	Station	Buckets	Dominant species
Martinique			
Fort-de-France	6	33.5	AN
Grande Anses d'Arlet	4	35.0	SA, SI, RS
St.-Pierre	2	13.0	RS
St. Lucia			
Anse Choiseul	2	30.0	PL, TH
Caraibe Point	1	5.0	SA
Castries Harbor	2	0.5	AN
Gros Islet Bay	1	0.5	Mixed
Marigot Bay	3	14.5	AN
Petit Trou	1	0	—
Roseau Bay	3	88.5	SA, TH
Soufrière Bay	1	25.5	SI
Vieux Fort	5	13.5	TH
Tobago			
Great Courland Bay	1	1.0	—
Man-of-War Bay	4	89.0	RS
Rockly Bay	1	3.0	PL

	Station	Buckets	Dominant Species
Trinidad			
Chaguaramas Bay	11	1,055.0	SA, TH
Chupara Bay	4	247.0	SA
Port of Spain Harbor	3	50.0	PL
Las Cuevas Bay	1	6.0	PL
Lampara Net			
Jamaica			
East Kingston	2	52.0	AN
Lime Cay	1	15.0	SI
Port Royal	1	0	—
Dominican Republic			
Bahía de Ocoa	2	125.0	PL, TH
Boca del Yuma	1	0	—
Saona Island	1	0	—
Jamaica			
Lime Cay	1	12.0	DH
Long Bay	1	8.0	AN
Negril Harbor	2	2.0	AN
Pigeon Island	1	70.0	DH

	Station	Buckets	Dominant Species
Port Antonio	1	4.0	SI
Port Royal	1	10.0	AN
Port Royal Cays	3	102.0	DH, SI
Port Royal Mangrove	1	45.0	AN
Dominican Republic			
Bahia de Semana	2	30.5	AN
Venezuela			
Islas Los Roques	1	87.0	SI
Curaçao			
Plaza Abao	2	5.0	RS
Portanare Bay	1	3.5	SI

[1]AN = anchovy (Engraulidae)
DH = dwarf herring (*Jenkinsia*)
PL = pilchards (*Harengula*)
RS = round scad (*Decapterus*)
SA = sardine (*Sardinella*)
SI = silversides (Atherinidae)
TH = thread herring (*Opisthonema*)

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MFR PAPER 1085

Results of Troll Fishing Explorations in the Caribbean

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ABSTRACT—Exploratory and experimental troll fishing or "towing" was accomplished by all three project vessels, Alcyon, Calamar, *and* Fregata, *during the project period. During most of Phase I (1966-1969) this effort was incidental. In May of 1969 and subsequently, specific cruises were either wholly or partially devoted to trolling.*

Trolling explorations took place in the waters around Jamaica, around the banks north of Hispaniola, throughout the Lesser Antilles, and along the South American continental shelf down to lat.8°30'N. Experimental work included studies of lure preference; fishing depth; and line material, length, number, arrangement, and position. Vessel trolling speeds and the catch by time of day were investigated. Incidental trolling accomplished during Project Phase II is noted.

Summaries of catch rate data show a seasonal availability of troll-caught pelagic fish in the eastern Caribbean which begins very early in the year, rises to a peak during May, then falls off abruptly until the end of the year. This tendency is most pronounced on the banks in the northern Leeward Islands. The total weight of fish caught during cruises where trolling was a major portion of the effort was just over 28,000 pounds. Blackfin tuna (Thunnus atlanticus) *made up 37 percent of the total, great barracuda* (Sphyraena barracuda) *16 percent, and little tunny* (Euthynnus alleteratus) *13 percent. All tunas as a group (blackfin, little, yellowfin, and skipjack) made up over 60 percent of the catch by weight. Trolling has displayed only slight success in harvesting the pelagic resources in the Caribbean.*

Trolling or "towing" as it is generally called in the West Indies involves a moving vessel dragging one or more lines behind it; some form of hook and lure combination is attached to these lines. The motion of the lure causes the fish to strike it and become hooked. The line is then retrieved, the fish removed, and the line trailed out again. The method has been in use for a long period and is today practiced in the project region mostly by fishermen on islands possessing narrow shelf edges. These trolling efforts are conducted almost entirely by very small boats towing only two to four lines.

Prior to the project's efforts, only a small amount of offshore trolling using larger vessels had been conducted. Whiteleather and Brown (1945) trolled six lines from a 77 foot LOA(length overall) modified U.S. west coast purse seiner in the vicinity of Trinidad and Tobago and obtained good results—up to nearly 200 pounds/hour off Tobago. Off Jamaica, Oswald (1963) reported catches of up to 200 pounds

a day taken by the Jamaica Fisheries Division vessel *Bluefin*.

