in nearshore waters in order to acquire comparative data or to demonstrate more efficient gear or methods. Progress and details of these efforts were, from time to time, published as consecutive Cruise Reports and Fishing Logs and made available to the participating authorities and other interests to provide up-to-date information. At the end of project Phase I (31 August 1969) interim progress reports covering the period from December 1966, when the project vessels began operation, to July 1969 were prepared on methods and results of principal explorations. These provided timely information on which to base commercial operations and planning for Phase II (August 1969-August 1971) explorations.

This report covers part of the work accomplished on one of the two most promising latent demersal fishing potentials in the region—namely, for snappers and related species using the handline method. The objectives of this work were: (1) Locating new or unutilized snapper fishing grounds. (2) Providing training in the use of mechanical and electrical handline methods. (3) Confirming available information on the snapper and related species resource. (4) Providing fish for experimental marketing demonstrations in participating countries. The results of snapper trap or pot work are reported in a separate paper (Wolf and Chislett 1974). Rathjen, Yesaki, and Hsu (1969) summarize demersal fishes available to otter trawls.

The Caribbean Sea is bounded by the Greater Antilles on the north, the Lesser Antilles on the east, the islands of Trinidad and Tobago and the north coast of South America on the south, and the east coast of Central America on the west. The total surface area eastward from the Jamaica Rise is about 800,000 square miles, from which the surrounding countries produce about 440 million pounds of fish (FAO 1968) annually. The continental shelves are generally very narrow in the Greater and Lesser Antilles area, with rather steep slopes descending directly into the ocean depths. Those off the north coast of South America and the east coast of Central America are relatively extensive and productive because of numerous river outflows or upwellings.

There are a number of banks or reefs along the Jamaica Rise between Nicaragua and Jamaica as well as in the Leeward Islands area. They are typically of coral and thus have a relatively rugged bottom. The edges of those banks or reefs are generally steep, dropping off from depths of 30 to 50 fathoms to 400-500 fathoms.

The local fishing industries are small, using mostly the daily beaching type craft at numerous locations due to a small number of natural or man-made harbors. This results in limited landings at a given location and prevents further development of necessary facilities. The typical fishing methods are pot fishing with some traditional handlining for demersal fish and boat or beach seining for pelagic fish, which seasonally approach shore. Gill nets or longlines are employed seasonally in very limited areas. The dominant northeasterly trade wind of the region limits small craft operation to the inshore leeward portions of the islands from October to May, while hurricane threats limit their fishing range during the rest of the season.

At present most of the inshore grounds near those populated islands are intensively fished and larger catches can be expected on the inshore grounds only from pelagic species whose migration routes pass nearshore.

There are a few foreign investments in fishing vessels and shore facilities in the Caribbean area, but these are almost entirely in shrimp, spiny lobster, and tuna. Otherwise, only snappers and related species on the eastern margins of the Central American continental shelf have been commercially utilized by foreign fleets to any extent. This leaves a number of unexploited or underexploited areas on the offshore banks or around unpopulated island shelves which possess the potential for increasing production by Caribbean countries utilizing an appropriate size of fishing enterprise. Dominant species on these banks or outer continental shelves are snappers (Lutjanidae), groupers (Serranidae), and jacks (Carangidae).

HISTORICAL REVIEW

Considerable exploratory fishing for these species throughout the area was conducted by the U.S. National Marine Fisheries Service research vessel *Oregon*. These efforts have employed a variety of fishing methods, such as bottom or mid-water trawling, handlining, bottom longlining, gill netting, and fish traps. Carpenter and Nelson (1968), stated that "Immediate increased snapper and grouper production can be realized through adoption of modern hook-and-line fishing techniques." They also state "limited scale fisheries should be sustainable throughout the Antilles, although they would almost necessarily be a hook-

and-line or trap nature, since relatively little trawlable bottom exists." Gulland (1970) estimates a range of values for the potential annual catch of larger bottom fish from the Caribbean, including off eastern Venezuela, from 50,000 to 200,000 tons. He also feels that this range is in reasonable agreement with the snapper and grouper estimate of 41,000 tons by Carpenter and Nelson. These figures indicate an optimistic target for the increase of demersal fish production by participating project countries in the Caribbean.

From these potential stocks, a full-scale commercial fishing effort by Japanese vessels was attempted by two 110 ton modified tuna longliners based at St. Martin from August 1967 to March 1968 (Anonymous 1967). From two to four catcher boats (2-ton type) were shipped on the larger vessels for mothership operation, utilizing handlines and bottom longlines. During the 8-month period, one vessel produced 240,000 pounds of fish valued at U.S. $45,600 from the entire Caribbean area, while the other caught 395,000 pounds of fish (U.S. $78,400) from only the Leeward Islands area. For various reasons, including marketing problems caused by some of the fish from the Leeward Islands being ciguatoxic, the Japanese operations were discontinued.

In Jamaica in December 1968, the first commercial snapper reel fishing was initiated by a fishermen's cooperative. They purchased a secondhand Florida type snapper vessel, 51 feet length overall (LOA), and manned it with Jamaican fishermen. A skilled U.S. snapper fisherman was employed as captain. The boat fished mostly the offshore banks southwest of Jamaica and produced nearly 150,000 pounds of fish valued at U.S. $35,700 by November 1969, making a total of 14 cruises, each averaging about 2 weeks. The result was economically feasible to them and encouraged further enterprises using cooperative operation.

Off the north and northeastern coasts of South America, a commercial red snapper fishery has existed for past decades along the broad continental shelf. Four vessels, ranging from 70 to 90 gross tons and fishing from Martinique, land about 1,000 metric tons of snapper annually. They regularly call at French Guiana where another five snapper vessels (35 to 39 tons) are based (Fourmanoir 1968). A local schooner (size unknown) in Guyana caught 36,500 pounds of snapper and grouper valued at U.S. $11,000 during 16 trips in 11 months with a crew of nine (Allsopp 1958). Ten similar vessels based in Guyana produced a total of 284,451 pounds of fish in 1958. In the adjacent Gulf of Mexico, a snapper and grouper fishery has existed for over a century. In 1962, the U.S. snapper fleet of nearly 300 vessels produced a total of 18.2 million pounds valued at $3.58 million (Carpenter 1965). The average catch per vessel is calculated at approximately 61,000 pounds or U.S. $12,000 a year. The fleet has tended to increase since 1955. It appears that in Guyana the rapidly growing offshore shrimp industry, commencing in about 1958, may have retarded development of the snapper fishery by diverting the available manpower to it. The owner/skipper operation may become the next approach for the majority of the local fishing industries in the Caribbean.

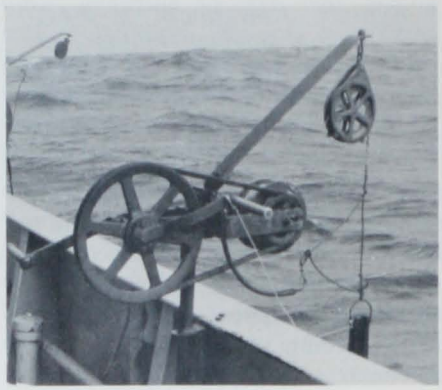
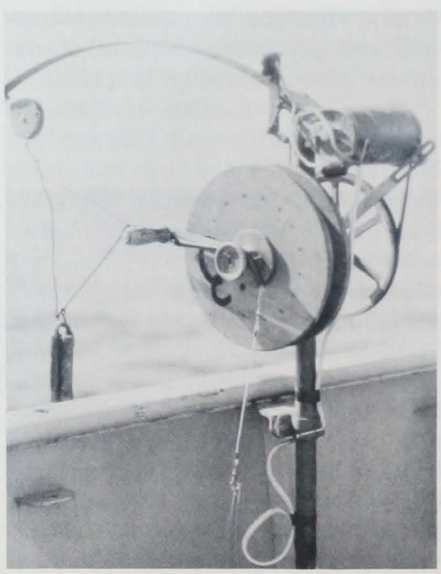


Figure 1.—Hand reel.

Figure 2.—Electric reel.



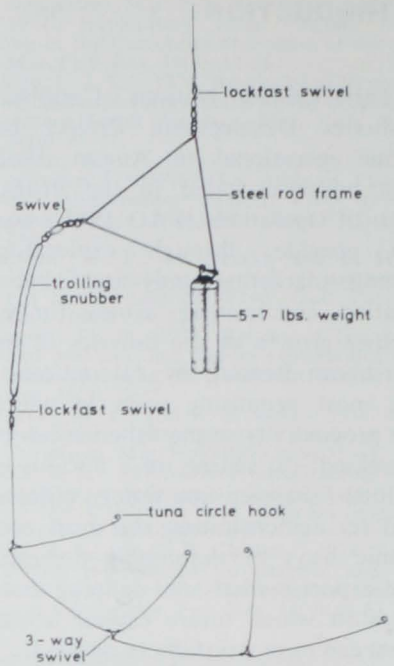


Figure 3.—Diagram of terminal gear used with powered snapper reels during project explorations.

VESSELS, GEAR, AND FISHING PROCEDURES

Vessels

Each of the three project vessels, *Alcyon*, *Calamar*, and *Fregata*[1], was used for exploratory fishing during the project life. *Alcyon* and *Calamar* are sister vessels built in Japan in 1966. They were designed for multipurpose exploratory fishing and training. They are offset house side trawlers. Each vessel accommodates eight crew, eight trainees, and two technicians. *Fregata* is a bridge forward seiner style steel vessel designed for combination fishing and training. It accommodates 10 persons. The *Calamar* and *Fregata* were operated from Barbados while *Alcyon* was based in Jamaica. The crews were made up of local fishermen/trainees except for captains, who were FAO masterfishermen.

[1]See paper by Wolf and Rathjen, this number, for photographs and specifications.

Fishing Gear

Principal gear used for the exploratory snapper fishing were handline gear and some experimental use of bottom longline. Descriptions follow.

Handline gear

Types of handline gear used were (1) traditional hooks and line, and (2) mechanical reels—hand powered and motorized (electric).

The hook and line outfit was constructed of 100-150 pound breaking strain monofilament nylon mainline about 200 yards long, with one end tied to a wooden winding frame and the other end fastened to a ½-1½ pound iron weight with a lighter thread. From three to five 150-pound test standard swivels (size number 1) or three-way swivels were attached to the mainline at equal intervals of about 1½ feet from the weight. To each swivel was tied about a foot of 55-75 pound test nylon line with a hook at the free end (Mustad-O'Shaugnessy)[2] number 4/0 (for yellowtail snapper) to number 6/0 (for large jacks or groupers). Exclusive use of this gear was made only for the first cruise of the *Alcyon* (cruise 67-6). Thereafter mechanical snapper reels were the main gear although the handlines were used occasionally for shallow water snappers.

The mechanical snapper reels used were a bicycle type of hand reel (Fig. 1) and an electric motor driven reel (Fig. 2). Six hand reels were used on the *Alcyon* until December 1968, when two of them were replaced by electrical reels. The electrical reel is driven by a modified automobile generator powered from a 12-volt heavy duty marine battery. This reel has a designed line take-up speed of 50 fathoms per minute running free and about 41 fathoms per minute under heavy load. After *Alcyon's* successful use of the two electric reels for six cruises, the remaining hand reels were replaced by electric reels for the rest of the period. *Fregata* used five electric reels while *Calamar* used five electric reels and one hand reel during her snapper exploratory fishing periods.

Typical gear fitted on the hand or electric reel was a 3/64 inch stainless steel line with a terminal rig (Fig. 3) introduced by a skillful Gulf of Mexico snapper fisherman from the United States assigned to the project as a snapper fishing consultant. The terminal rig is made of a triangle-shaped wire (8 S.W.G.) with a 5-7 pound iron weight on one bottom corner and a rubber snubber plus a short 250 pound test monofilament line with usually three snoods on another bottom corner, the top corner being secured to the main steel wire by a lockfast swivel. Hooks used on the snood were number six to nine tuna circle.

Bottom longline gear

Bottom longline gear was fabricated in units of baskets. A basket of longline was comprised of a 60-fathom mainline to which were attached 18-inch long 160-pound test nylon monofilament leaders spaced 4 fathoms apart (except for the first two cruises of *Fregata* which used a 2-fathom interval). Seven to ten baskets were joined together in one line to make a set. The main line was made of a ¼-inch diameter, tarred "Kuralon" rope commonly used for tuna longline gear. The hooks used were number six or seven tuna circle. Weights and floats were attached to the line at intervals so that the gear was suspended just above the bottom. This method was used mostly by *Fregata* and a few times by *Alcyon*.

Bait

The most common bait used for line fishing was imported frozen squid (*Loligo* sp. and *Daryteuthis* sp.) and Spanish mackerel (*Scomberomorous maculatus*). There was some use of herring (*Clupea harengus*), Pacific saury (*Cololabis saira*), and Pacific mackerel (*Scomber japonicus*). Some native fish baits such as Atlantic thread herring (*Opisthonema oglinum*), bumper (*Chloroscombrus chrysurus*), and fourwing flyingfish (*Hirundichthys affinis*) were tested as well. The squid and bait fish used were cut to proper size to cover a hook.

Fishing Methods

Handline and reel fishing

Handline gear and mechanical reels were mostly used from the starboard side and the stern. The mechanical reels were mounted along the inside of the starboard bulwark at about 10-ft intervals on the *Alcyon* and *Calamar* (Fig. 4). On the *Fregata* three reels were fixed on the starboard side and two on the port side. A bait board fitted to the gunwale and a bait cutting knife were provided for each reel operator. Gear repairing tools such

[2]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Figure 4.—Hand reels mounted inside of *Alcyon's* bulwark.

Table 1.—Fishing log—handline and reel fishing cruises for snapper and related species.