With these encouraging results, the Caribbean Fishery Development Project began trolling activities which were only incidental to other fishing activities during the project's Phase I (1966-69). The results of this incidental trolling were summarized by Yesaki (1969). He reported that about two-thirds of the incidental troll catch was taken above lat. 15°N and that blackfin tuna[1] accounted for nearly one-third of all fish caught. During the Phase I period, the Jamaica Fisheries Division research vessel *Bluefin* had observed an overall catch rate of 67 pounds per fishing hour during nine cruises on various banks around Jamaica from August to December 1967.

At the beginning of the project's Phase II (September 1969 to July 1971) more emphasis was placed on troll fishing. Two objectives were set:

1. To explore, insofar as possible, the project region to determine the availability of surface pelagic species to troll fishing.
2. To test various types and arrangements of trolling gear and to determine their effect on fish availability.

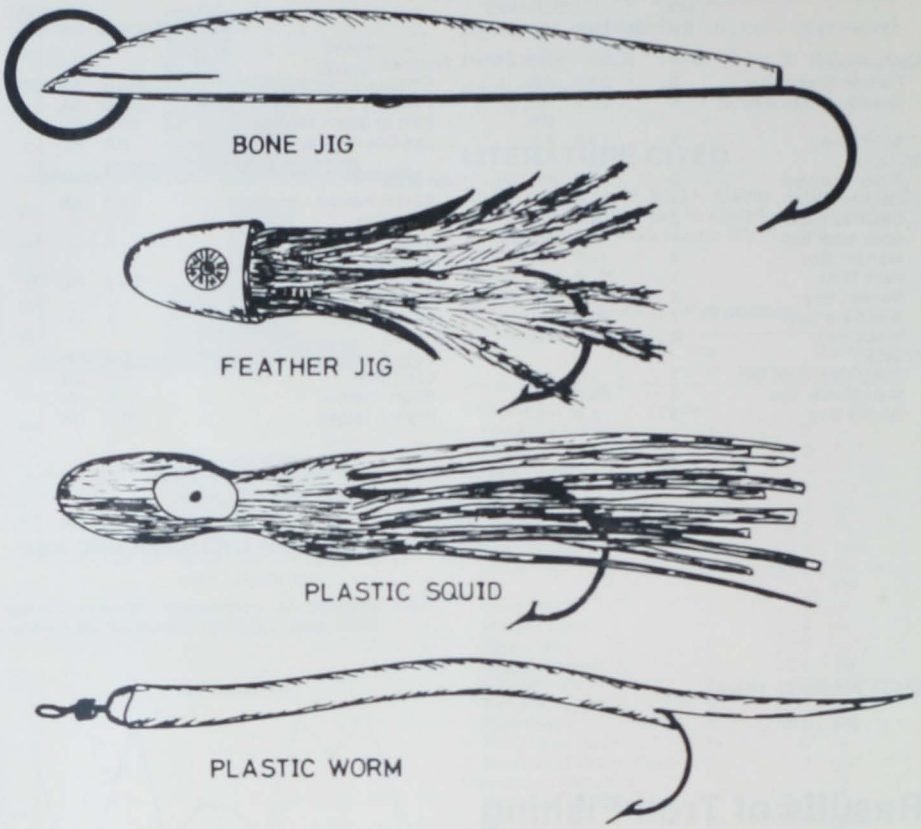

Figure 1.—Various lures used during project trolling exploration.

VESSELS AND GEAR

All three project vessels were used in this work. *Calamar* and *Alcyon* are sister ships built in Japan in 1966.[2] These two ships have large well decks and small stern areas. *Fregata* was built in England in 1967.[2] This vessel is similar in design to the U.S. west coast salmon troller and was rigged in a similar fashion.

All vessels were fitted with trolling outriggers that varied in length and design from ship to ship. *Fregata*'s outriggers were 30 feet long and made up of sections of steel pipe, starting with a 3 inch pipe at the butt and tapering down to 1½ inches at the tip. These outriggers were mounted approximately at midship and held out by a stiff arm attached between the deckhouse and a point about one-third of the way out from the butt. Guy lines and a topping lift were then attached close to the outer tip of the pole and secured fore, aft, and to the masthead. Stabilizers were also fitted. *Alcyon*'s outrigger poles were rigged in a similar manner but were 35 feet long and made of 2½-inch pipe from butt to tip and mounted aft of the fo'c'sle on top of the bulwark. Outriggers designed specifically for trolling were not fitted on *Calamar*. From the port side of the vessel, a 15-foot boom which had been installed for towing plankton nets was used in trolling, and on the starboard side, a wooden pole of about the same length was fitted. *Fregata* and *Alcyon* could tow three to four lines from each of the poles, while *Calamar* was limited to two lines per outrigger.

Three hydraulic trolling gurdies were fitted both port and starboard on *Fregata* in 1970. Two of the spools on each set were of 10-inch diameter and one on each set was 12 inches. These larger spools were intended for deep subsurface trolling, while the standard size reels were for surface trolling. These gurdies were found to be much slower in retrieving lines than the hand-over-hand method and were used only experimentally.