Cruise No	Month	Date	Area covered	Sea-days	Snapper fish.-day	Fish.-effort (line-hour)	Total Catch no	Total Catch lbs	Snappers no	Snappers lbs	Groupers no	Groupers lbs	Jacks no	Jacks lbs	Others** no	Others** lbs
A.* 67- 6	June July	19- -16	Pedro Bank, Rosalind Bank and Walton Bank	16	15	777	3,846 (+?)	7,627	3,364	6,230	259	361	44	252	179 (+?)	784
A. 67- 8	Sep.	7-24	Mona Passage, Silver & Navidad Banks	17	5	266	480	1,348	179	441	249	630	14	85	38 (+?)	192
A. 67- 9	Oct.	8-14 16-20	SE of Morant Cay	10	3	67	113	340	30	101	47	132	17	74	19	33
A. 67-10	Nov.	1-11 16-27	Pedro Bank	22	19	1,586	4,632 (+?)	12,547	2,907 (+?)	8,077	856 (+?)	1,512	294 (+?)	1,720	575 (+?)	1,238
A. 68- 2	Feb.	7-25	Pedro Bk., Rosalind Bk., Alice Sh'l east of Central America	19	15	639	3,396	11,675	2,391	6,894	190	945	534	3,261	281	575
A. 68-3a	Mar.	13-30	Monte Cristi Bk., Navidad and Silver Banks	(40)	11½	523	2,841	12,086	2,445	10,269	111	408	201	1,027	84	382
A. 68-3b	Apr.	3-22	Virgin Island Shelf Northern Leeward Islands	40	11	589	1,920	9,222	1,537	6,191	123	1,586	213	1,237	47	209
A. 68- 4	May	9-23	Rosalind, Alice Shoal East of Central America shelf	14	12	1,303	4,635	22,704	1,620	7,042	67	233	1,698	12,156	1,250	3,273
A. 68- 5	June	8-17	East of Central America	9	6	451	4,998	17,592	349	889	14	150	4,091	15,549	544	1,004
A. 68- 9	Dec.	4-18	Pedro Bk., Rosalind Bk., & East of Central America	14	12	663	4,775	13,565	2,064	4,847	98	470	2,059	7,004	554	1,244
A. 69- 1	Jan.	9-27	Pedro Bk., Mackerel Bk., New Banks, Blossom Bk., California Bk.	18	12	694	1,872	6,698	1,198	4,331	168	354	107	543	399	1,470
A. 69- 2	Feb.	10-26	Monte Cristi Bank, Navidad and Silver Bank	16	11	366	1,819	7,125	1,518	5,789	85	323	196	886	20	127
A. 69- 3	Mar.	11-28	Navidad Bank, Mona Passage Puerto Rican coasts	17	10	750	1,093	4,458	818	3,404	114	478	91	406	70	170
A. 69- 4	Apr.	10-24	East of Central America	14	11	1,104	5,068	22,087	2,032	5,004	34	212	1,959	13,000	1,043	3,871
A. 69- 5	May June	10- -4	Northern Leeward Is.	24	14	660	1,631	6,213	1,494	4,427	74	1,250	60	516	3	20
A. 69- 6	June	16-20 21-30	Pedro Bk., Rosalind Bk. East of Central America	14	8½	310	4,227	11,192	804	1,806	67	230	2,898	7,764	458	1,392
A. 69- 7	July	14-17 21-24	SE of Morant Cay Pedro Bk., Mackerel Bk.	6	5	126	386	1,469	348	1,164	14	180	17	115	7	10
A. 69- 8	Aug.	5-18	Pedro Bk., Alice Shoal SE Coast of Jamaica	13	12	601	1,249	4,557	962	3,672	129	309	88	447	70	129
A. 70- 8	Aug.	11-25	East of Central America	14	10	1,008	9,804	23,719	5,252	9,717	82	347	3,837	12,291	633	1,364
A. 70- 9	Sep.	16-27	East of Central America	11	8	1,179	9,971	24,679	3,720	7,329	28	188	4,477	13,318	1,746	3,844
A. 70-10	Oct.	1-8	East of Central America	7	4	438	6,468	12,722	3,073	5,800	6	15	1,652	3,495	1,737	3,412
21			*Alcyon*'s total	315	215	14,100	75,224	233,625	38,105	103,424	2,815	10,313	24,547	95,146	9,757	24,743
C. 70- 9	Oct.	7-28	Off French Guiana	21	14	404	1,237	6,208	1,095	4,080	100	1,619	35	499	7	10
C. 70-10	Nov.	12-27	Off Surinam	15	10	91	369	1,314	283	893	80	415			6	6
C. 70-11	Dec.	3-18	Off Guyana	15	12	198	1,899	10,702	1,810	9,865	62	725	7	79	20	33
F. 68- 1	Jan. Oct.	9-26 21-	Netherland Leeward Islands	17	3	12	9	50			3	10	4	38	2	2
F. 68- 8	Nov.	-18	Lesser Antilles — North	27	16	600	1,867	8,289	1,632	6,582	60	865	147	812	28	30
F. 68- 9	Dec.	2-18	Lesser Antilles — Middle	16	10	312	85	140	52	95	3	9	11	27	19	9
F. 69- 1	Jan. Feb.	8-25 14-	Lesser Antilles — South	18	12	405	125	542	93	418	4	64	17	54	11	6
F. 69- 2	Mar.	-7	Lesser Antilles — South	21	7	512	446	1,556	305	946	24	171	75	395	42	44
F. 69- 3	Mar. Apr.	17-29 14-	Barbados	13	11	222	43	97 (+?)	16	17 (+?)	4	32	13	40 (+?)	10	8
F. 69- 4	May May	- 4 20-	Lesser Antilles — North	21	13	408	1,840	7,370	1,567	5,018	59	952	119	653	95	747
F. 69- 5	July July	- 5 28-	Netherland Leeward Islands	46	23	514	209	670	85	136	44	189	23	163	57	182
F. 69- 6	Aug.	-26	Off Surinam & Guyana	29	14	746	1,916	7,263	1,749	5,789	138	1,180	14	199	15	95
F. 69- 7	Sep. Sep.	15-20 29-	Off Guyana	5	1	25	10	6	10	6						
F. 69- 8	Oct. Nov.	-23 10-	Off Surinam	24	12	631	1,134	5,280	1,098	4,713	33	548	2	19		
F. 69- 9	Dec.	-16	Off Guyana	36	7	314	1,150	7,487	1,142	7,419	4	14	4	54		
36			Grand total	639	380	19,494	87,563	290,599	49,042	149,401	3,433	17,106	25,018	98,178	10,069	25,915

*A represents *Alcyon* cruise, C. for *Calamar* and F. for *Fregata*.
**Including rainbow runner.

as wire cutters, pliers, a crimping tool (Nico-press) for wire and nylon lines, and scoop nets and gaffs for large fish were provided at a rate of about one for three operators. A fish gutting table and knives, washing tank, and a few sets of marker buoys with anchors and a grapnel to take up the marker buoy were also necessary for the operation. Bait was used at a rate of about 15 pounds per day per line or reel. Depending on the vessel, 5-12 tons of ice were carried. This was used at a ratio of about 1 pound of ice for a pound of fish.

On a typical exploratory fishing expedition an area would be chosen and fishing operations conducted on transects near and on the slope edge of the bank, or shelf, or at a recognized depth range on the shelf such as 30 to 45 fathoms for red snapper or 14 to 25 fathoms for yellowtail snapper.

Electronic depth sounding machines were fully utilized over the fishing ground to record bottom topography and evidence of fish concentration. When the machine traced a hard or rugged bottom, a ridge, or any abrupt transformation of the slope edge, a closer examination was made by cutting across it from many directions at slow speed. At a likely spot on slope edges or upon recording a school of fish, fishing tests were made. If the result was good, an anchored marker buoy was usually set to facilitate maintaining position. The buoy made it easier to determine current movements as well. Fishing was commonly accomplished while drifting or by keeping the vessel against wind and current by repeated use of engine and rudder for position keeping. This maneuver keeps the fishing lines close to the vessel to reduce fouling and permit a better feel of the fish biting. The drift was repeated until biting slacked off or was considered sufficient for evaluation. Occasionally the vessel was anchored over a likely fishing spot.

Typically fishing was conducted only during daytime for deepwater snapper, but on grounds where yellowtail snappers and jacks were abundant efforts were made intermittently throughout both day and night by concentrating on the biting periods as noticed by the deck watchman who operated a few monitoring lines.

Catch results were recorded and notations were made on species and size of fish, number and weight captured, number of lines, type of bait, duration, and depth (range) of fishing. Some biological data such as gonad stage, sex, or stomach content were also collected whenever time permitted.

Special care was paid to the handling and preservation of the catch for further marketing demonstrations on shore. The fish were gutted and washed carefully. When time permitted they were arranged in a plastic fish box belly down and stored in the iced fish hold. When conditions did not permit boxed storage the fish were iced in the conventional manner and boxed during unloading.

Bottom-set longline fishing

This method was conducted during four coastal multipurpose cruises and four snapper reel fishing cruises by *Fregata*. In these cruises 3-10 baskets were used. Each basket was baited and joined in one line; floats and weights were attached along the mainline on a chute fixed on the stern deck (Fig. 5). After surveying the bottom the vessel steamed in one direction as the set was made by hand passing from one basket to another throwing first line, then the hook, repeatedly. The gear was anchored at each end and marked with a flag buoy tied to one end of the lift rope, the other end of which was connected to either end of the serial baskets of line.

The gear was fished 2-5 hours and then retrieved by a hydraulic longline hauler on the starboard deck through a side roller mounted on the gunwale. Catch records similar to those previously mentioned were obtained.

Production fishing

Ten simulated commercial type production fishing cruises for snapper and related species were carried out to demonstrate commercial feasibility during the project period. Typically the fishing was accomplished by a mothership operation, with *Alcyon* acting as a mothership or base for up to three maneuverable small catcher boats. A variety of catcher boats—local dug-out canoes, 19-foot dories familiar on the Grand Bank of Newfoundland, an 18-foot plywood runabout boat, and a 16-foot work boat—were used. The fishing methods used were primarily mechanical reels on the *Alcyon* and handlines on the catcher boats. Up to eight local commercial fishermen from Jamaica were employed at full share-pay basis (50 percent of their catch) to fish from the catcher boats or from *Alcyon*.

These cruises were conducted on known productive grounds. The fishing operations were not restricted to either daylight or dark hours, but were continued as long as they were

Figure 5.—Setting bottom longline from *Fregata*.

Table 2.—Fishing hours, catch rate, and catch composition by area and bank.

Area	Total hours and days fished (hrs)	(days)	Catch rate lb/line/day	Catch composition (% in weight) Snapper	Jack	Grouper	Grunt	Other[2]
Jamaica south to southwest waters								
Jamaica Coast and vicinity banks	29.1	4.5	[1] 6 (4)[3]	52.7	17.9	18.5	4.3	6.5
Banks SE of Morant Cay	24.9	4.5	49 (27)	47.7	24.6	19.3	1.1	6.8
Mackerel Bank	62.5	8	103 (81)	69.7	5.2	4.5	0	19.8
Walton Bank	3.4	0.5	3 (2)	0	0	100	0	0
Pedro Bank, East	174.9	14.5	79 (95)	74.5	11.9	9.7	2.8	1.1
Pedro Bank, South	18.7	2	25 (23)	39.4	3.9	21.9	8.8	26.0
Pedro Bank, SW	263.5	22	76 (92)	71.7	6.8	8.5	3.9	9.2
Pedro Bank, West	25.5	2	40 (51)	76.2	18.8	5.2	0.9	2.6
Pedro Bank, NW	32.0	3	180 (191)	91.6	3.2	2.2	0.4	0.1
Alice Shoal	75.0	5.5	87 (119)	59.3	25.1	11.0	2.0	2.6
Rosalind Bank	46.1	6	109 (85)	58.7	25.3	9.5	3.1	3.5
A bank between Rosalind and Honduras	33.7	2	88 (148)	53.6	37.2	5.2	4.0	0
East of Honduras, 2nd shelf (E)	180.1	14.5	94 (130)	69.7	16.3	4.1	5.3	4.5
2nd shelf (W)	21.7	2	105 (115)	50.8	22.9	18.2	4.6	3.4
1st shelf	32.3	2	71 (114)	32.3	56.7	7.4	3.6	0
East of Nicaragua	581.6	56.5	270 (276)	26.2	60.8	1.5	2.4	2.0
Total[4]	1,605.0	149.5	W.M.[5] 151 (161) U.M.[6] 87 (97)					
Hispaniola to Virgin Islands								
Monte Cristi Bank	91.7	13	150 (110)	87.0	5.2	4.6	2.3	0.8
Silver Bank	58.5	5	132 (153)	80.2	6.6	10.2	1.2	1.8
Banks between Silver and Navidad Bank	15.0	1	27 (40)	13.3	9.9	65.7	5.8	5.3
Navidad Bank	108.0	11.5	245 (229)	78.9	12.5	5.6	0.8	2.3
Mona Passage	53.3	6	21 (18)	45.7	12.5	36.8	0	5.0
Puerto Rican Coasts	35.4	4	69 (51)	64.9	18.0	15.5	0	0.9
Shelf and Banks around Virgin Is.	50.5	5	154 (156)	61.2	15.0	21.7	0	1.4
Total	412.4	45.5	W.M. 145.0 (132) U.M. 114.0 (108)					
Leeward Islands Waters								
Sombrero Bank	36.1	3.5	110 (114)	90.5	2.8	6.5	0	0.2
A bank SE of Sombrero	8.5	1.5	184 (156)	86.8	6.3	6.9	0	0
Anguilla Bk. NW edge	8.5	1.5	76 (43)	62.0	13.0	19.3	0	5.6
Anguilla Bk. N edge	35.9	4	174 (156)	64.9	12.4	22.5	0	0.2
Anguilla Bk. NE edge	19.9	3.3	99 (60)	58.6	6.4	30.2	0	4.7
Anguilla Bk. E edge	183.6	13.5	159 (215)	68.0	11.1	14.7	0	6.3
Anguilla Bk. SE edge	10	1	59 (59)	49.7	9.5	40.8	0	0
Saba Bank	6.3	1	20 (12)	57.3	12.1	25.8	4.8	0
Barbuda Bank N to NE edge	44.6	4.8	123 (116)	80.4	10.1	8.9	0.1	0.4
Barbuda Bk. W edge	67.7	8	140 (118)	84.9	8.0	7.2	0	0
Barbuda Channel East edge	1.1	0.3	69 (30)	100	0	0	0	0
Antigua SE to S edge	5.9	0.8	0	0	0	0	0	0
Nevis Is. (SW)	7.4	1	2 (2)	100	0	0	0	0
Redonda (NE)	2.7	0.5	97 (52)	53.4	0	46.4	0	0
A bank NE of St. Kitts	2.7	0.5	7 (4)	100	0	0	0	0
Haver's Shoal and Montserrat	25.7	3	83 (71)	84.0	11.5	4.4	0	0
Guadeloupe	6.9	6	7 (5)	72.0	15.9	8.4	0.8	2.9
Dominica	7.1	0.8	15 (10)	15.4	84.6	0	0	0
Offshore banks SE of Dominica	7.5	1.8	1 (1)	0	85.7	0	0	14.3
Total	488.1	56.8	W.M. 116 (101) U.M. 75 (64)					
Windward Islands waters								
Martinique (ESE)	18.0	2	3 (3)	42.2	33.3	8.9	8.9	66.7
St. Lucia	59.6	7	17 (15)	79.2	8.1	12.7	0	0
St. Vincent	3.5	1	2 (2)	33.3	0	0	0	66.7
Barbados	86.4	9	2 (2)	9.7	37.5	46.5	0.7	5.6
Traders Bank	11.0	0.5	28 (28)	30.6	67.1	2.3	0	0
Grenadine	58.6	6	5 (5)	41.2	17.6	31.9	3.3	6.0
Grenada (SW)	29.2	2.3	88 (88)	65.3	31.5	1.7	0.9	0.6
Total	266.3	27.8	W.M. 16 (15) U.M. 21 (20)					
Shelves NE of S. America								
Aruba, Curacao and Bonaire	120.8	23	13 (7)	20.3	24.3	28.2	0	27.2
Trinidad and Tobago	83.0	12	34 (23)	61.6	9.5	27.7	0	1.2
Venezuela East Coast	27.4	7	55 (21)	53.8	0.4	44.7	0	1.0
Guyana	139.9	19	258 (178)	94.6	1.7	3.5	—	0.1
Surinam	159.8	21	88 (67)	82.1	2.8	13.8	—	1.3
French Guiana	156.8	22	126 (89)	76.0	4.9	18.8	—	0.1
Total	566.9	81	W.M. 189 (132) U.M. 112 (756)					
Grand total	3,460	382	W.M. 129 (117) U.M. 78 (74)	51.4	33.8	5.9		8.9

[1]Catch rate is total weight of catch in pounds per one line equalized to ten fishing hours per day from actual catch rate obtained from the project vessels.
[2]Catch rate in parenthesis is actual catch rate (catch + hours fished).
[3]Other species include rainbow runner.
[4]Local fisherman's effort and catch from production fishing cruise are not inlcuded.
[5]W.M. = Weighted mean of catch rate from total fishing efforts and catch in the area.
[6]U.M. = Unweighted mean of catch rate for total area.

productive and the stamina of the crew allowed. Catches were recorded and stored as those in exploratory fishing except that the local fishermen's catch was stored in marked plastic fish boxes.

AREA AND PERIOD COVERED

The region of project exploratory operations was basically all the Caribbean waters eastward from the Jamaica Rise including adjacent waters and off the northeast coast of South America—Guyana, Surinam, and French Guiana. Since emphasis in selecting areas to be fished was made primarily for the interest of project participants, the northern shelf of South America off Venezuela, the inner shelf east of Central America, and the coastal waters of Haiti were not included.

During exploratory line fishing for snapper and related species, a total of 587 sea-days was spent making 38 cruises and 382 actual fishing days during the 5 years of vessel operations.

The Jamaica-based *Alcyon* was used to cover the northern region of the Caribbean from the eastern margin of the Central American shelf eastward to the Leeward Islands. Utilizing handlines and reels, she spent 315 sea-days during 21 months in four consecutive years (1967 to 1970) with 215 actual fishing days. This included six exploratory fishing cruises and nine simulated commercial production demonstration cruises to the southwestern waters off and around Jamaica, four exploratory fishing cruises from north of Hispaniola to Puerto Rico, and two exploratory cruises in the Leeward Islands waters.

With the same method as *Alcyon* the Barbados-based vessels, *Fregata* and *Calamar*, spent a total of 272 days conducting exploratory fishing in the waters along the Lesser Antilles arc, the Netherlands Antilles (Aruba-Curacao-Bonaire), and off northeast South America. Their operations covered a total of 17 months from 1968 to 1970 with a total of 15 cruises and 165 actual fishing days. This included some repetitive cruises to the same area. *Fregata* did exploratory fishing from the Leeward Islands to northeastern South America including the Netherlands Antilles with a repeated cruise to the Leeward Islands and Netherlands Antilles for seasonal coverage. *Calamar* was used for further extensive coverage on the northeast South American shelf for three cruises during late 1970 where *Fregata* had completed limited coverage during the later half of 1969.