The total number of trolling lines used on each vessel and the rigging of these lines varied over the period of explorations. *Fregata* and *Alcyon* could tow as many as 11 lines, while *Calamar* was limited to 7 lines due to the short outriggers. The rigging used on these lines can be described for three different arrangements. The first arrangement was a tagline of 5/32-inch stainless steel cable fastened to the outrigger at one end and attached to a snubber of shock cord at the other end. The mainline, made of ⅛-inch Kuralon[3] 20 to 35 fathoms long, was attached to the snubber by an A/K snap. A leader of 0.045-inch × 2-feet stainless steel was then attached to the mainline with a 4/0 snap swivel terminating with the lure. The second and least sophisticated arrangement was a 3/16-inch polypropylene cord tied into the line 3 or 4 feet down from the outrigger, and a 2 foot steel leader with a lure was then connected to the mainline with a snap swivel. These lines were also from 20 to 30 fathoms in length. The final and what appeared to be the most efficient line rigging consisted of a length of ¼-inch poly-

[1] Scientific names of all fish represented in exploratory trolling catches are given in Table 2.

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

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

propylene line extending back from the outrigger to a point in line with the stern of the vessel. A 4/0 standard snap swivel was then attached. From the swivel either the mainline of 50 to 500 pound test monofilament was fastened or links of ¼-inch chain or a lead ball was connected between the tagline and mainline. The chain or ball was used to carry the lines slightly below the surface. In most cases no leader was used; the lure was attached directly to the mainline. Stern lines were rigged similarly to the outrigger lines except that taglines were eliminated.

A variety of lures were evaluated for suitability in the Caribbean area. These included bone and feather jigs of different sizes plus various types of plugs, flashers, spinners, and plastic worms (Fig. 1). Mustad double hooks in sizes 4/0, 6/0, and 8/0 were used most of the time. Barbless hooks were also tried, but it was decided that too many fish were lost because of them, and they were abandoned after a short period. Only artificial lures were used in order to make the method free of the need to divert valuable fishing time to obtaining natural bait. No assessment of the effectiveness of artificial versus natural lures was made. On the basis of the results of incidental trolling, it was decided to aim our trolling operations at the tuna group—blackfin, little tunny, skipjack, and yellowfin—as representative of the most promising portion of the resource. Initial gear arrangements and lure selections were made with this in mind.

SURVEY EFFORT

The normal technique during a cruise was to troll along the bank or shelf slopes holding generally to the 100-fathom depth sounding. Where the edge was precipitous, the vessel zigzagged on and off the edge. A small proportion of time was spent trolling in very deep water or over the bank proper when conditions (bird flocks, etc.) warranted. Whenever concentrations of fish were encountered, the vessel would fish the immediate area until biting diminished before continuing on.

During most of the explorations gear experimentation of some sort also took place. Original planning called for early experimental efforts giving rise to a standard trolling arrangement that would be used throughout the remainder of the work, but due to a scarcity of fish caught this was not achieved until near the end of the work.

Between May 1969 and June 1971, most of the banks and waters adjacent to islands had undergone some exploration into their trolling potential. The areas explored stretched from west of Jamaica, east to the northern Leeward Islands, then south through the Windward Islands to about lat.8°30'N. The project region was divided into five areas for purposes of this report (Fig. 2):

1. Jamaica south and southwestern waters.
2. Waters adjacent to Hispaniola and Puerto Rico south to lat.15°00'N.
3. The Leeward Islands.
4. The Windward Islands.
5. Trinidad and the northeastern South American shelf.

In Table 1, the major exploratory trolling efforts in ship hours by month and area are given. Area III received the greatest proportion of effort because of the relative success there. Areas I and IV received high proportions because of their proximity to operational bases (*Alcyon* in Jamaica and *Fregata* and *Calamar* in Barbados). Many factors were considered in the planning of a cruise to a particular location. Among these were the expected abundance of fish, results of incidental trolling, vessel operational limitations, gear experimentation, and extent of geographical coverage of the region.

The units of fishing effort are the ship hour and line hour. The former is the number of hours that the ship explored a given area, while the latter is the product of the number of ship hours times the number of lines towed.

RESULTS

Species Composition

Common and scientific names for all species identified from troll catches are given in Table 2.

The species compositions of the catches from all cruises where trolling was a major fishing effort are given in Table 3. In Areas I and II, the pattern is generally similar. Barracudas dominate the catches in both numbers and pounds. When the four tuna species are grouped together, they comprise a good proportion of the total in both areas. In Area II, wahoo make up about one-fourth of the total weight, but only 7 percent of the numbers. This is due mostly to *Alcyon* cruise 70-1 (January) when 17 wahoo caught averaged over 42 pounds each. In Area III, blackfin tuna make up nearly half of the total catch by weight and numbers. The tunas as a group constitute over three-fourths of the total by weight and over 80 percent by number. No other species make significant contributions to the totals. Blackfin tuna make up about one-fourth of the catch by weight and 30 percent by