Geographic coverage using bottom set longlines was limited to some shelves of the Windward Islands and Netherlands Antilles by *Fregata* during her exploratory or experimental cruises to the areas. Practical fishing days by this method totaled 60 from eight cruises made during 1968 and 1969. *Alcyon* experimented with this method for 2 days on the shelf east of Central America during a production cruise to the area in June 1968.

DISCUSSION

Handline and Mechanical Reel Fishing

Catch

A total of about 291,000 pounds (round weight) of fish was taken by this method during these explorations. The catch and fishing effort, area, and period of individual cruises for each vessel for the entire period are shown in Table 1. The major groups in total catch by weight were: snapper of various species 51.4 percent, jacks 33.8 percent, grouper 5.9 percent, and other miscellaneous species 8.9 percent. Total fishing effort expended was about 19,901 line-hours (a typical line is a handline or mechanical reel line with three hooks) obtained during 3,460 hours in 382 days of actual fishing including simulated production cruises.

The overall average catch rate was 760 pounds of fish per day from 9.8 fishing hours with 5.3 lines, which equalled 146 pounds per line. These rates include both pure exploration and simulated commercial-type production fishing. The catch rate, fishing effort, and composition of catch (percent in weight) by main fish groups, by area of each bank or shelf are shown in Table 2.

Species

More than 70 species representing 15 families were caught on handlines and reels. The most important of these are members of the snapper (Lutjanidae), jack (Carangidae), and grouper (Serranidae) families. Table 3 lists the most important species caught.

The principal varieties of snapper were black, blackfin, and silk snapper along the shelf edge, and yellowtail and smaller sizes of blackfin snapper on the continental shelf in the northern region of the Caribbean; blackfin, queen, and silk snapper in the Windward Islands area; and Caribbean red snappers, vermillion snappers, and lane snappers off northeastern South America.

Jacks are usually considered pelagic fishes, but they were often caught on snapper handlines or reels. Best jack catches were on the eastern margins of the Nicaraguan shelf. The dominant species captured during all seasons were green jack by number, and horse-eye jack by weight. Considerable numbers of rainbow runner and amber jack were also taken seasonally. Black jack was the dominant species of the group on offshore banks in the area between south of Jamaica and the Leeward Islands. Amber and almaco jacks (sometimes recorded as one species) and horse-eye jack, although common, were not taken in quantity.

Grouper catches were generally light but added significantly to the totals. Hinds and yellowfin groupers were the main species of grouper on ragged hard bottoms in the northern region of the Caribbean. Nassau, red, yellowfin, and misty groupers were also common species in the eastern part of the Greater Antilles and in the Leeward Islands areas. Yellowedge, snowy, and Warsaw groupers were prevalent species of groupers only in the southern region of the Caribbean from north of Venezuela to French Guiana.

Grunts and triggerfishes formed most of the remaining group, in addition to the rainbow runner which is included in the "other" group in our recordings.

Average weight of fish for all species was 3.3 pounds each, being 3.0 pounds for snapper, 3.9 pounds for jacks, 5.0 pounds for grouper, and 2.6 pounds for other species.

Gear efficiency

Comparisons were made as to the amount of time required for one cycle

of handlining, mechanical reel, and electric reel fishing. The operation consisted of baiting (three hooks), lowering the line, hooking the fish, retrieving the line, and removing the fish. These observations were made in 60 fathoms of water under relatively good baiting conditions. The average total elapsed time was 4.7 minutes for the handline, 4.3 minutes for the mechanical reel (4.0 minutes when operated by two men), and 4.7 minutes for the electric-powered reel. Thus it can be calculated that when using handline or electric reels a maximum of 13 hauls per hour is possible or 14 hauls for one man on a mechanical reel. This is theoretical however, since line breakage, tangling, and other factors tend to reduce this figure to about 10 hauls per hour with each type of mechanical gear.

Of the two different types of hooks used, straight shank or tuna circle, each had advantages and disadvantages. Tuna circle hooks, shaped to resist escapement, were better for catching more fish in one haul, hence they were good for deeper bottom, but had some disadvantages in unhooking fish (for larger fish) and baiting (for small hook). The straight shank hooks (O'Shaugnessy) seemed better for hooking fish or bait, but allowed easy escapement of fish under water, hence this type of hook was mostly used only in shallow water. Small hooks produced a greater variety of fish such as vermillion snapper or triggerfishes which are often regarded as troublesome bait stealers.

Squid was the best bait for both catching fish and remaining longer on the hook. Some fishermen switched to mackerel bait, however, when squid produced few fish. Other baits like herring, shark, and sprats were poor in catching fish and/or staying on the hook.

Catch rate and fishing efficiency

Based on the hauling cycle limitation previously noted, under ideal conditions, the maximum theoretical catch rate obtainable is estimated to be about 40 fish/line/hour (at 3 hooks/line). Under average practical conditions this falls to about 15 to 20 fish / line / hour. Since the average weight of fish caught was 3.3 pounds (Table 1) the catch rate in weight for the latter becomes about 50 to 66 pounds / line / hour, considering the deviations caused by differences of depth, fish size, or fishing performance (fish biting hours). Table 4 shows some

Table 3.—Common name, scientific name, and some local names of fish caught by handline or reel methods.

Common name	Scientific name	Local name
(Snappers)	(Lutjanidae)	
Black snapper	*Apsilus dentatus*	Deep-sea snapper (JA)* chopa negra (P.R.)
Blackfin snapper	*Lutjanus buccanella*	Burnt-fin snapper (JA) negra (P.R.)
Dog snapper	*L. jocu*	Dogteeth snapper (JA)
Gray snapper	*L. griseus*	Caranjito (Pa.)
Lane snapper	*L. synagris*	Walliacke (Tr.)
Mahogany snapper	*L. mahogoni*	
Mutton snapper	*L. analis*	
Queen snapper	*Etelis oculatus*	Satin snapper (JA) Brim (Le)
Red snap. (Carib.)	*L. purpueus*	Pargo (Pa.)
Silk snapper	*L. vivanus*	Yelloweye (W.I.) Chillo (P.R.)
Schoolmaster	*L. apodus*	
Vermillion snapper	*Rhomboplites aurorubens*	
Volaz	*Pristipomoides macrophthalmus*	Deep-sea wenchman (JA)
Yellowtail snapper	*Ocyurus chrysurus*	Colirrubia (P.R.)
(Jacks)	(Carangidae)	
African pompano	*Alectis crinitus*	Silver jack (JA)
Almaco jack	*Seriola rivoliana*	Amberjack, medregal (P.R.)
Greater amberjack	*Seriola dumerili*	Medregal (P.R.)
Bar jack	*Caranx ruber*	Cojinuda (P.R.)
Black jack	*C. lugubris*	Jurel negron (P.R.)
Crevalle jack	*C. hippos*	
Green jack	*C. crysos*	Blue runner (W.I.)
Horse-eye jack	*C. latus*	Jurel ojon, cojobeo (P.R.)
Yellow jack	*C. bartholomaei*	
Rainbow runner	*Elagatis bipinnulata*	Salmon (JA) Tabio (B'dos)
(Groupers)	(Serranidae)	
Black grouper	*Mycteroperca bonaci*	Djanpau (Pa.)
Marbled grouper	*Dermatolepis inermis*	
Scamp or grey manock	*Mycteroperca phenax*	
Tiger grouper	*M. tigris*	
Yellowfin grouper	*M. venenosa*	Guajil (P.R.)
Yellowmouth grouper	*M. interstitialis*	
Jewfish	*Epinephelus itajara*	
Misty or moustache grouper	*E. mystacinus*	Guasa (P.R.)
Nassau grouper	*E. striatus*	Cherna (P.R.) Jacupepu (Pa.)
Red grouper	*E. morio*	Meru (Pa.) Vieille rouge (Tr.)
Snowy grouper	*E. niveatus*	
Warsaw grouper	*E. nigritus*	
Yellowedge or white grouper	*E. flavolimbatus*	
Coney	*Cephalopholis fulvua*	Manteguills (P.R.) Butterfish (JA) Purunchipretulfa (Le)
Red hind	*Epinephelus guttatus*	Cabrilla (P.R.)
Rock or speckled hind	*E. adscensionis*	
(Grunts)	(Pomadasyidae)	
Cottonwick	*Haemulon melanurum*	
Margate	*H. album*	Viuda (P.R.)
White grunt	*H. plumieri*	Cachicata, boquicolorado (P.R.)
(Others)		
Jolthead porgy	*Calamus bajonado*	
(Squirrelfishes)	(Holocentridae)	
Longspine squirrelfish	*Holocentrus rufus*	Gallo, candilero (P.R.) welchman (JA), (Le)
Ocean triggerfish	*Balistes vetula*	Oldwife (W.I.) Puerco (P.R.)
Sand tilefish	*Malacanthus plumieri*	Sandfish or sandeel (W.I.) jolocho (P.R.)
Blackline tilefish	*Caulolatilus cyanops*	
Moray eels	*Gymnothorax* spp.	
Sharks	*Carcharhinus* spp. *Negaprion* sp. *Sphyrna* sp. *Eulamia* sp.	

*(JA) — Jamaica, (P.R.) — Puerto Rico, (Le) British Leeward Is., (Pa.) — Papiamento, (Tr.) — Trinidad, (B'dos) — Barbados, and (W.I.) — West Indies.

short-time catch rates recorded on relatively good fishing grounds where fish schools were found on the echo sounder. Such short-time catch rates, however, are highly variable during the course of a day due to change of fish biting condition, difference of the vessel's passing duration over the fish school if drifting, change of current and/or wind, or sometimes a reduction of stamina of the crew.

Day catch rates for the best catches from principal banks or shelves during the explorations of the three project vessels are shown in Table 5. The catch rate in terms of numbers of fish ranges from 3.3 to 20.1 fish/line/hour with relatively longer biting durations. The catch rate in terms of weights has a wider range, from 10 to 137 pounds/line/hour depending on the size of fish available in the area.

Average catch rates from total fishing effort in Table 2 are far below the above figures since geographic and seasonal abundance are involved.

The catch rate from this type of fishing method would vary not only with the skill of the skipper, as in bottom trawling or purse seining, but also depend greatly on individual technique and incentives to the fishermen. To illustrate this, the fishing efficiency of the project vessel's crew and trainees, who engaged on the fishing cruises without bonus (except fixed sea allowance), is compared in Table 6 with catch rates of the local commercial fishermen who worked with them but upon a contract of full share-pay from their catch during the simulated production cruises. As footnoted in the table, there were some handicaps to the commercial fishermen in fishing methods and gear in the early cruises, but those were evened out in the later cruises. The technical ability of the commercial fishermen who were from the most skillful and experienced group of fishermen in Jamaica, was of course higher than that of the trainees, who undertook more than one-half of the *Alcyon's* fishing efforts. Trainees were replaced every 6 months at the termination of their course.

It is assumed, therefore, that project vessel catch rates during production fishing would be about 15 percent less than that of a commercial vessel having an experienced crew.

Discussion of fishing grounds by area

The average catch rate and catch composition by principal groups of species for all reel fishing efforts appear in Table 2. While this is of overall general interest, more specific information relative to fishing grounds, fish species, and season are necessary to select the best areas and seasons for carrying out commercial operations. These data are presented in tabular form with accompanying narrative for the following geographical areas and subareas in the Appendix:

(1) Jamaica south to southwestern waters of project area:

(a) South coast—Jamaica.

(b) Offshore south of Jamaica.

Table 4.—Selected short-time catch rates (average from five reels).

Date	Fishing grounds	Depth (fm)	Duration (hrs)	Actual no	Catch (lbs)	Catch rate no/hr	Catch rate lb/hr
20-3-68	Monte Cristi Bk. (N. edge)	30-40	1.25	82	417	11.8	60
21-3-68	Monte Cristi Bk. (N. edge)	35-40	0.5	50	257	20.0	102
19-3-68	Monte Cristi Bk. (WSW edge)	35-120	2.5	98	421	7.8	34
20-3-68	Monte Cristi Bk. (WSW edge)	50-120	2.0	44	202	4.4	20
26-3-68	Navidad Bank (NNE edge)	55-60	1.0	46	225	9.2	45
26-3-68	Navidad Bank (NNE edge)	55-60	1.2	61	264	10.2	44
27-3-68	Navidad Bank (NNE edge)	45-90	1.2	109	366	18.2	61
27-3-68	Navidad Bank (NNE edge)	45-90	1.5	84	301	11.2	40

Table 5.—Catch rates observed from the best catches on the best fishing grounds.

Area	Date	Total catch no	Total catch lbs	Total fishing (hrs)	Depth (fm)	Main species	Catch rate (-/line/hr) no	Catch rate (-/line/hr) lbs
E of Nicaragua	13-6-68	1,278	3,984[1]	18.7	18-24	HEJ, GRJ[2]	20.0	62
	24-6-69	1,204	3,328	10.4	18-24	GRJ, HEJ	20.1	56
	17-8-70	1,233	3,734[1]	9.0	22	YTS, GRJ	13.1	40
E of Honduras (2nd shelf)	13-8-70	743	909[1]	9.1	20	YTS	8.4	10
	15-2-68	263	1,113	10.0	28-120	BKS, YTS	3.3	14
Rosalind Bk.	1-7-67	300	664	4.2	22	YTS	9.5	21
	10-2-68	142	677	7.6	50-55	BKS, BFS	3.4	16
Alice Shoal	24-2-68	244	1,018	4.4	40-100	BKS, BFS	10.1	45
Pedro Bank (E)	23-7-69	219	896	10.0	35-130	BKS, SKS	3.7	15
Pedro Bank (SW)	24-6-67	584	1,174	5.3	14-30	YTS	15.7	32
Pedro Bank (NW)	13-8-69	461	1,775	9.7	40-80	BKS	7.9	31
Monte Cristi Bk.	20-3-68	278	1,428	5.5	50-120	BKS	10.1	52
Navidad Bank	26-3-68	611	2,305	12.3	50-60	BKS, BFS	11.0	42
Silver Bank	25-3-68	376	1,437	10.1	45-150	SKS, BKS	7.4	29
Virgin Islands (Barracuda Bk.)	15-4-69	364	1,542	9.3	35-60	BKS	7.8	33
Anguilla Bk.	8-4-68	376	1,969	12.2	50-120	BFS, BKS	6.2	32
Barbuda Bk.	30-10-68	293	1,237	8.2	35-125	SKS	7.1	30
Trinidad & Tobago	5-12-70	105	406	2.1	60-70	CRS	8.3	32
Guyana (N)	14-11-69	754	5,041	10.6	34	CRS	14.2	95
	12-12-70	395	3,901	4.3	41	CRS	13.9	137
	13-12-70	550	3,770	3.6	33-41	CRS	19.1	131
Surinam	20-8-69	374	1,076	10.0	37	CRS	7.5	22
	5-10-69	138	758	4.5	37	CRS	6.1	34
French Guiana (NE)	14-10-69	312	1,870	9.5	43	CRS	6.6	39
French Guiana (E)	16-10-70	313	1,391	10.7	52-63	CRS, VMS	4.9	22

[1]Production fishing cruise, but commercial fishermen's catch is excluded.
[2]HEJ = Horse-eye jack, GRJ = Green jack, YTS = Yellowtail snapper, BKS = Black snapper, BFS = Blackfin snapper, SKS = Silk snapper, CRS = Caribbean red snapper, and VMS = Vermillion snapper.

Table 6.—Catch rate comparison of crew, trainees, and commercial fishermen.

Cruise	Crew and trainees (lbs/line/hr)		Commercial fishermen (lbs/man/hr)[1]	
67-3[10]	7.8	(37)[2]	20.9	(100)[2]
68-4[4]	225.2	(121)	20.9	(100)[2]
68-5	46.0	(202)	22.8	(100)[2]
68-5[9]	16.7	(57)	29.1	(100)[2]
69-5,6[1]	8.9	(106)	8.4	(100)[2]
69-5[4]	18.0	(78)	23.1	(100)[2]
70-5[8]	20.4	(66)	30.8	(100)[2]
70-5[9]	18.7	(85)	22.0	(100)[2]
70-5[10]	27.0	(80)	33.8	(100)[2]
Total (average)	17.7	(78)	22.6	(100)[2]

[1]The fishermen occasionally used two lines at a time for one man and the catch rate includes the total catch from the two lines as lb/man/hr.
[2]Index. Commercial fishermen's catch rate = 100.
[3]Commercial fishermen fished mostly from satellite catcher boats in the night for yellowtail snapper in shallow waters while crew and trainees fished in daytime for deepwater snappers at edges.
[4]This cruise was the first experience for the commercial fishermen in catching numerous large-size jacks (10 lbs on average). The mechanical reels had the advantage for taking large-size fish while the commercial fishermen were discouraged because of sore fingers from their handlines from the heavy catch.
[5]Commercial fishermen fished most of the time from *Alcyon's* deck and also used mechanical reels whenever available.
[6]Mostly daytime fishing for deepwater snappers on slope edges.