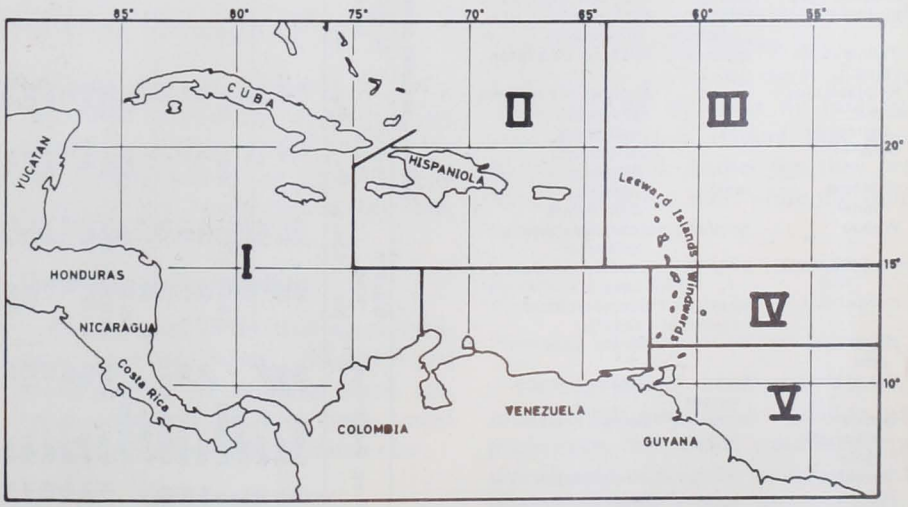

Figure 2.—Caribbean Fisheries Development Project region showing areas where exploratory trolling was conducted.

Table 1.—Ship hours of effort expended trolling by area and month.

Area I			Area II			Area III			Area IV			Area V		
Month	Year	No. hrs.	Month	Year	No. hrs.	Month	Year	No. hrs.	Month	Year	No. hrs.	Month	Year	No. hrs.
Sept.	69	120	Jan.	70	92	May	69	99	July	70	98	Sept.	70	22
Oct.	69	124	Nov.	70	39	Aug.	69	99	Sept.	70	91	Oct.	70	75
Feb.	70	17	May	71	35	Nov.	69	27	Nov.	70	97	Feb.	71	19
—	—	—	June	71	41	Dec.	70	97	Feb.	71	84	—	—	—
—	—	—	—	—	—	Mar.	71	125	Mar.	71	78	—	—	—
—	—	—	—	—	—	Apr.	71	30	May	71	59	—	—	—
—	—	—	—	—	—	June	71	151	—	—	—	—	—	—
Total		261			207			628			507			116
Percent		15.2			12.0			36.5			29.5			7

Table 2.—Common and scientific names of troll caught fish.

Accepted Common Name	Other Name	Scientific Name
Blackfin tuna	bonito	*Thunnus atlanticus*
Little tunny	false albacore	*Euthynnus alletteratus*
Yellowfin tuna	albacore	*Thunnus albacares*
Skipjack tuna		*Katsuwonus pelamis*
Great barracuda		*Sphyraena barracuda*
Dolphin		*Coryphaena hippurus*
Rainbow runner	tapio	*Elagatis bipinnulata*
Wahoo	kingfish	*Acanthocybium solanderi*
King mackerel	kingfish	*Scomberomorus cavalla*
Cero	spanish mackerel	*Scomberomorus regalis*
Horse-eye jack		*Caranx latus*
Green jack	blue runner	*Caranx crysos*
Greater amberjack	almaco jack	*Seriola dumerili*
Frigate mackerel		*Auxis thazard*
Tripletail		*Lobotes surinamensis*
Requiem Sharks		Carcharhinidae

Table 3.—Species composition of exploratory trolling cruises by area and month. (Figures in parentheses are percentages.)