(c) Banks southwest of Jamaica.
(d) Central American shelf.

(2) North of Hispaniola to Virgin Islands:
(a) Banks north of Hispaniola.
(b) Mona Passage.
(c) Puerto Rico and the Virgin Islands shelf.

(3) Leeward Islands:
(a) Sombrero Island—Anguilla Bank.
(b) Barbados—Antigua Bank.
(c) St. Kitts—Dominica.

(4) Windward Islands.

(5) Aves Island.

(6) Aruba—Curacao—Bonaire.

(7) Continental shelf of South America from Trinidad to French Guiana:
(a) Shelves around Tobago east of Trinidad.
(b) Shelves east of Orinoco River (lat.10°N to 9 °N).
(c) Shelves off Guyana.
(d) Shelves off Surinam.
(e) Shelves off French Guiana.

Bottom Longline Fishing

Catch

Only about 1,888 pounds (round weight) of fish was taken utilizing this method during the expeditions. Table 7 shows the catch, fishing effort, general area, and period by cruise.

Catch rate on average was only 3.3 pounds per basket (60 fathoms long with 15 to 16 hooks) or 19 pounds per 100 hooks from 87 sets in 58 fishing days. The catch by weight was about 15 percent (17 percent in number of fish) snapper, 21 percent (19 percent in number) grouper, 43 percent (25 percent in number) jack, and 21 percent (39 percent in number) shark and other fish. Chief species of these varieties are similar to those from the handline methods.

Discussion of bottom longline catch rate and gear efficiency

Catch rate and species composition by fishing area are shown in Table 8.

Soaking time ranged from 1.5 to 6.9 hours and averaged 3.1 hours. Results indicated that the catch rate did not increase with soaking time. Table 9 is a comparison of catch rates of each five sets between the longest and shortest soaking time. There was considerable bait loss, as evidenced by empty hooks, even during the sets of shortest duration. The "bait stealers" were not identified. Since snappers and jacks took baits soon after the lines reached bottom during handline operations, this feeding habit might be one of the reasons increased soaking time did not yield increased catches.

The catches deeper than 100 fathoms produced mostly sharks and a few moray eels. Best results were generally obtained from 30 to 80 fathoms.

As previously described the interval between each hook along a 60 fathom mainline was 4 fathoms, but 2-fathom intervals were used during the first two cruises on the Aruba and Bonaire shelves. A comparison of catch rates between the two different intervals of branchlines is shown in Table 10. The result is inconclusive due to the inequality of season and depths fished. Probable factors affecting these two different intervals are that snapper schools are generally compact and narrow while the groupers or jacks in these areas usually are well dispersed.

Fishing grounds

Catches and catch rates (pounds/basket) by fishing subarea and month are summarized in Table 11. Only the shelf edges off Tobago show relatively high catch rates, but even these amounts indicate bottom longlining is not as efficient as reel handlining.

Results of experimental bottom longline operations by Japanese in the Leeward Islands area also indicate the relative inefficiency of this gear for snapper. Their efforts produced a total of 2,533 pounds of fish (1,057 pounds of snappers) in six fishing days on Saba Bank using a total of 38,555 hooks (348 baskets) for 25 sets. The catch rate was only 6.6 pounds per 100 hooks with a range of 3.3 to 9.5. Their daily set ranged from 20 baskets (2,200 hooks) to 66 baskets (7,260 hooks) on 14 to 154 fathoms bottom.

DISCUSSION OF RESULTS AS RELATED TO COMMERCIAL POTENTIAL OF UNUTILIZED OR UNDERUTILIZED STOCKS OF SNAPPER AND RELATED SPECIES

Since most of the un- or underexploited areas exist beyond the range of the present local fishing boats, these boats cannot be expected to utilize the potential stock unless their size and their crews' technical know-

Table 7.—Fishing log—bottom longline fishing cruises for snapper and related species.

Fregata Cruise no	Month	Date	Area covered	Bottom longline fishing days	Fishing effort sets	baskets	hooks	Total Catch no	lbs	Snappers no	lbs	Groupers no	lbs	Jacks no	lbs	Others no	lbs
68-1	Jan. Feb.	9-26 12-	Aruba Bonaire	7	11	74	2,115	70	508	8	25	4	10	50	399	8 (5 sharks = 63 pounds)	74
68-2	Mar. Mar.	- 4 29-	(Klein Bonaire)	2	5	19	570	13	63	2	36	8	20	1	3	2	4
68-3	Apr. Aug.	-26 12-	Barbados	10	11	110	1,760	29	107	2	4	6	4	3	19	18	80
68-7	Sep.	-20	Trinidad & Tobago	11	19	175	2,663	152	817	27	91	35	229	38	332	52	165
69-1	Jan. Feb.	8-25 14-	St. Lucia - St. Vincent	7	10	59	944	44	66	9	29			1	5	34	32
69-2	Mar.	- 7	Grenadine Is.	6	10	41	656	41	187	7	26	12	104	3	37	19	20
69-3	Mar.	17-29	Barbados	7	12	44	704	12	69 (+?)	7	61	1	4	1	4	3	?
69-5	May July	20- - 5	Aruba-Bonaire	8	9	42	568	24	22 (+?)	2	5	6	17 (+?)			16	?
8 cruises			Total	58	87	564	9,980	385	1,839 (+?)	64	277	72	388 (+?)	97	799	152	375 (+?)

Table 8.—Bottom longline catch rate by area.

Fishing area	Catch rate lb/100 hooks	Catch rate fish/100 hooks	Catch composition (% in wt) Snap.	Jacks	Group.	Shark	Others	Total hooks	Depth ran (fathoms)
St. Lucia shelf	10.2	2.7	46	16	10	0	28	300 (20)*	18-110
St. Vincent shelf	11.8	7.5	38	0	16	35	11	360 (24)	30- 45
Grenadine Is. shelf	7.7	3.8	48	0	49	3	0	873 (57)	17-210
Near Tobago	39.3	5.7	10	36	36	10	8	2,211 (149)	21-148
SE offshore Tobago	16.2	5.1	22	41	2	34	2	396 (24)	18- 56
Near Trinidad	6.9	5.9	19	0	35	38	8	375 (25)	25- 35
Barbados shelf	8.2	2.4	36	19	4	38	3	2,480 (158)	28-255
Aruba shelf	21.2	3.2	5	77	3	12	3	2,435 (94)	27-152
Bonaire shelf	15.9	3.1	29	2	20	32	17	902 (41)	18-195

*Number of baskets.

Table 9.—Catch rates by soaking time.

Soaking time (hr)	Catch rate (fish/100 hooks)	Total hooks
Longest soaking time		
6.9	0	160
6.3	0.6	160
5.2	0.6	160
4.9	0	60
4.5	3.1	120
Shortest soaking time		
1.5	9.2	120
1.6	6.7	75
1.7	1.3	75
1.7	9.2	120
1.8	8.3	60

ledge of navigation and modern fishing methods are increased. Economically, an appropriate size boat would be between 45 and 60 feet long depending on the cruising range from its base.

As indicated in the Appendix, the areas with the greatest potential for commercial fishing operations are east of Nicaragua, Navidad Bank, Barracuda Bank, Anguilla Bank, and the Guyana shelf.

The use of a mothership type operation, taking one or two small satellite boats, has considerable potential. The advantage of the mothership type operation is a remarkable increase in catch at a lesser increase in the cost of production. This type of operation, however, is restricted by sea conditions for the satellite boat. From the experience of the project vessels, these boats of 17 to 19 feet, open dory type, could not go fishing from the mothership when the wind exceeds Beaufort scale 3. Since the trade winds in the Caribbean area often blow continuously with more force, this type of operation may be possible only during part of the year.

A possible deterrent to the expansion of the fishery for snapper, grouper, and jacks in the northern Leeward Islands and adjacent banks is the fact that individual fish from these groups may be occasionally ciguatoxic and, therefore, cause ciguatera fish poisoning when eaten by man.

According to Halstead (1970), there is a growing amount of evidence to suggest that the largest populations of toxic fish are found within the Virgin and Leeward islands, with the epicenter at the St. Kitts-St. Eustatius-Redonda Island complex. Historically certain species, such as yellowfin groupers, dog-tooth snappers, and horse-eye jacks, over a certain size (about 2 kilograms) from specific localities have been considered suspect. Accordingly these species, as well as others, are avoided by commercial fishermen, and if caught they are discarded. After fish caught by one of the project vessels reportedly caused ciguatera poisoning it became project policy to save, for research purposes, demersal species caught in the northeastern portion of the Caribbean, rather than sell them. An exception was silk snapper, since this species usually inhabits depths from 60 to 100 fathoms, and fish caught at these depths are less frequently ciguatoxic than those from shallower waters. No cases of ciguatera were reported from the silk snapper sold. At the present time a ciguatera studies project is being carried out by the Caribbean Research Institute at the College of the Virgin Islands. The laboratory facilities for the project are located at Benner Bay, St. Thomas, Virgin Islands.

It should be clearly understood that the catches of snapper, jacks, and groupers from the banks southwest of Jamaica, north of Hispaniola, and off the northeast coast of South America contained no ciguatoxic fish, and the development of the great latent fishery resources these groups represent should not be overlooked because ciguatera is associated with these groups in the northern Leeward Islands and adjacent banks.

CONCLUSIONS

Considering the results obtained from 5 years of exploratory fishing, the project has concluded that the resource of demersal snappers and related species in the Caribbean and adjacent waters could support increased annual production by utilizing presently under- or unexploited grounds. Based on the estimate of 20,000 to 25,000 tons presently taken yearly from the region by local fishermen on local grounds this increase could be two to four fold based on estimates of Carpenter and Nelson (1968) and of Gulland (1970).

The handline (electric reel) fishing method has produced profitable catch rates from a number of locations throughout the region. It is selective towards larger fish and therefore does not catch some species having only small size ranges. The bottom longline fishing method has not demonstrated commercial potential.

Table 10.—Catch rate comparison at 2 and 4 fathom hook intervals.

	Around Bonaire fish/basket	Around Bonaire fish/100 hooks	Aruba NW shelf fish/basket	Aruba NW shelf fish/100 hooks
30 hooks/basket (2 fathom intervals)	0.7	[1]3.2	1.1	[3]3.6
15 hooks/basket (4 fathom intervals)	3.6	[2]24.2	0.5	[4]2.8

[1]March 1968, 5 sets (570 hooks — 19 baskets) on 18-105 fathom bottoms.
[2]May and June 1969, 4 sets (269 hooks — 18 baskets) on 65-195 fathom bottoms.
[3]January 1968, 9 sets (1,815 hooks — 62 baskets) on 27-110 fathom bottoms.
[4]June 1969, 4 sets (320 hooks — 20 baskets) on 96-152 fathom bottoms.

Table 11.—Bottom longline catch rates by subarea.

Fishing ground	Month	Total set (baskets-hooks)	Depth range (fm)	Catch rate (lb/basket)	Catch by Species			
					Snapper	Jack	Grouper	Others
St. Lucia shelf								
N to NW side	Jan. 1969	2 (12-180)	30- 110	2.5	3 (14)	1 (5)	2 (3)	2 (9)
South side	Jan. 1969	1 (8-120)	18	0	0	0	0	0
St. Vincent shelf								
West side	Jan. 1969	1 (8-120)	30- 40	3.3	0	0	6 (7)	5 (19)
S to SE side	Jan. 1969	2 (16-240)	30- 45	1.4	4 (16)	0	6 (?)	4 (-)
Grenadine Is. shelf								
S to SW of Bequia	Jan. 1969	2 (10-150)	21- 39	0.7	1 (4)	0	5 (3)	0
West of Quatre	Jan. 1969	1 (5- 75)	17- 19	1.4	1 (4)	0	2 (3)	2 (-)
NE of Sail Rock	Jan. 1969	1 (5- 75)	27	0	lost gear			
NE of Carriacou	Feb. 1969	1 (10-160)	45	0	0	0	0	0
N to NE of Grenada	Feb. 1969	3 (17-259)	17- 27	3.0	4 (24)	0	16 (27)	0
S to SW of Grenada	Feb. 1969	2 (10-154)	196-210	0.2	2 (2)	0	0	2 (2)
Tobago								
East side	Sep. 1968	5 (50-763)	43- 78	9.5	6 (39)	18 (138)	23 (196)	13 (103)
East side	Feb. 1969	6 (23-319)	42-148	6.0	4 (3)	3 (37)	11 (95)	0 (25)
N to NE side	Sep. 1968	6 (58-869)	33- 60	1.9	9 (23)	5 (40)	5 (20)	10 (25)
SW side	Sep. 1968	1 (8-108)	30	16.1	1 (11)	8 (95)	0	5 (23)
SE side	Sep. 1968	1 (10-152)	21- 25	1.8	1 (9)	0	0	2 (9)
Off-shore SE of Tobago	Sep. 1968	3 (24-396)	18- 56	2.7	6 (14)	2 (26)	1 (1)	11 (23)
Trinidad N & NE side	Sep. 1968	3 (25-375)	25- 35	1.0	4 (5)	0	5 (9)	13 (12)
Barbados shelf								
South side	Mar. 1968	10 (100-1,600)	42-210	1.0	2 (4)	2 (16)	6 (4)	18 (80)
South side	Mar. 1969	5 (20-300)	28- 87	4.6	8 (70)	4 (20)	1 (-)	1 (2)
West side	Mar. 1968	1 (10-160)	57- 38	0.3	0	1 (3)	0	0
West side	Mar. 1969	4 (16-240)	60-195	?	0	0	0	6 (?)
N to NW side	Mar. 1969	3 (12-180)	75-255	0.3	0	0	1 (4)	7 (?)
Aruba								
NW side	Jan. 1968	9 (62-1,815) *	27-110	8.0	6 (24)	48 (389)	4 (10)	8 (74)
NW side	June 1969	4 (20-320)	96-152	0.4	0	0	5 (8)	4 (?)
SE side	Jan. 1968	2 (12-300)	29- 63	0.9	2 (1)	2 (10)	0	0
Around Klein Bonaire	Mar. 1968	5 (19-570) *	18-105	3.3	2 (36)	1 (3)	8 (20)	2 (4)
Bonaire Klein Bonaire	May-Jun. 1969	4 (18-269)	65-195	4.4	2 (5)	0	1 (9)	12 (66)
East tip	May 1969	1 (4- 63)	45- 60	0	0	0	0	0

*25 to 30 hooks per basket.

Ciguatera will remain a deterrent to expansion of the snapper, grouper, and jack fishery in the northern Leeward Islands, but research efforts are underway to overcome this problem.

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APPENDIX

Jamaica South to Southwestern Waters (Fig. A-1)

South coast of Jamaica

Within reach of local fishing vessels out of Kingston Harbor, more than one dozen offshore banks exist. These have already been heavily exploited by effective fish traps and handlines. In July 1967 and January and August 1969 experimental fishing was carried out to effect comparisons with efforts in unexploited areas. As indicated in Table A-1, poor fishing results were obtained.

Offshore south of Jamaica

As anticipated, offshore banks which are within the operational range of only the larger local boats produced much better results. Mackerel Bank comprises two separate banks which lie about 25 miles south of Kingston. The total area is 11.5 square miles with a total circumference of about 21 miles.[3] A few fishermen from Port Royal or from Old Harbor set pots or do handlining there. The nearest part of Pedro Bank, the northeast edge, is about 50 miles from Kingston. It extends westward about 100 miles, has a total area of about 2,365 square miles, and a total circumference of nearly 319 miles. The eastern shelf around the cays on the bank has been extensively exploited by pot fishermen based on the cays serviced by carrier vessels. The mid-part of the north side is being fished by some larger canoes from the southwest coast of Jamaica during good weather. The remaining area is fished very little.

Three unnamed banks about 35 miles southeast of Morant Cay are seldom fished and have a total area of 36.5 square miles with 44 miles circumference. Catch rates for specific locations in the offshore waters south of Jamaica are given in Table A-2.

The catch rate from Mackerel Bank ranged from 12.4 pounds/line/hour in January to 4.0 pounds/line/hour in

[3] All miles in this paper are nautical miles.