Cruise	Area	Month-Year	Blackfin tuna		Little tuna		Yellowfin tuna		Skipjack tuna		Barracuda		Dolphin (fish)		Rainbow runner		Wahoo		King mackerel		Cero		Others		Total	
			No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
A[2]69-9	I	Sept. 69	44	202	1	9	—	—	44	544	73	542	16	85	9	47	4	127	—	—	2	7	6	10	199	1,573
A59-10	I	Oct. 69	27	107	4	16	—	—	4	45	135	715	4	40	11	47	1	30	—	—	1	4	18	10	205	1,014
A70-2	I	Feb. 70	2	14	—	—	—	—	—	—	22	148	—	—	—	—	6	54	—	—	—	—	—	—	30	216
		Totals	73	323	5	25	—	—	48	589	230	1,450	20	125	20	94	11	211	—	—	3	11	24	20	434	2,803
		Percent	(16.8)	(11.5)	(1.2)	(0.1)	—	—	(11.1)	(21.0)	(53.0)	(50.1)	(4.6)	(4.4)	(4.6)	(3.4)	(2.5)	(7.5)	—	—	(0.7)	(0.4)	(5.5)	(0.7)	(100.0)	(100.0)
A70-1	II	Jan. 70	37	269	6	22	—	—	1	5	132	1,207	12	123	4	23	17	715	2	45	11	84	6	28	228	2,521
A70-11	II	Nov. 70	12	131	6	24	—	—	—	—	38	392	18	75	12	60	3	55	—	—	1	4	5	21	95	762
A71-4	II	May-Jun. 71	11	72	5	23	—	—	—	—	14	82	6	101	—	—	7	154	1	6	3	13	7	36	54	487
		Totals	60	472	17	69	—	—	1	5	184	1,681	36	299	16	83	27	924	3	51	15	101	18	85	377	3,770
		Percent	(15.9)	(12.5)	(4.5)	(1.8)	—	—	(0.3)	(0.1)	(48.8)	(44.6)	(9.5)	(7.9)	(4.2)	(2.2)	(7.2)	(24.5)	(0.8)	(1.4)	(4.0)	(2.7)	(4.8)	(2.3)	(100.0)	(100.0)
C[2]69-5	III	May 69	639	4506	299	1226	31	898	16	75	37	111	35	497	13	56	3	25	19	151	10	44	—	—	1,102	7,589
C69-9	III	Aug. 69	227	1262	64	280	1	6	31	125	24	60	3	21	18	94	3	105	2	22	1	8	6	33	380	2,016
A69-11	III	Nov. 69	8	53	7	30	—	—	1	8	14	70	3	13	—	—	3	125	1	10	—	—	—	—	37	309
F[3]70-11	III	Dec. 70	75	436	63	285	—	—	3	19	—	—	26	261	1	3	1	6	2	20	8	23	—	—	179	1,053
F71-2	III	Mar. 70	161	1021	195	780	—	—	2	12	53	306	32	296	22	86	7	201	2	28	9	31	3	19	486	2,780
C71-6	III	Apr. 71	200	526	55	223	5	41	1	5	32	159	14	199	8	31	—	—	4	22	—	—	—	—	319	1,206
C71-8	III	Jun. 71	268	1426	134	596	47	587	49	437	60	304	1	3	78	440	10	311	18	263	9	43	1	7	675	4,417
		Totals	1578	9230	817	3420	84	1532	103	681	220	1,010	114	1,290	140	710	27	773	48	516	37	149	10	59	3,178	19,370
		Percent	(49.7)	(47.7)	(25.7)	(17.7)	(2.6)	(7.9)	(3.2)	(3.5)	(6.9)	(5.2)	(3.6)	(6.7)	(4.4)	(3.7)	(0.9)	(4.0)	(1.5)	(2.7)	(1.2)	(0.8)	(0.3)	(100.0)	(100.0)	
F70-7	IV	July 70	13	87	—	—	—	—	—	—	15	78	1	22	—	—	1	8	—	—	—	—	—	—	30	195
F70-8	IV	Sept. 70	—	—	—	—	—	—	1	6	10	36	1	7	—	—	3	53	—	—	—	—	—	—	15	102
F70-10	IV	Nov. 70	29	139	2	7	7	26	3	9	22	100	4	14	1	4	1	1	—	—	—	—	—	—	69	300
F71-1	IV	Feb. 71	9	32	2	12	—	—	1	9	32	102	—	—	5	25	2	55	—	—	—	—	—	—	51	235
F71-3	IV	Mar. 71	31	222	—	—	9	55	13	77	9	28	1	6	3	15	5	125	1	18	—	—	3	7	75	554
F71-4	IV	May 71	—	—	1	4	—	—	—	—	3	21	5	86	—	—	34	447	—	—	—	—	—	—	43	558
		Totals	82	480	5	23	16	81	18	101	91	365	12	135	9	44	46	689	1	19	—	—	3	7	283	1,944
		Percent	(29.0)	(24.7)	(1.8)	(1.2)	(5.7)	(4.2)	(6.4)	(5.2)	(32.2)	(18.8)	(4.2)	(6.9)	(3.2)	(2.3)	(16.3)	(35.4)	(0.43)	(1.0)	—	—	(1.1)	(0.7)	(100.0)	(100.0)
F70-8	V	Sept. 70	—	—	—	—	—	—	—	—	—	—	1	3	—	—	—	—	—	—	—	—	—	—	1	3
F70-9	V	Oct. 70	6	17	1	2	—	—	—	—	15	97	—	—	—	—	1	7	—	—	—	—	—	—	23	123
F71-1	V	Feb. 71	1	3	2	13	—	—	—	—	—	—	9	91	—	—	2	64	—	—	—	—	—	—	14	171
		Totals	7	20	3	15	—	—	—	—	15	97	10	94	—	—	3	71	—	—	—	—	—	—	38	297
		Percent	(18.4)	(6.7)	(7.9)	(5.1)			—	—	(39.5)	(32.7)	(26.3)	(31.6)	—	—	(7.9)	(23.9)	—	—	—	—	—	—	(100.0)	(100.0)
	Regional Totals		1800	10525	847	3552	100	1613	170	1,376	740	4,558	192	1,943	185	931	114	2,668	52	586	55	261	55	171	4,310	28,184
	Percent		(41.8)	(37.3)	(19.7)	(12.6)	(2.3)	(5.7)	(3.9)	(4.9)	(17.2)	(16.2)	(4.5)	(6.9)	(4.3)	(3.3)	(2.6)	(9.5)	(1.2)	(2.1)	(1.3)	(0.9)	(1.3)	(0.6)	(100.0)	(100.0)

[1]A = Vessel *Alcyon*.
[2]C = Vessel *Calamar*.
[3]F = Vessel *Fregata*.