July. The best catches occurred from 35 to 45 fathoms on the southeastern edge. Black snapper comprised 66 percent of the total catch. Most black snappers were feeding heavily on *Clavelina* (a species of tunicate called "Sea Tapioca" by Gulf of Mexico snapper fishermen). Snapper from other productive banks (Silver, Navidad, etc.) were also feeding heavily on Sea Tapioca. Black jack and hinds were the next dominant species in the area. On one occasion a school of rainbow runners congregated around the vessel and 56 fish (278 pounds) were captured in 2 hours. From this area, during the production cruise in January 1969, the commercial fishermen aboard averaged 99 pounds/man/day during 6 days fishing.

The catch rate of deepwater snapper in daytime on the eastern edges of Pedro Bank from Portland Rock to the southeast tip of the bank ranged from 3 to 17 pounds/line/hour. The catch rate from the commercial fishermen aboard a satellite catcher boat at night in shallower waters was 136 pounds per 9 hours fishing per man. This was mostly yellowtail. Black, followed by blackfin and silk, snapper dominated catches from the slope edge from 35 to 80 fathoms, with volaz (deep sea wenchman) dominating from 80 to 130 fathoms. Black jack, horse-eye jack, yellowfin grouper, hinds, grunts, and triggerfish were common, but did not collectively comprise more than 30 percent of the total catch by weight. Fishing along the south edges of Pedro Bank resulted in catches ranging from only 1.2 to 3.0 pounds/line/hour. The species caught were similar to those from the east edges. The shelf southwest of NW Ridge was relatively productive for yellowtail snapper. The daily catch rate ranged from 6.6 to 31.6 pounds/line/hour in June 1967 (83 percent yellowtail). Catches ranged from 2.1 to 14.9 pounds/line/hour in November 1967 (45 percent yellowtail). The lower catch rate and percentage of yellowtail was due to the project vessel fishing more for deepwater snapper: silk, black, and blackfin. The satellite boat with commercial fishermen produced fish in 14-16 fathoms at a rate of 223 pounds (66 percent yellowtail)/man/day for 10 days fishing. In December 1968 and August 1969 a few days fishing for yellowtail and deepwater snappers near the southwest tip of the bank resulted in poorer catch rates—1 to 9.7 pounds/line/hour.

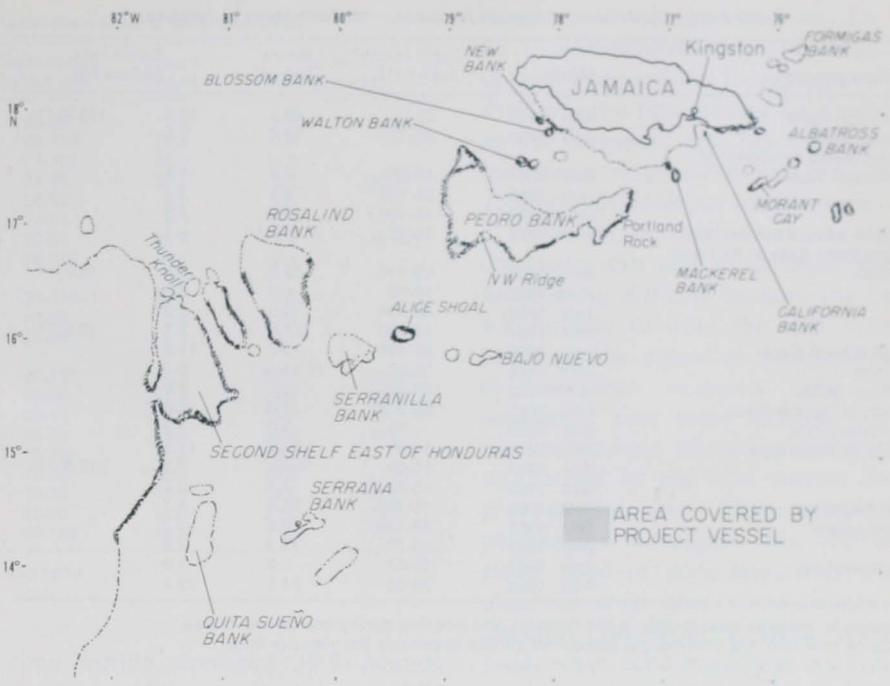

Figure A-1.—Area of operations—Jamaica south to southwestern waters.

Table A-1.—Catch rates observed at specific locations off south coast of Jamaica.

Fishing ground	Month	Depth range fished (fm)	Hours fished	Catch rate (lb/line/hr)
New Bank	Jan. 1969	60-100	4.7	0.2
Blossom Bank	Jan. 1969	25-110	3.8	0.5
Cow Bay	Aug. 1969	50-110	1.2	0
Lamottes Bank	Aug. 1969	40-80	2.8	0
Norseman Bank Dingle Bk. & Morant Pt.	Aug. 1969	40-140	6.6	0
California Bank	Jan. 1969	35-90	6	2.0
California Bank	Aug. 1969	30	4	2.0
Walton Bank	July 1967	20-50	3.4	0.3

Fishing operations on the western edges of the bank northward from the southwest tip resulted in rather poor catch rates. In February 1968, 117 silk snappers (200 pounds) were caught from 100 to 120 fathoms in one day. In August only 10 silks (23 pounds) were caught along with a few blackfin snapper, black snapper, amberjacks, horse-eye and black jacks, yellowfin grouper, and hinds. High catch rates of 30.5 and 25.4 pounds/line/hour (85 percent black snapper) were obtained in 40 fathoms from the northwest tip of the bank in August 1969.

The three unnamed banks southeast of Morant Cays were fished for one-half day in July 1967, one day in July 1969, and three days in October 1967. The catch rates resulted in 11.6, 3.1, and 4.8 pounds/line/hour, respectively. The dominant species were black snapper, black jack, and some groupers. Waves from a relatively strong current and wind along the edges of the banks hampered efforts to keep appropriate depths on the rather steep slope edges in the area. A small bank 13 miles west of Morant Cay was fished by handline at depths of 18 to 35 fathoms for three nights and two days during a pot fishing cruise in July 1970. The catch rate was about 4.1 pounds/line/hour. The species caught were similar to those from the three unnamed banks above.

There are several banks east of Jamaica, namely Formigas Bank, Grappler Bank, Henry Holmes Bank, Albatross Bank, and Decca Ridge, in order from north to south, but being within reach of the local fishermen no efforts were expended there.

Table A-2.—Catch rates at specific locations—offshore south of Jamaica.

Fishing ground	Month	Depth range fished (fm)	Hours fished	Catch rate (lb/line/hr)	
Mackerel Bank	Jan. 1969	25-85	48.5	12.4	(16.6)**
Mackerel Bank	July 1969	30-120	14.0	4.0	
Three banks southeast of Morant Cays	July 1967	40-80	2.5	11.6	
	July 1969	35-130	8.5	3.1	
	Oct. 1967	18-150	13.9	4.8	
A bank west of Morant Cay	July 1970	18-35	(5 days)*	4.1	
Pedro Bank East of Portland Bank	Jan. 1969	12-110	28.3	6.6	(8.5)**
	June 1967	15-50	4.0	7.8	
	July 1969	40-135	5.0	3.6	
	Nov. 1967	13-130	127.6	7.7	(9.5)**
E. of Blower Bank	July 1969	35-130	10.0	14.9	
SE Tip	July 1970	30-40	(7 days)*	8.7	
Shanon Shoal	June 1967	20-40	14.7	2.6	
South of Banner Reef	Aug. 1969	60-100	1.0	3.0	
Southwest R'K	Aug. 1969	10	3.0	1.2	
South of NW Ridge	June 1969	14-35	84.2	11.5	
	Nov. 1967	11-60	109.5	7.2	(12.6)**
	Dec. 1968	18-40	2.5	3.0	
Southwest tip	Aug. 1969	10-100	23.8	4.1	
West edges	Feb. 1968	55-140	8.2	6.2	
	Aug. 1969	30-70	17.3	2.8	
Northwest tip	July 1967	15-50	7.8	1.8	
	Aug. 1969	28-80	24.2	23.4	

*Fished by landline gear mostly in the morning and evening during pot fishing cruise.
**Catch rate from the commercial fishermen aboard in pounds per line per hour

Table A-3.—Catch rates at specific locations on banks southwest of Jamaica.

Fishing ground	Month	Depth range fished (fm)	Hours fished	Catch rate (lb/line/hr)	
Alice Shoal	Feb. 1968	40-50	12.4	24.5	
	May 1968	28-30	8.0	3.7	(3.1)**
	Aug. 1968	14-100	54.6	6.0	
Rosalind Bk. east edge	Feb. 1968	26-140	20.7	6.4	
	May 1968	14-25	7.0	6.8	(18.7)*
	June 1969	30-60	1.0	4.4	
	July 1967	20-50	7.3	22.0	
	Dec. 1968	21-25	3.0	12.8	(11.7)*
West edge	Feb. 1968	45-110	7.6	16.2	
Banks between Thunder Knoll & Rosalind Bank	Feb. 1968	25-130	33.7	8.8	

*Catch rate of commercial fishermen aboard in lb/line/hr.

Banks southwest of Jamaica

Farther southwest of Jamaica, between 200 and 300 miles, is Alice Shoal (77 square miles with 33 miles circumference), Serranilla Bank (291 square miles with 75 miles circumference), Serrane Bank (105 square miles with 56 miles circumference), Rosalind Bank (1,441 square miles with 157 miles circumference), Thunder Knoll (49 square miles with 26 miles circumference), and a few unnamed banks (347 square miles and 93 miles circumference in total) between Rosalind Bank and Thunder Knoll. Of these, only the two banks on which some cays exist are being fished to some extent by the carrier-canoes type of operation previously mentioned. This leaves a tremendous area practically unfished and certainly offers good commercial potential (Table A-3).

On Alice Shoal, the northeastern part of the edge showed a catch rate ranging from 11.7 to 42.1 pounds/line/hour of black and blackfin snappers and black and horse-eye jacks in 32 to 100 fathoms during daytime. At night it was 3 to 9 pounds/line/hour for horse-eye jack, blackfin snapper, and hinds on the shallower bottom (14-28 fathoms). The catch rate on the south edge was 5.4 to 15.0 pounds/line/hour. The rest of the edges were poor in catch. Only four silk snappers (37 pounds) were caught on Alice Shoal. On Rosalind Bank, a good catch rate of yellowtail snapper at 21.1 pounds/line/hour was obtained from 22 fathoms on the northern part of the east edge in daytime. In February, May, December of 1968 and June of 1969 overnight fishing produced mostly yellowtail snapper and horse-eye jacks. One daytime fishing operation for deepwater snappers resulted in only 3.7 pounds/line/hour (mostly of silk snapper and some blackfin snapper) with the best catches at 120 fathoms. One daytime fishing operation on the west edge (lat.16°29'N) resulted in a 16.2 pounds/line/hour catch rate, the best depth being 50 to 55 fathoms for black snapper and 60 to 80 fathoms for blackfin snappers. During the production cruise the commercial fishermen fished in 14 to 25 fathoms at night only, with catch rates of 178 pounds/man/day in May 1968 and 88 pounds/man/day in December 1968.

In 45 to 130 fathoms on the northeast edge of the unnamed bank west of Rosalind Bank the catch rate was 18.5 pounds/line/hour of mostly silk snapper during daytime. Night catch rates on the shelf (25-58 fathoms) were less at 6.7 to 8.4 pounds/line/hour, chiefly for blackfin, yellowtail, and black snappers and horse-eye jack.

Central American shelf

The second shelf, connected by a narrow neck to the main continental shelf east of Honduras, and some shelf margins east of Central America are within 350 miles range from Kingston. The second shelf has an area of about 1,920 square miles with about 184 miles circumference. The Central American shelf from Pt. Blanca (about lat.10°N) northward to Cape Camarón (about long.85°W) has almost 29,000 square miles with 660 miles of shelf margin (excluding the second shelf). Exploratory fishing on and near the margin for snappers was extended to the area for overall evaluation of the fishing grounds in the Caribbean. The catches appear in Table A-4.

On the second shelf, night catch rates (from 14 nights' fishing in various months) in 18-40 fathoms along the edges ranged from 2.7 to 17.9 pounds/line/hour with an average of 8.2 pounds. Day catch rates (from six daytime operations) on the same shelf (20-34 fathoms) ranged from 4.3 to 12.2 pounds/line/hour with an average of 7.6 pounds. Dominant species were yellowtail snapper and horse-eye jack with traces of blackfin, dog, schoolmaster, and lane snappers, green and yellow jacks and amberjack, red and yellowfin groupers, hinds, triggerfish, white and margate grunts, and porgy. The productive area for yellowtail snappers on the shelf was around

Table A-4.—Catch rates at specific locations—Central American Shelf.

Fishing ground	Month	Depth range fished (fm)	Hours fished	Catch rate (lb/line/hr)	
Second shelf NE edge	Feb. 1968	20-25	10.5	4.8	
East edge	Feb. 1968	22-130	29.8	8.6	
South edges	Feb. 1968	22-130	56.8	14.8	
	Apr. 1969	24-90	32.0	6.7	(23.5)*
	May 1968	28-30	5.5	2.5	
	June 1969	24-34	4.1	7.9	
	Aug. 1970	20-32	41.4	8.2	(16.4)*
SW edge	Feb. 1968	18-120	21.7	10.4	
Main shelf edge from the neck to 15°N	Feb. 1968	21-110	20.8	8.6	
	Apr. 1969	40-80	3.0	1.6	
	May 1968	22-25	8.5	4.7	
Main shelf edge from 15°N to 14°30'N	Feb. 1968	28-120	17.3	20.7	(22.9)*
	Apr. 1969	16-90	101.4	22.6	(22.5)*
	May 1968	20-40	100.5	29.2	
	June 1968	18-70	57.5	46.0	(35.0)*
	June 1969	18-100	51.6	39.5	
	Aug. 1970	16-22	50.4	30.8	(41.5)*
	Sept. 1970	15-20	65.6	18.7	(22.0)*
	Oct. 1970	18-20	39.0	27.0	(33.8)*
	Dec. 1969	20-100	98.3	17.2	(35.6)*

*Catch rate from the commercial fishermen aboard in lb/line/hr.

lat. 15°16'N, long. 81°12'W to lat. 15°21'N, long. 81°28'W (20-30 fathoms). Catch rates for deepwater snappers along the edges ranged from 4.5 to 23.6 pounds/line/hour with an average of 12.5 pounds/line/hour from nine daytime efforts mostly in February 1968. On the east edges, silk and blackfin snappers and amberjack were dominant at 85 to 130 fathoms. Around the south point of the shelf where a few bottom slopes protruding into deep water exist, relatively high catch rates of black and blackfin snappers were obtained with traces of black jack and amberjack, margate grunts, red grouper, and hinds mixed. On the southwest edges of the shelf, Caribbean red snapper, silk, and blackfin snappers were captured from 60 to 120 fathoms at a rate of 23.6 pounds/line/hour. The commercial fishermen aboard produced fish, mostly yellowtail snapper, at a rate of 254 pounds (April) and 171 pounds (August)/man/day.

Along the edge of the main shelf, from the neck to the second shelf southward to lat. 14°15'N, yellowtail snapper, horse-eye jack, and green jack were abundant around ridges along the shelf edges. The best ground is located at about lat. 14°33'N, long. 81°45'W where a ridge running along the edge becomes highest (16 to 18 fathoms below the surface) and the edge line of the shelf is convex. Daily catch rates here ranged from 8.5 to 98.0 pounds/line/hour. Most were higher than 20 pounds/line/hour. Catch rates in daytime fishing averaged 39.9 pounds/line/hour with a range between 15.2 and 93.9, while nighttime catch rates on the same bottom were less at 24.6 pounds/line/hour, ranging from 8.6 to 52.2. The catch was composed mostly of horse-eye and green jacks and yellowtail snappers, but mutton snapper accounted for 70 to 81 percent of the snapper group in May and June (30 fathom bottom near the ridge) and some large amberjack (20 to 30 pounds size) occupied 15 to 21 percent of the jack group in April, May, and August (from 16 to 20 fathoms). Rainbow runners were caught seasonally from April to June, the amounts being from 7.7 percent to 16.5 percent of the total catch. This species was caught mostly near the surface at night by cast and pull type of operation with a line and baited hook. The commercial fishermen on board produced fish at 323 pounds/man/day on average from a total of 47 fishing days in this area, the range of the average catch rate by month being: April 1969—266, May 1968—234, June 1968—356, August 1970—517, September 1970—267, October 1970— 337, and December 1968—282. From the above location farther north to the neck of the second shelf or south about lat. 14°15'N, only a few places—lat. 15°19'N, 14°53' to 14°50'N near the shelf edge—had a catch rate of more than 20 pounds/line/hour for the shallow-water snapper and jacks.