Table 4.—Catch rate in pounds per trolling hour and pounds per line per hour by cruise, area, and month.

Cruise	Area	Month-Year	Pounds of fish	Ship trolling hours	Line hours	Lbs/hour	Lbs/ Line hour
A[1]69-9	I	Sept. 69	1,573	120	788	13.1	2.0
A69-10	I	Oct. 69	1,014	124	744	8.2	1.4
A70-2	I	Feb. 70	216	17	108	12.7	2.0
Total			2,803	261	1,640	10.7	1.7
A70-1	II	Jan. 70	2,521	90	529	23.0	4.8
A70-11	II	Nov. 70	762	39	213	19.5	2.8
A71-4	II	May-Jun. 70	487	76	702	6.4	0.7
Total			3,770	205	1,444	18.4	2.5
C[2]69-5	III	May 69	7,589	99	592	76.7	12.8
C69-9	III	Aug. 69	2,016	99	594	20.4	3.4
A69-11	III	Nov. 69	309	27	169	11.4	1.8
F[3]70-11	III	Dec. 70	1,053	97	970	10.9	1.1
F71-2	III	Mar. 71	2,780	125	1,250	22.2	2.2
C71-6	III	Apr. 71	1,206	30	150	40.2	8.0
C71-8	III	Jun. 71	4,417	151	1,057	29.3	4.2
Total			19,370	628	4,782	30.8	4.1
F70-7	IV	July 70	195	98	490	2.0	0.4
F70-8	IV	Sept. 70	102	91	637	1.1	0.2
F70-10	IV	Nov. 70	300	97	970	3.1	0.3
F71-1	IV	Feb. 71	235	84	840	2.8	0.3
F71-3	IV	Mar. 71	554	78	780	7.1	0.7
F71-4	IV	May 71	558	59	590	9.4	0.9
Total			1,944	507	4,307	3.8	0.5
F70-8	V	Sept. 70	3	22	144	0.1	0.07
F70-9	V	Oct. 70	123	75	525	1.6	0.2
F71-1	V	Feb. 71	171	19	190	9.0	0.9
Total			297	116	859	2.4	0.3
Regional total			28,184	1,717	13,032	16.4	2.2

[1]A = Vessel *Alcyon*. [2]C = Vessel *Calamar*. [3]F = Vessel *Fregata*.

number in Area IV. The tuna group is about equal in weight contribution to that of wahoos, but they contribute a much greater number. Barracudas are the most numerous species. From the relatively few fish caught in Area V, barracudas are again most numerous, but are about equal in weight to dolphin fish. Wahoos again make up an important proportion of about one-fourth of the weight. Since the regional totals are so dominated by catches from Area III, a resume of species composition for the region as a whole is meaningless.

Catch Rates

The trolling catch rates in pounds/ship hour and pounds/line hour are given in Table 4. The highest catch rate was observed on *Calamar* cruise 69-5 in Area III during May 1969 when nearly 77 pounds per ship hour and 13 pounds per line hour were caught. Area III displayed the highest consistent catch rates and also the highest average at about 31 pounds per ship hour. The average catch rate observed in Area III was in excess of the rates observed on any cruise in any of the other areas.

When the catch rates are plotted by the month when they were observed an indication of seasonal availability is obtained (Fig. 3). Sufficient data to present a seasonal evaluation were

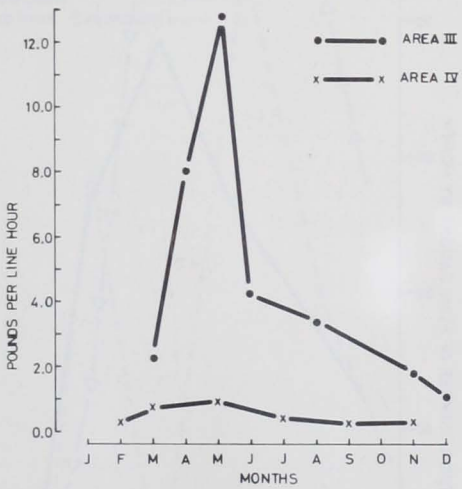

Figure 3.—Trolling catch rate variation by month.

available for Areas III and IV only, but both reflect the same general pattern of highest availability during the second quarter of the year and relatively low levels during the first, third, and fourth quarters.