The catch rates for deepwater snappers on the edge of the slope were relatively low, ranging from 1.6 to 25.3 pounds/line/hour. The edge of the slope around the foregoing convex shelf was the best ground for Caribbean red snappers and black snappers, but the average catch rate was only 12.4 pounds/line/hour for all species.

A strong northerly current which dominates this area often made handline fishing difficult because the boat was unable to hold the best fishing position. The period of biting of these shallow-water snappers and jack seemed to bear some relation to the current changes (direction and velocity) caused by the tidal current complex in the area. There were two phenomena to suggest this; one that either good or poor bites were often observed soon after some change of direction following a slack current event when echo soundings confirmed the existence of fish under the ship. The other reason is that with swinging of the vessel due to wind (east-northeasterly) and current (northerly), the nature of the bottom under the ship could change considerably during the fishing trial and different species of fish would be caught at different periods. It was observed that catches of grunts, hinds, or triggerfish would be made after initiating good bites by yellowtail snappers or jacks, or vice versa. Both phenomena were observed during successive fishing for several days by securing the vessel on the best spot by anchor with 90 to 120 fathoms of rope. Moon phase, which influences the tidal current, seemed to affect the night fishing by its brightness as well. Noticeable quantities of horse-eye jack and green jack were seen under the ship lights, and were caught by cast and pull type handlines on dark nights but not on full moon nights.

North of Hispaniola to Virgin Islands (Fig. A-2)

Banks north of Hispaniola

North of Hispaniola are three significant banks within 50 miles range of the coast. One is Monte Cristi Bank, which is an extended island shelf with an area of 309 square miles. The second is Silver Bank (868 square miles with 138 miles circumference) and the third is Navidad Bank (196 square miles with 73 miles circumference).

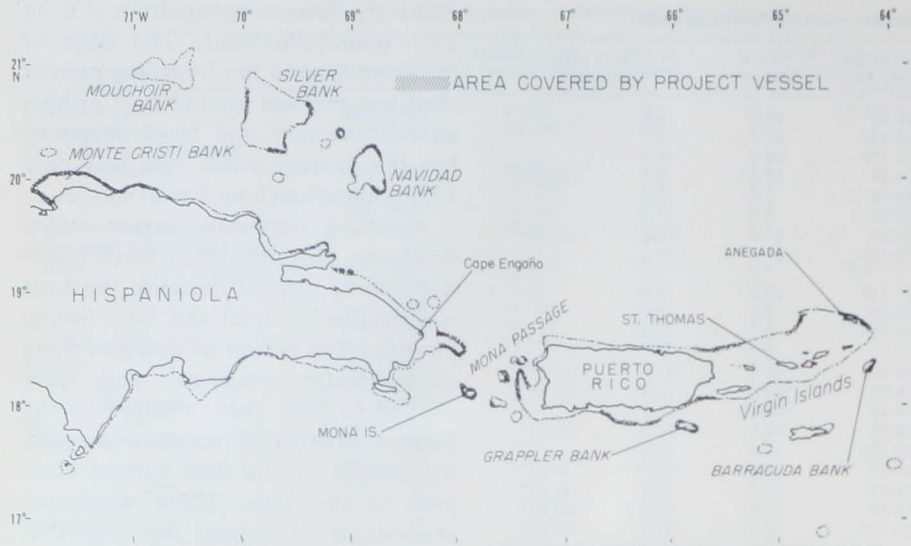

Figure A-2.—Area of operations—north of Hispaniola to Virgin Islands.

Three unnamed small banks exist between the latter two offshore banks, and one to the south of Silver Bank with a total area and circumference of 27.8 square miles and 34.5 miles, respectively. Catch results are given in Table A-5.

Catch rates on the west tip of the Monte Cristi Bank ranged between 6.5 and 20.9 pounds/line/hour, with over 60 percent of the total catch being black snapper. Silk snapper (10 to 20 percent), blackfin snapper (2 to 3 percent), vermillion snapper (1 to 2 percent), and queen snapper (0 to 30 percent) were common. Black, horse-eye, and amberjack or almaco jacks were also common, but collectively accounted for only 4 to 8 percent of the total catch. Nassau and red groupers, hinds, and grunts were the other varieties included in the total. The best depth range for snappers in this area was 60 to 70 fathoms (black snapper), 50 to 60 fathoms (blackfin snapper), 80 to 105 fathoms (silk snapper), 120 fathoms (vermillion snapper and volaz), and 114 to 130 fathoms (queen snapper). On the north edges of the bank only the western side showed better catch rates, from 3.5 to 51.7 pounds/hour, while the eastern side was unpromising. The dominant species in this area is black snapper (nearly 90 percent of the total catch). No queen or vermillion snapper was caught, but dog and mutton snappers were present. Silk, blackfin, and yellowtail snapper, amberjack, almaco, and horse-eye jacks, yellowfin and misty grouper, hinds, and grunts were also present in trace quantities. On these edges, black snappers were produced from shallower bottom (34 to 45 fathoms). On some occasions, black and blackfin snappers, horse-eye jacks, and triggerfish were caught in 10 to 15 fathoms near the surface over a 40 fathom bottom, being recorded on the echo sounder like a surface school of fish. Dog snappers were caught at 40 to 44 fathoms during daytime, but from 14 fathoms after dark. Mutton snappers were caught in 30 to 35 fathoms. Small size yellowtail snappers were caught from 30 to 54 fathoms.

A productive place on Silver Bank was the north side of the east tip around lat.20°39'N, long.69°22'W. On this edge, silk snapper was abundant at 80 to 110 fathoms while most black and blackfin snappers were found at 40 to 80 fathoms. Vermillion and queen snappers and volaz were included in snall quantities from waters over 100 fathoms. Common species of jacks and groupers were black jack, misty grouper, and hinds. On the shallow (12-16 fathoms) south and west edges, the only snapper caught were blackfin and yellowtail. Other varieties of fish caught on these shallow bottoms were Nassau, yellowfin, and tiger groupers; hinds; and grunts. The catch rates were low at 3.3 to 4.3 pounds/line/hour. One stop for 1.6 hours' fishing at southeast tip of the bank produced a high catch rate of 20.5 pounds/line/hour for mostly black snappers.

The edges along the north tip of the Navidad Bank were productive. The daily catch rates ranged from 58.7 to 165 pounds/line/hour. Dominant species were black and blackfin snappers and black jack. The explorations on these edges were made only in February 1969 and March 1968 and 1969. The following is a comparison of catch composition (percent in weight) for the main species. (Figures in parentheses are percent number of fish.)

	Feb. 1969	Mar. 1968	Mar. 1969
Black snapper	48.0 (41.3)	52.7 (45.6)	57.1 (46.6)
Blackfin snapper	33.6 (40.9)	25.1 (33.6)	24.3 (30.4)
Black jack	11.0 (9.9)	12.5 (11.7)	3.9 (3.3)
Groupers	2.3 (3.8)	1.1 (1.4)	9.3 (14.5)
Others	5.1 (4.1)	8.6 (7.7)	5.4 (5.2)

The average catch rate in March 1969 was less than half that of the same month of the previous year (16.1 pounds versus 36.3 pounds), but the catch composition for snappers shows

Table A-5.—Catch rates at specific locations—banks north of Hispaniola.

Fishing ground	Month	Depth range fished (fm)	Hours fished	Catch (lb/line/hr)
Monte Cristi Bank West edge	Feb. 1969	30-100	13.4	6.5
	Mar. 1968	25-120	31.8	20.9
North edge	Feb. 1968	30-100	6.6	2.8
	Mar. 1968	25-120	30.5	19.7
East half	Mar. 1968	42-120	9.4	1.6
Silver Bank				
East edge	Feb. 1969	40-80	14.2	13.1
East edge	Mar. 1968	45-150	10.1	28.5
Southern edge	Sept. 1967	12-14	20.6	3.3
SE tip	Feb. 1969	40-80	1.6	20.5
West edge	Sept. 1967	16	12.0	4.3
Navidad Bank				
South edge	Sept. 1967	14-40	17.5	8.9
North edge	Feb. 1969	40-80	33.5	32.3
	Mar. 1968	45-90	23.0	36.3
	Mar. 1969	25-80	34.0	16.1
A small Bank NW of Navidad Bank	Sept. 1967	15-18	15.0	2.7
Banks east of Samana Bay	Mar. 1968	52-100	4.5	7.0

almost the same ratio, the balance being affected mostly by the occurrence of black jack and groupers. A remarkable difference in fishing for the two March fishing operations was the depth occurrence of the snappers, the productive depth range for the 1968 cruise being from 50-60 fathoms while in 1969 it was shallower—30 to 50 fathoms. In February, the depth occurrence for the snapper was more like the previous March at 45 to 60 fathoms. Occasionally fishing effort at a certain depth affects the catch composition as well as catch rate but, since a drift for fishing is made from shallow to deep water (or vice versa according to current and wind direction), as long as fish biting continues the catch compositions by species and the depth occurrence given above can be regarded as representing the abundance of the good commercial species.

On the south edges of the bank, the catch rates on the shallow bottom from 14 to 40 fathoms near the edge resulted in 8.4 to 10.5 pounds/line/hour producing more groupers (yellowfin, hinds, Nassau, misty, etc.) than snappers (blackfin, silk, black, and yellowtail).

One day's fishing in 10 fathoms on one of the unnamed small banks resulted in a poor catch rate of 2.7 pounds/line/hour for the shallow bottom near the edges. Hinds and groupers occupied nearly 66 percent of the total catch, while snappers and jacks occupied 13 percent and 10 percent of the total, respectively.

One-half day coverage on the three small banks east of Samana Bay produced 157 pounds of fish, mostly black snappers, from a total of 4.5 hours fishing with five reels on various deep spots. The catch rate of 7.0 pounds/line/hour on the average includes only four other varieties: blackfin snapper, amberjack, yellowfin grouper, and red hind.

Mona Passage area

In the Mona Passage area, there exist relatively extended island shelves, one on the east coast of Hispaniola and another on the west coast of Puerto Rico, with a few offshore banks in between. The species caught were similar to those north of Hispaniola, but the catch rates were very low ranging from nil to 6.1 pounds/line/hour. Strong northerly currents between Mona Island and the east coast of Hispaniola are totally unfavorable to bottom fishing for deepwater species. The shelf west of Puerto Rico has been intensively fished by pot fishermen of the area. Catch details are given in Table A-6.

Table A-6.—Catch rate at specific locations—Mona Passage.

Fishing ground	Month	Depth range fished (fm)	Hours fished	Catch rate (lb/line/hr)
East end shelf of Hispaniola	Mar. 1969	40-100	4	0.4
	Sept. 1967	50-60	6.3	1.7
Isla Monito	Sept. 1967	28-60	7.5	5.8
Isla Monito & Mona Island	Mar. 1969	42-90	2.1	0.3
Placer Bank	Mar. 1969	44-91	1.5	Nil
Sponge Bank	Sept. 1967	16-30	0.8	Nil
	Mar. 1969	16-110	16.3	0.0

Table A-7.—Catch rates at specific locations—Puerto Rico and Virgin Islands shelf.

Fishing ground	Month	Depth Range fished (fm)	Hours fished	Catch rate (lb/line/hr)
Puerto Rico S. of Ponce	Mar. 1969	20-70	15.0	4.3
Grapler Bank SE of Puerto Rico	Mar. 1969	44-50	14.3	9.8
Puerto Rico off Pta. Guyanes	Mar. 1969	80-130	2.7	8.2
Puerto Rico N of Cabo San Juan	Mar. 1969	30-90	3.4	3.3
WNW of Whale Bank	Apr. 1968	50-120	20.9	16.6
North of St. Thomas	Apr. 1968	50-120	9.1	7.5
NE of Anegada Island	Apr. 1968	50-120	11.2	5.4
Barracuda Bnk, NE edges	Apr. 1968	35-60	9.3	33.2

Puerto Rico-Virgin Islands shelf

This is a large area of about 3,450 square miles with a total length of 482 miles of shelf edge. The shelves around Puerto Rico and within reach of the local boats in the Virgin Islands have already been heavily exploited. Only a few offshore banks exist in the south off the shelves. A total of nine fishing days was spent to cover the area during April 1968 and March 1969.

Relatively productive places were on the northeast edge of Barracuda Bank, chiefly for black snapper (67 percent), and the shelf edge WNW of Whale Bank, chiefly for silk snapper (41 percent), misty grouper (31 percent), and blackfin snapper (11 percent). Other varieties of fish included in the catch from this area were yellowtail, vermillion, schoolmaster, dog snapper, and volaz (deep sea wenchman) for snappers, black, horseeye, green, bar, almaco jacks and amberjack, misty, Nassau, yellowfin, yellowmouth groupers, coney, and hinds. Table A-7 gives the catch rate by ground and month.

Leeward Islands (Fig. A-3)

In this area two large island shelves, namely Anguilla Bank and Barbuda-Antigua Bank, and a large offshore bank, Saba Bank, exist. Around these three banks a few small unnamed offshore banks are scattered. The shelves of other islands are all narrow and have been intensively fished, mostly by fish pots.

Anguilla Bank

The Anguilla Bank has an area of about 1,310 square miles with a total of 192 miles circumference. There are two small unnamed banks (31.6 square miles with 34 miles circumference) and Sombrero Bank (16 square miles with 15 miles circumference) on the northwest of the bank and a relatively large one (approximately 59 square miles with 31 miles circumference) on the southeast. A total of nearly 28 fishing days in three different months were expended on exploratory fishing in this area. The catch rates are depicted in Table A-8.

The results in Table A-8 represent only spring and fall seasons in the area and contain insufficient elements for proper comparison. The varieties of snappers were mostly black, blackfin, and silk snappers throughout the area and season. However, a few vermillion and volaz were from Sombrero and the unnamed bank, and some vermillion, yellowtail, volaz, queen, and a few mutton and dog snapper were from Anguilla Bank. These snappers comprised 72 to 99 percent of the total catch from

Sombrero and the unnamed bank and 42 to 82 percent of the total from Anguilla Bank. Jacks caught were limited to black, almaco, and horse-eye jack. These were included in the total catch at 1.0 to 6.3 percent in weight on Sombrero and the unnamed bank and 2.8 to 16.6 percent on Anguilla Bank. Groupers captured were misty, red, yellowfin, and Nassau with some hinds on the Anguilla Bank. No yellowfin or red grouper was caught from Sombrero and the unnamed bank. These species occupied 9.3 to 55.4 percent of the total catches on Anguilla Bank and nil to 25 percent on Sombrero and the unnamed bank. The range of daily catch rate in pounds/line/hour on the different edges of the Anguilla Bank were 4.8 to 21.5 on the northwest edges, nil to 32.3 on the north to northeast edges, 5.6 to 19.0 on the north edges of the eastern part, and 4.8 to 30.7 on the east tip. The slope edges of the Anguilla Bank were generally very steep, falling to more than 100 fathoms from 30 to 50 fathom edges. The fishing was most effective where comparatively gradual slopes exist, such as the east tip or the north tip of the bank. A total of 10 nights' fishing, mostly 32 to 38 fathoms at anchorage near the east tip of the bank, produced almost the same main varieties of fish as those in daytime, but most of the yellowtail snapper and horse-eye jack were caught during night fishing. The catch rate ranged from 4.8 to 21.4 pounds/line/hour with a total average of 13.4 pounds.

Body temperatures of some species from various depths were measured during April 1968 on Anguilla, Sombrero, and Barracuda Banks. The results are given in Table A-9.

It is not certain that the body temperature coincides with that in their living water layer because of no simultaneous bathythermograph cast. However, the body temperature of snappers apparently changes with depth and has a small deviation among individuals at equal depths. Though the measurements are insufficient to draw definite conclusions, it is thought that those of black jack and yellowfin grouper indicate some relatively large vertical movements of short duration.

Saba Bank, which lies several miles west of Saba Island, has been exploited only by a few motor fishing boats (25 to 45 foot) from nearby islands. The catch from those boats ranges from 500 to 1,800 pounds for a 4- to 6-day trip with a crew of three to five. One of the two mother ship operation units described in this paper carried out some exploratory fishing in August 1967 utilizing bottom longline methods by the catcher boats and handline methods by the mother ship itself. The daily catch ranged from only 130 to 500 pounds. The area of the bank is about 644 square miles and the circumference is nearly 107 miles. One small unnamed bank (10 square miles with 24 miles circumference) exists a few miles to the north.