Gear Experimentation

During most of the trolling explorations various kinds, lengths, and arrangements of trolling lines and types and sizes of lures were tested to evaluate their effect on catch rate.

Lure preference

During *Alcyon* cruises 69-9 and 69-10 conducted on the banks around Jamaica (Area I) during September and October 1971, complete records on the catch of various types and sizes of lures were kept. Red/white and yellow/white feather jigs were compared with bone jigs and plastic bodied and skirted squids. In Table 5 the lure preference data are summarized. Overall, red/white feather jigs were found to be superior to the other types used. Considering the most numerous species as separate groups the barracuda were nearly evenly divided in preference between yellow/white feather jigs

Table 5.—Lure type preference.

Fish Species	Numbers of fish caught: Red/White feather jigs	Yellow/White feather jigs	Bone jigs	Plastic squid
Barracuda	56	46	59	9
Blackfin tuna	45	9	10	2
Skipjack tuna	29	7	5	6
Little tuna	3	1	—	—
Rainbow runner	11	4	3	1
Dolphin	11	1	1	3
Jacks	5	3	1	—
Mackerels	2	1	—	—
Wahoo	3	1	1	—
Total fish	165	73	80	21
Hours trolled	323.5	172.8	231.6	71.3
All fish/ hour	0.51	0.42	0.35	0.29
Barracuda/ hour	0.17	0.27	0.25	0.13
All tuna/ hour	0.24	0.09	0.06	0.11

and bone jigs, but displayed a definite lesser preference for red/white feather jigs and plastic squids. In contrast, the tunas as a group overwhelmingly preferred red/white feather jigs.

When examining the catch of barracudas and of all tunas by lure size (see below), it is evident that when barracudas took feather jigs they preferred the larger size, while the tunas preferred the smaller.

	3 ounce feather jig	6 ounce feather jig
Barracuda	0.09[1]	0.45
All tunas	0.32	0.19

[1]Number of fish caught per lure/hour of trolling.

During cruises conducted by *Fregata* in 1970, attention was paid to lure preference, but results were inconclusive due to a scarcity of fish caught. Beginning with cruise 70-11, *Fregata* used all small sized red/white or all white feather jigs during nearly all the

subsequent trolling cruises. The decision was based on their performance with the tuna group during previous *Alcyon* work and the preference of a commercial tuna troll fisherman consultant to the project from the west coast of the United States. This pattern was varied only once during two days' fishing on *Fregata* cruise 71-1, when white plastic worms were directly compared with white feather jigs. The results are shown below.

	White plastic worms	Jigs
Barracuda	0.03[1]	0.16
All tunas	0.02	0.06

[1]Number of fish caught per lure/hour trolling.

Again feather jigs were shown to be the most effective.

Trolling line variations

Material.—Monofilament trolling lines were found to be most satisfactory. They created less drag than braided cotton or synthetic line of comparable strength, were more difficult for fish to see in the water, had built-in strike shock absorption, and a greater range of breaking strengths were readily available. One disadvantage was that monofilament was more difficult to hand-retrieve than a larger diameter line would have been. Experience showed, however, that its advantages considerably outweighed its disadvantages.

Number of lines.—During this work there were no specific experiments aimed at determining the effect of a differing number of trolling lines on the catch rate. Although the number of lines used by any of the vessels did vary somewhat, the changes usually took place between cruises and not during them. There was, however, ample visual evidence that a positive correlation existed between the catch and the number of lines. The tuna group, which constituted the largest proportion of the overall catch, displayed a marked tendency to strike all lines almost simultaneously when a school was encountered. This was particularly true during the first encounter but was evident even after repeated encounters. Even when a variety of lures was being towed, the same phenomenon occurred, but lure selectivity became evident after the first encounter. Catches of species other than tunas were more random and were probably the result of factors other than the number of lines towed.

Line length.—Originally all the vessels were using trolling lines of not less than 25 fathoms. When more than six lines were streamed these had a tendency to cross and foul during a turn. Through experimentation and advice from consultants, an arrangement of line lengths was worked out with a maximum length of 30 fathoms down to as short as 3 fathoms from the stern. These variable line lengths allowed an increase in the number of lines towed while decreasing line fouling problems but still retaining catching efficiency. The longer lines caught a larger number of fish in areas of low productivity in that the occasional strike would be on the longer lines, but in areas of fish concentrations line length was not critical, and all lines would hook fish at about the same rate. This arrangement was used throughout all *Fregata* trolling efforts