Throughout the exploratory period by handline and reel methods, only 1 day was spent on this area covering some edges on the east and north of the bank and the small bank. The result was almost negative, producing only 18 fish (62 pounds) of various species from 70 to 130 fathom shelf edges from 6.3 hours fishing. Some extensive seasonal coverage in this area utilizing pot methods (which followed the exploratory period), however, disclosed rather productive bottoms along the northern edges, chiefly for silk snapper.

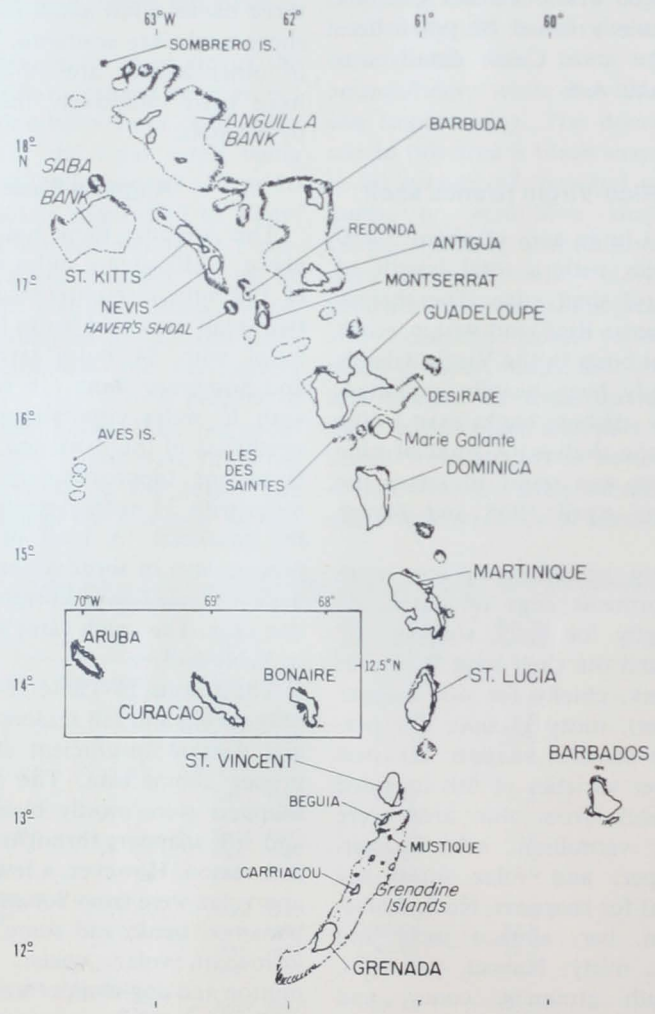

Figure A-3.—Area of operations—Leeward and Windward Islands waters, Aves Island, Aruba, Curacao, and Bonaire.

Barbuda-Antigua Bank

Barbuda-Antigua Bank has an area of nearly 978 square miles with about 163 miles circumference. On the bank, two relatively large islands exist, Barbuda Island in the north and Antigua Island in the south, 25 miles apart. From these two islands more than 60 boats, of which about 50 are equipped with inboard engines, are fishing on this bank, most of them concentrated on the Antigua shelf. The annual landing from this bank is around 1.6

Table A-8.—Catch rates at specific locations—Sombrero Island-Anguilla Bank.

Fishing ground	Month	Depth range fished (fm)	Hours fished	Catch rate (lb/line/hr)	Dominant species
Sombrero Island	Apr. 1968	50-120	11.8	21.0	BK-SK[1]
	May 1969	50-125	20.0	6.2	BK-SK
	Oct. 1968	93-120	4.3	6.1	SK-BF
Unnamed bank NW of Anguilla Bank	Apr. 1968	50-120	8.5	18.4	BK-SK
Anguilla Bank NW edges	Apr. 1969	28-111	7.3	6.0	BK-SK
	Oct. 1968	30-100	1.2	17.3	BF-SK
Anguilla Bank N to NE edges	Apr. 1968	50-120	12.2	32.3	BF-BK
	May 1969	50-150	18.0	9.4	BK-BF
	Oct. 1968	27-126	5.7	10.6	SK-BF
Anguilla Bank NE in the east	Apr. 1969	36-38	10.2	12.7	BF-SK
	May 1969	75-150	8.0	7.2	BF-SK
	Oct. 1968	45	1.7	5.6	BF-O
Anguilla Bank East tip	Apr. 1968	50-60	10.5	17.6	BF-BK
	Apr. 1969	34-129	128.9	14.8	BF-BK
	May 1969	50-125	18.0	8.3	SK-BF
	Oct. 1968	35-135	26.2	23.8	BF-BK
Anguilla Bank SE edge	May 1969	50-125	10.0	5.9	BF-SK

[1]BK = black snapper, BF = blackfin snapper, and SK = silk snapper.

million pounds. A few small offshore banks (a total of 2 square miles circumference) lie on the west side of Barbuda Bank.

The project vessels, from a total of 13 days fishing in this area, produced relatively high catch rates along the northern half of the Barbuda Bank including the offshore banks, in spite of the short distance from the coastline of Barbuda. The catches were composed of 65 to 92 percent snapper, 3 to 33 percent jacks, and 0 to 14 percent groupers. The variety of snapper was chiefly silk, but blackfin and black snappers were also common and a few vermillion, queen, and dog snappers were taken. Except for one night when three horse-eye jacks were caught, amberjack or almaco and black jacks were the only species of the jack group captured. Yellowfin, misty, red, and Nassau groupers and hinds were the common varieties of the grouper. The daily catch rate ranged from 8.6 to 19.8 pounds/line/hour on the northeast to north edges and 7.0 to 30.2 pounds on the west edges of Burbuda Bank. Table A-10 shows the catch rate by month and area.

St. Kitts to Dominica

The other island shelves in the Leeward Islands are generally narrow and exploited intensively with fish pots by the local fishermen. Table A-11 gives the approximate area and the circumference of the shelves of these islands, including neighboring offshore banks. The fishing month and depth range in the last two columns in the table are supplementary to the information in Table 2.

As shown in Table 2, the catch rates (the catch rate in Table 2 is for 10-hour fishing periods) obtained from the edges of these southern Leeward Islands shelves were very poor, being less than 2.3 pounds/line/hour, except Haver's shoal and Redonda Island shelf which showed comparatively higher catch rates of 8.9 to 15.0 pounds/line/hour. The variety of fish caught from these areas were similar to those from the northern Leeward Islands except that queen snapper were included in the common species of snapper.

Windward Islands

The island shelves and their utilization in the Windward Islands are very similar to those in the southern Leeward Islands—narrow and extensively fished, except for the Grenadine Islands shelf which has an area of about 1,010 square miles. Offshore banks are few and small, most of them lying within reach of the local fishing boats. Table A-12 gives the area and perimeter of each shelf, with the fishing month and depth range in the last two columns.

Despite an ample geographic coverage transecting the edges of these shelves with echo sounder and test fishing, the catch results were mostly very poor. Eighteen out of a total of 28 fishing days in these areas produced practically zero catch. The most productive area was around the south tip of the Grenadine Island shelf where 9.2 to 11.0 pounds/line/hour was obtained. The catch was composed of 65 percent snapper (chiefly blackfin), 32 percent jacks (black, green, amberjack, and horse-eye), and 3 percent

Table A-9.—Body temperature of some fish species caught in Leeward Islands (°C).

Depth (fm)	Black snapper	Blackfin s.	Silk snapper	Blackjack	Yellowfin grouper	Time (hr)	Surface w. temp. (°C)	Area
39	(7)* 25.2 + 0.2 − 0.3**	(2) 25.2 + 0.0 − 0.0	—	—	—	14	26.3	Barbados
53	(5) 24.9 + 0.3 − 0.4	(1) 25.2	—	(7) 25.3 + 0.2 − 0.3	—	15	25.7	Anguilla (E)
54	(5) 24.3 + 0.7 − 1.3	(5) 24.3 + 0.2 − 0.3	(1) 24.0	(1) 24.0	—	14	26.3	Barbados
70	(3) 24.2 + 0.3 − 0.2	(4) 24.0 + 0.1 − 0.3	—	—	—	08	25.4	Anguilla (NE)
80	(5) 22.6 + 0.5 − 06	—	—	—	—	11	25.5	Sombrero
90	(1) 22.8	(1) 22.8	(1) 22.0	—	(1) 18.0	08	25.4	Anguilla (NE)
100	—	(1) 22.0	(1) 20.5 + 0.5 − 0.8	—	—	11	25.5	Sombrero
100	(1) 22.0	(1) 22.7	—	—	—	08	25.4	Anguilla (NE)
110	(2) 23.2 + 0.1 − 0.1	(1) 23.5	—	(3) 25.4 + 0.1 − 0.2	—	10	25.6	Anguilla (E)

*Figure in parenthesis shows number of fish measured.
**Deviation from maximum and minimum

Table A-10.—Catch rates at specific locations—Barbuda-Antigua Banks.

Fishing ground	Month	Depth range fished (fm)	Hours fished	Catch rate (lb/line/hr)
Barbuda, N-NE edges	May 1969	50-130	40.5	11.9
	Nov. 1968	36-125	4.1	16.0
W. edges	May 1969	55-100	17.5	10.8
Small banks W of Barbuda Bank	Apr. 1969	36-110	9.7	6.1
	Nov. 1968	24-135	40.5	17.8
Between Barbuda & Antigua E edge	Nov. 1968	42-120	1.1	3.5
Antigua S-SE edges	Apr. 1968	60-110	5.9	0.0

Table A-11.—Principal characteristics of specific localities fished—St. Kitts-Dominica.

Name of shelf	Area (sq. mil.)	Perimeter (miles)	Fishing month	Depth range fished (fm)
St. Kitts-Nevis	219	109	Nov. 1968	30-135
Redonda	38	24	Apr. 1968	60-120
Montserrat	41	33	Nov. 1968	42-135
Havers Shoal	1.9	4.8	Nov. 1968	28-130
Three banks in Guadeloupe passage	45	55	Dec. 1968	
Guadeloupe	444	159	Dec. 1968	30-140
Flandre Bank	10.3	10	Dec. 1968	30-138
Marie Galamte Is.	39	36	Dec. 1968	30-120
Ile des Saintes etc.	67	33	Dec. 1968	—
A bank between Marie-Galante & Ile des Saintes	11	14	Dec. 1968	—
Dominica	97	78	Nov. & Dec. 1968	12-111
A bank SE of Dominica	40	25	Nov. & Dec. 1968	45-135

mixed fish with grouper, grunt, and squirrelfish. A short period of fishing on the north edge of Dominica Island shelf caught fish (85 percent black jack) at a rate of 5.2 pounds/line/hour. Around the south tip of the St. Lucia Island shelf, daily catch rates of 1.6 to 4.4 pounds/line/hour (77 percent queen snapper) were obtained from the 75 to 150 fathom slopes. These catch rates are probably good only for the local fishing boats equipped with outboard engines, whose cost of operation and depreciation rate are very low. The remainder of the shelves in this area give less than 1.0 pound/line/hour.

Aves Island Area

The Aves Island (or Bird Island) and several small offshore banks exist about 120 miles west of Dominica. The total area of these shelves is approximately 17 square miles and their edges total 35 miles long. The exploratory fishing was extended to this area during May and August 1969. A total of 8 hours transecting bottoms of these banks during May found no proper spot for snapper fishing. One hour's fishing in August captured only two coneys (1 pound) from 13 fathoms bottom. It is interesting that one black jack in August 1967 and six black jacks in August 1969 were captured with other pelagic species while surface trolling in this area.

Table A-12.—Principal characteristics of specific localities fished—Windward Islands.

Name of shelf	Area (sq. mil.)	Perimeter (miles)	Fishing month	Depth range fished (fm)
Martinique Is.	353	106	Dec. 1968	24-207
A bank ENE of Martinique	18	17	Nov. & Dec. 1968	45-135
St. Lucia Is.	157	84	Jan. 1969	30-153
A bank south of St. Lucia	2.5	5	—	—
St. Vincent Is.	43	49	Jan. 1969	To-125
Grenadine Is.	1,010	234	Jan. & Feb. 1969	22-135
Barbados Is.	89	60	Mar. 1969	18-280
The shallows	18	18	Mar. 1969	25-75

Table A-13.—Catch rates—Aruba-Curacao-Bonaire area.

Fishing ground	Month	Depth range fished (fm)	Hours fished	Catch rate (lb/line/hr)
Aruba Island	May to June 1969	10-104	19	2.2
Bonaire Is.	May to June 1969	—	37	0.8
Curacao Is.	May to June 1969	—	45	1.0

Aruba-Curacao-Bonaire Area

The shelves of these three islands are very narrow having widths of less than 1 mile. Only the north and south shelves of Aruba Island are slightly broader, 5 miles and 2 miles, respectively, the east side of the shelf being connected by a 104-fathom sea floor to the north edge of the Venezuela shelf. A total of 23 fishing-days were spent on exploratory fishing for snappers and related species on these shelves during the months of May and June 1969, Table A-13. The catch results on these shelf slopes were mostly very poor, the catch rates ranging from 0 to 0.8 pounds/line/hour on the Bonaire shelf, 0 to 1.0 pound on the Curacao shelf, and 0.3 to 8.1 pounds on the Aruba shelf, the north edge of the Aruba shelf being comparatively productive. The catch was composed of snappers (38 to 45 percent in number), jacks (6 to 24 percent), groupers (6 to 27 percent), and trash fish (24 to 31 percent).

The majority of the snapper species was mainly blackfin with some queen, silk, vermillion, and volaz. The jack species were mostly amberjack, but some black and horse-eye jacks were present.

Continental Shelf of South America from Trinidad to French Guiana

The continental shelf of South America is 50 to 90 miles wide from the coastline to the shelf edge of the 100-fathom line. The area and the edge line are about 57,400 square miles and 930 miles long from the north of the west boundary of Trinidad to northeast of the Oyapock River, the east boundary of French Guiana (Fig. A-4). As previously stated, commercial snapper fishing on this shelf has existed for past decades, but the number of vessels operating there has not increased. It is estimated, however, that a considerable amount of snapper has been and is being caught incidentally by those shrimp trawlers (402 vessels in 1969) operating on the interior part of the shelf (10 to 35 fathoms) where lane snappers, vermil-

lion snappers, and some Caribbean red snappers are present.

The exploratory fishing by the project vessels covered almost all of the likely bottoms for snappers along the edge of the shelf as well as the interior part of the shelf. Most of the bottom of this vast shelf has a featureless smooth bottom with a gradient of 1 fathom or 2 for every 2 miles or a slow slope on the edges, with, of course, some exceptions. Generally, fish schools were not found by echo sounder on these bottoms, but they were located on some outcrops or so-called "hard bottom" on the shelf, around ridges or rugged bottoms near the edges, or on the reasonably steep edge slopes where the deep ocean floor is close to the edge. Further details of catch results and good fishing grounds by area are as follows.

Shelves around Tobago and east of Trinidad.—The catch results around Tobago and the eastern shelf of Trinidad were generally poor (Table A-13). The catch rate by area around Tobago ranged from 0 to 13.2 pounds/line/hour, the edges east of the island being more productive while the shelf south to southwest of the island yielded mostly zero catch. The dominant species on the slope edges were Caribbean red snappers and black jack. A few yellowedge grouper, amberjack, and coneys were included in the catch. The catch rate along the shelf edges east of Trinidad ranged from 0 to 32.2 pounds/line/hour. The best catch was obtained on the 60 to 70 fathom bottom around 10°27′N. The inward shelf yielded few fish. The dominant species for snapper were Caribbean red snapper, vermillion snapper, and yellowedge grouper. Some blackfin snapper, Warsaw grouper, and porgy were included in the catch. Table A-13 gives further details by month and area.

Shelves east of Orinoco River (lat.10°N to 9°N)—From a total of seven days spent in this area, two narrow areas—edges around lat. 9°40′N and around lat. 9°05′N—showed good catch rates, 17.4 and 25.7 pounds/line/hour, respectively. Catches from the inward shelf were almost nil. On these edges Caribbean red snapper, blackfin snapper, and vermillion snapper were the main snapper species, but in total weight,

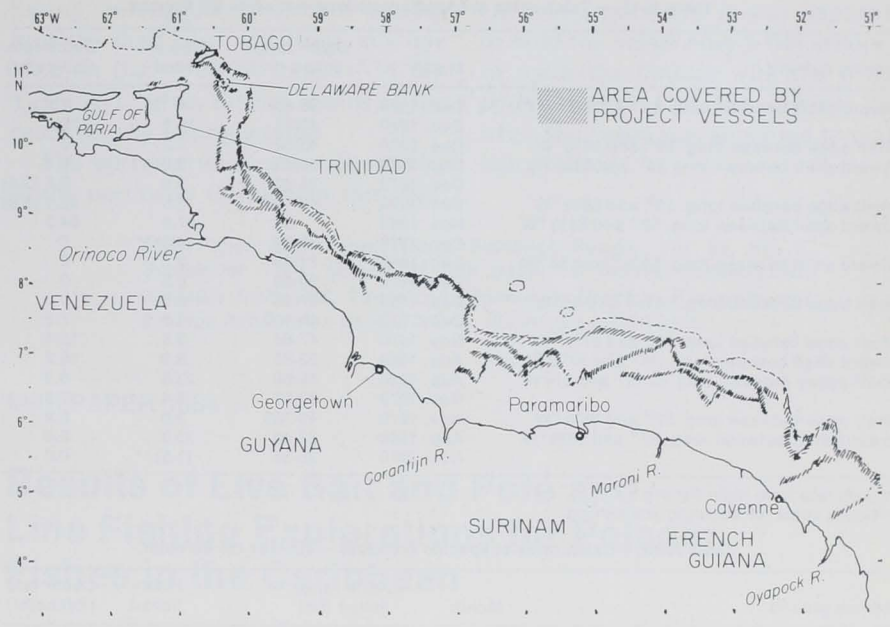

Figure A-4.—Area of operations—continental shelf of South America from Trinidad to French Guiana.

Table A-13.—Catch rates at specific locations of Trinidad and Tobago.

Fishing ground	Month	Depth range fished (fm)	Hours fished	Catch rate (lb/line/hr)
Around Tobago	Feb.-Mar. 1969	22-150	59.1	2.6
	Dec. 1970	29-90	0.7	0.0
Inward shelf east of Trinidad	Dec. 1970	9.46	1.9	2.7
East of Delware Bk.	Mar. 1969	37-120	17.6	0.1
Edges from 10°N to 10°30′N	Dec. 1970	46-70	4.6	15.3

Table A-14.—Catch rates at specific locations—shelves east of Orinoco River.

Fishing ground	Month	Depth range fished (fm)	Hours fished	Catch rate (lb/line/hr)
Inward shelf N of Orinoco River	Dec. 1970	30-44	0.1	0.0
Edges from 10°N to 9°30′N	Dec. 1969	36-90	9.5	0.4
	Dec. 1970	33-100	4.0	16.8
Edges from 9°30′N to 9°18′N	Dec. 1969	45-49	11.3	0.0
	Dec. 1970	34-61	0.2	1.6
Edges from 9°18′N to 9°N	Dec. 1970	55-100	2.3	23.7
Inward shelf N of Waini R.	Dec. 1970	33-42	0.1	0.0

groupers, chiefly yellowedge grouper, sometimes contributed more than snapper to the total catch. The catch rate by specific locality appears in Table A-14.

Shelves off Guyana.—A total of 19 fishing days was spent in this area. Considerable echo sounding transects were run on the slope edges as well as likely bottoms (30 to 40 fathoms) on the inward shelf. The shelf edges usually have a steep gradient, but the shelf proper was largely even excepting for some very small bottom outcrops. As shown in Table A-15, the three best catches were produced from such outcrops (about 6 feet high) on the inward shelf in this area. One in November 1969 produced 7,400 pounds of fish in 2 days by *Fregata*, and one in December 1970 by *Calamar*, caught nearly 7,700 pounds of fish in less than 8 hours fishing in 2 days. These catch rates averaged 95 to 137 pounds/line/hour with more than 99 percent of the total being Caribbean red snappers. The snapper caught by the *Fregata* averaged 6.6 pounds each while those caught by the *Calamar* averaged 8.1 pounds each. The former area is located at about lat. 8°18′N, long. 58°32′W (34 fathom bottom) and the latter at lat. 8°46′N, long. 59°12′W, about 50 miles northwest from the former. Fishing during the December 1970 *Calamar* cruise at the former position and March 1971 cruise at the latter position, showed no sign of the fish school. It is likely that those large schools of fish move from one small outcrop to another due to a limited supply of food. The shelf edge with rather steep gradient displayed good potential. Relatively

Table A-15.—Catch rates at specific locations—shelves off Guyana.

Fishing Ground	Month	Depth range fished (fm)	Hours fished	Catch rate (lb/line/hr)
Inward shelf between long. 59° & 59½°W	Dec. 1969	35-45	11	0.5
	Dec. 1970	33-51	16.0	133.4
Shelf edge between long. 59° and 59½°W	Dec. 1970	45-52	0.3	0
Inward shelf between long 59° and 58½°W	Dec. 1969	35-45	10.9	0.1
	Dec. 1970	34-47	0.9	3.7 (3.4)*
Shelf edge between long. 59° and 58½°W	Dec. 1970	45-100	8.5	12.5 (9.9)*
Inward shelf between long. 59° and 58½°W	Nov. 1969	34	17.6	84.5
	Dec. 1970	30-52	(6.3)**	0
Inward shelf between long. 58½° and 58°W	Dec. 1969	31-34	2.5	0
	Dec. 1970	30-60	0.3	0
Shelf edge between long. 58½° and 58°W	Sep. 1969	27-95	5.0	0.2
	Dec. 1970	45-120	3.8	7.2
Shelf edge between long. 58° and 57½°W	Nov. 1970	47-68	2.8	12.1
Inward shelf between long. 58° and 57½°W	Aug. 1969	22-59	8.9	10.2
Shelf edges between long. 57½° and 57°W	Aug. 1969	45-60	23.5	8.9
	Nov. 1970	50-57	5.4	12.3
Shelf edge between long. 57° and 56½°W	Nov. 1970	49-150	3.0	5.9
Inward shelf between long. 57° and 56½°W	Aug. 1969	22-40	33.8	5.9
	Nov. 1970	35-36	(1.5)**	0.0

*Catch rate from night fishing.
**Hours spent for scouting and fishing.

Table A-16.—Catch rates at specific locations—shelves off Surinam.

Fishing ground	Month	Depth range fished (fm)		Hours fished	Catch rate (lb/line/hr)
Shelf edge between					
long. 56½° and 56°W	Aug. 1969	45-65		10.4	8.8
	Nov. 1970	51-75	0.8	(7.8)*	9.1
Long. 56° and 55½°W	Nov. 1970	56-145	0.7	(9.0)	2.4
Long. 55½° and 55°W	Nov. 1970	50-250	3.9	(15.4)	11.2
Long. 55° and 54½°W	Nov. 1970	55-120	0.5	(8.0)	0.0
Long. 54½° and 54°W	Nov. 1970	48-55	0.6	(5.5)	0.0
Long. 54° and 53½°W	Nov. 1970	45-52	0.6	(5.3)	0.0
Inward shelf between					
Long. 56½° and 56°W	Aug. 1969	35-38		33.2	24.7
	Nov. 1970	30-37	0.8	(6.3)	8.1
Long. 56° and 55½°W	Aug. 1969	34-54		18.8	6.6
	Nov. 1970	33-34	0.6	(4.6)	0.0
Long. 55½° and 55°W	Aug. 1969	27-60		9.5	3.5
	Nov. 1970	33-34	0.2	(4.8)	0.0
Long. 55° and 54½°W	Aug. 1969	27-35		11.0	0.6
	Nov. 1970	32-33	0.7	(3.8)	0.0
Long. 54½° and 54°W	Nov. 1970	30-50	0.2	(6.6)	0.0
Long. 54° and 53½°W	Oct. 1969	32-53		33.4	7.8

*Figures in parenthesis show total scouting and fishing hours.

Table A-17—Catch rates at specific locations—shelves off French Guiana.

Fishing Ground	Month	Depth range fished (fm)		Hours fished	Catch rate (lb/line/hr)	
Shelf edge between long. 53½° and 53°W	Oct. 1969	27-53		31.0	17.4	
	Oct. 1970	50-95	8.4	(14.8)*	2.6	
Long. 53° and 52½°W	Oct. 1969	43		24.5	7.0	
	Oct. 1970	50-85	2.4	(9.5)	11.4	
Long. 52½° and 52°W	Oct. 1969	43-55		20.0	4.4	
Offshore bank and edges between long. 52½° and 52°W	Oct. 1970	41-65	5.5	(18.8)	9.6	
Shelf edge between long. 52° and 51½°W	Oct. 1970	43-65	47.6	(133.0)*	17.6	(33.5)**
Long 51½° and 51°W	Oct. 1970	52-61	1.2	(11.4)*	19.9	
Inward shelf between 53½° and 53°W	Oct. 1969	27	6.3		*	0.0
	Oct. 1970	30-50	0.2	(14.7)*	0.0	
Long. 53° and 52½°W	Oct. 1970	30-41	0.0	(2.8)*	0.0	
Long. 52½° and 52°W	Oct. 1970	35-38	1.1	(6.0)*	6.6	
Long. 52° and 51½°W	Oct. 1970	25-35	1.8	(11.7)*	6.3	
Long. 51½° and 51°W	Oct. 1970	30-50	1.8	(11.3)*	4.5	

*Total scouting and fishing hours.
**Catch rate from night fishing.

productive positions were on the shelf edges around the longitudes of 58°45'W, 57°41'W, and 57°19'W. The varieties of the catch were chiefly Caribbean red snapper with some vermillion snapper and a trace of blackfin snapper. A few large amberjacks (13-20 pounds each) and one or two yellowedge, Warsaw, and/or yellowmouth groupers were also caught. Further details of catch results by localities are given in Table A-15.

Shelves off Surinam.—During the months of August and October 1969, exploratory fishing off Surinam was centered mainly on the inward shelf from 27 to 60 fathoms. The catch rate averaged 9.4 pounds/line/hour with a range from 0.6 to 34.9. The higher catch rates were obtained in 33 to 40 fathoms between long.56.5°W and 56°W, and in 37 fathoms around lat.7°08'N, long.53°44'W. During the month of November 1970, a total of 29.3 hours in about two fishing days was spent to cover a belt of 30 to 37 fathoms bottom (a total distance of 170 miles) along the coast. Only 18 small schools were located at an average interval of about 9.5 miles. From the 18 drifts on the schools, in 2 hours 9 minutes actual fishing time, the average catch rate was estimated at about 4.3 pounds/line/hour, yielding mostly zero catches excepting for the first area (long. 56.5°W to 56°W), which produced 15.4 pounds/line/hour.

On the shelf edges, during the later cruise, a total of 90.4 hours in eight fishing days covered about 270 miles. More fish schools were found along these edges than on the inward shelf. A total of 77 drifts was made into the fish schools with 13.1 hours of actual fishing. The average interval of these fish schools is about 3.5 miles. Estimation of catch rate from a total of 78.6 reel hours fishing effort and the catch (854 pounds) is 10.9 pounds/line/hour. The catch rates ranged from 0 to 13.1 pounds/line/hour with higher catch rates from the edges between the longitudes of 55°W and 55.5°W.

The catch in this area comprised about 33 to 85 percent snappers, 11 to 66 percent grouper, and the remainder, 1 to 4 percent, jacks and tilefish. The varieties of the catch were similar to those from the shelves off Guyana. Table A-16 gives further details of catch results by area.

Shelves off French Guiana.—The northwestern half of the shelf edge in this area has mostly a featureless gradual slope excepting for some bottom contours built up by low outcroppings on or about the 50 fathom line where some snapper schools were found. The shelf edges from about long. 52°W southeasterly were distinguished by steep slopes slanting directly onto the deep ocean floor. Inside of, but near the edges, they have favorable ridges. Numerous snapper schools were found along this 40 mile long edge. Probably the narrowness or steepness of the edge provided for more congregation of fish because

of the narrowness of the optimum depth range, as well as an advantageous biological environment. The interior part of the shelf between the edges and 30 to 33 fathoms bottom was mostly devoid of snappers and it has flat and smooth bottom features. There were some outcrops on 30 to 33 fathoms bottom, but the size of the fish schools found there was relatively small.

In October 1969 the northwestern half of this area was fished for a total of 8 fishing days, mostly near the edges at 43 to 60 fathoms. The catch rate averaged 9.8 pounds/line/hour with a range from 0 to 39.4. The catches from the inward shelves were mostly nil. A most productive ground was on 43 fathoms bottom around lat. 6°51′N, long. 53°13′W. In the same month of 1970 a total edge distance of about 200 miles and the 30 to 45 fathoms bottom on the inward shelf, about 240 miles long total, were covered in 14 fishing days. On the northwestern half of the shelf, the catch rate was 6.3 pounds/line/hour for the deeper bottoms near the edges (from 10.8 actual fishing hours out of 27.1 total hours on the grounds) and zero for the shallower bottoms on the inward shelf (from 1.3 actual fishing hours out of 23.5 total hours on the grounds). In the southeastern half the catch rates were nearly three times better at 18.5 pounds/line/hour on or near the edges (53.8 fishing hours out of 144.4 total hours) and 5.3 pounds/line/hour on the inward shelf.

The catch comprised 66 to 92 percent snappers, 7 to 26 percent groupers, and 1 to 8 percent jacks. A few tilefish and triggerfish were also present. Only three varieties of snapper were caught in this area. Caribbean red snapper was most dominant throughout followed by vermillion snapper. Lane snapper was captured only from shallower bottoms of 29 to 35 fathoms. Yellowedge, Warsaw, snowy, and yellowmouth groupers were common on the shelf edges, but on the shallower bottoms on the inward shelf only snowy, yellowedge, and red groupers were common. Jacks were rare in daytime fishing, only a few amberjacks and green jacks being caught. From one night's fishing 27 horse-eye jacks (427 pounds) were captured from 2 hours fishing on rugged 55 fathom bottom near the shelf edge, but from only one location (lat. 5°53′N, long.51°34′W). Table A-17 gives further details of the catch rate by fishing ground.

The currents were generally strong to the northwest throughout this area. On many occasions it was impossible to hold the vessel onto a fish school or to reach the bottom with the 6 to 9 pound sinkers on the fishing lines when the vessel was anchored to maintain position.

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MFR PAPER 1084

Results of Live Bait and Pole and Line Fishing Explorations for Pelagic Fishes in the Caribbean

DONALD P. WAGNER

ABSTRACT—This paper presents results of exploratory fishing in the Caribbean for live bait and for tuna, using the pole and line method, 1967-1970. Seasonal fluctuations in abundance of both bait and tuna stocks were evident. Bait fishes were caught throughout the Caribbean but were most abundant off the Windward Islands, Trinidad, and Tobago. Catches of bait ranged up to 700 pounds per station and were primarily Atlantic thread herring, Opisthonema oglinum; *dwarf herring,* Jenkinsia lamprotaenia; *pilchards,* Harengula *sp.; and sardines,* Sardinella *sp. Tuna catches were as high as 73 pounds per hour and were mostly skipjack,* Katsuwonus pelamis. *During 1970, an intensive survey near the Windward Islands produced catches averaging 24 pounds per hour.*

INTRODUCTION

From March 1967 through June 1970, the United Nations Development Program/Food and Agriculture Organization Caribbean Fishery Development Project (CFDP) made live-bait surveys and pole and line fishing explorations as part of investigations of available fishery resources in the Caribbean Sea and surrounding waters. The following objectives were set:

1. Develop information on the availability of live bait suitable for pole and line fishing.
2. Define the geographical and seasonal distribution of surface schooling fishes, principally tunas.
3. Conduct experimental tuna fishing by the pole and line method.

Exploratory fishing operations in 1967, 1968, and 1969 extended from the coast of British Honduras to Jamaica, Hispaniola, and Puerto Rico, thence south along the Antillean Arc to Trinidad and west along the north coast of South America to about long.75°W. The area surrounding the Windward Islands received the most extensive coverage in these 3 years due to encouraging reports from the U.S. Bureau of Commercial Fisheries research vessels *Geronimo* and *Undaunted*[1] and earlier results obtained by the CFDP that indicated a relatively greater abundance of tuna schools in this area. From January through June 1970, more concentrated surveys were made in the area west of the Windward Islands bounded by the St. Lucia Channel to the north and the southern tip of Grenada to the south.

The vessels used were the *Calamar, Alcyon,* and *Fregata.* They were designed as combination, multipurpose

[1] RV *Undaunted* Cruise Reports 66-2, 66-5, 67-1, and RV *Geronimo* Cruise Report 66-7 are available from the Southeast Fisheries Center, National Marine Fisheries Service, NOAA, 75 Virginia Beach Drive, Miami, FL 33149.