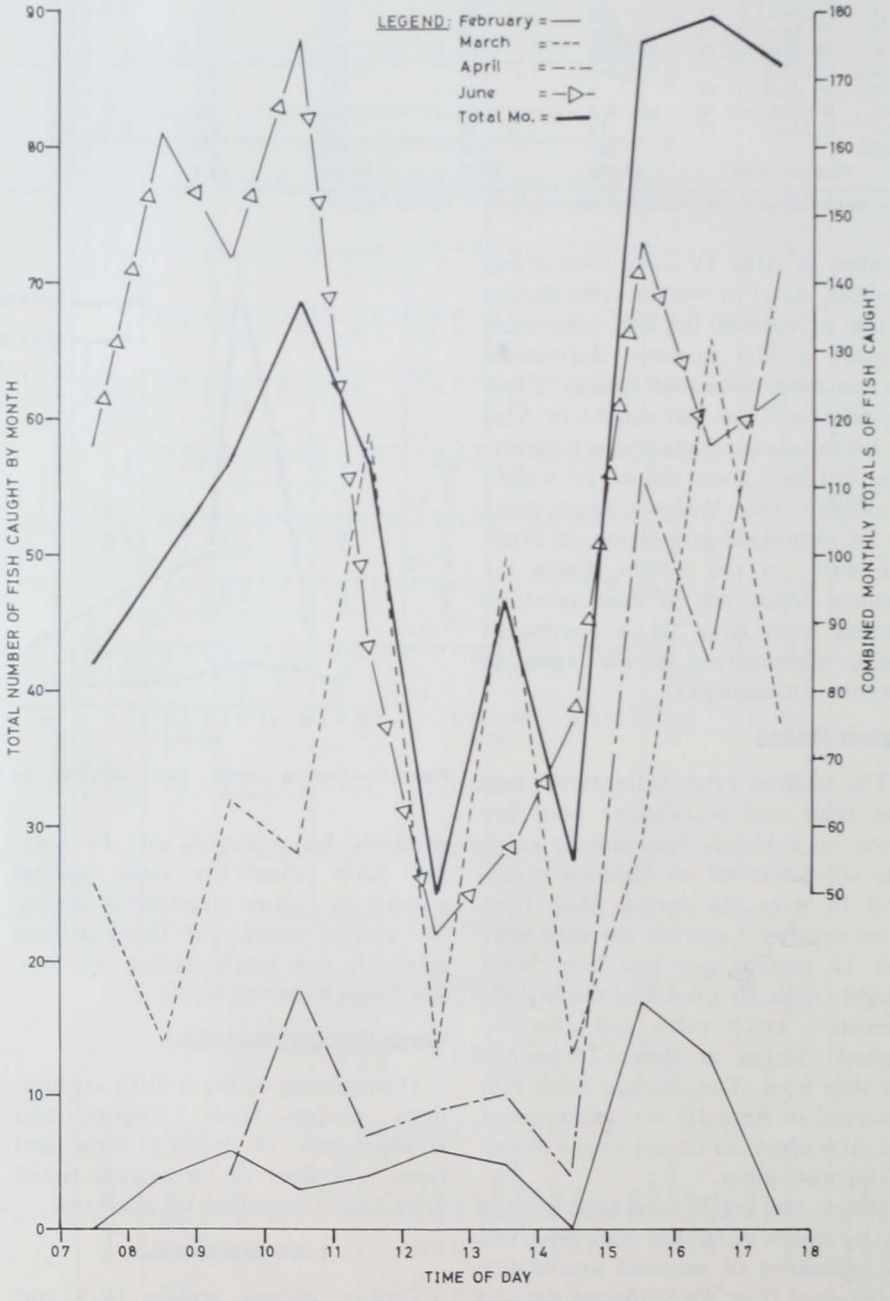

Figure 4.—Trolling catch in Area III (northern Leeward Islands) by time of day for the months indicated.

in late 1970 and on *Fregata* cruise 71-1.

Cruise	Line Length 3-10 fathoms	11-20 fathoms	21-30 fathoms	31 + fathoms
71-1	24.4[1]	69.3	74.0	—
71-3	—	8.4	7.2	5.0

[1]Number of fish caught per line.

When cruise 71-2 was completed, the results showed a higher catch rate for lines in the 11-20 and 21-30 fathom length range. The line arrangement was altered for cruise 71-3 when lines of under 10 fathoms were eliminated and lines in excess of 30 fathoms added. The results during cruise 71-3 show an almost even distribution of catch between the three length groups and this length arrangement was used by all vessels throughout the remainder of project trolling explorations.

Line Location.—During *Fregata* cruise 71-2 when the arrangement of line lengths on each side of the vessel was the same and all lines used the same lure (red/white feather jig - 1½ ounces); there was a decided superiority in the catch by lines on the port side of the vessel over lines on the starboard side.

Species	Port	Starboard	Ratio (port to starboard)
Barracuda	40[1]	18	2.2 : 1
All tuna	225	127	1.8 : 1
Other species	40	28	1.4 : 1
Total	305	173	1.8 : 1

[1]Number of fish caught.

Line Arrangement.—During *Fregata* cruise 71-2 the two 21-fathom lines located one in from the end of each trolling outrigger caught nearly one-third of all the fish caught by all 10 lines during the cruise. This is an indication, at least, that there is some effect on the position of the trolling line in the arrangement.

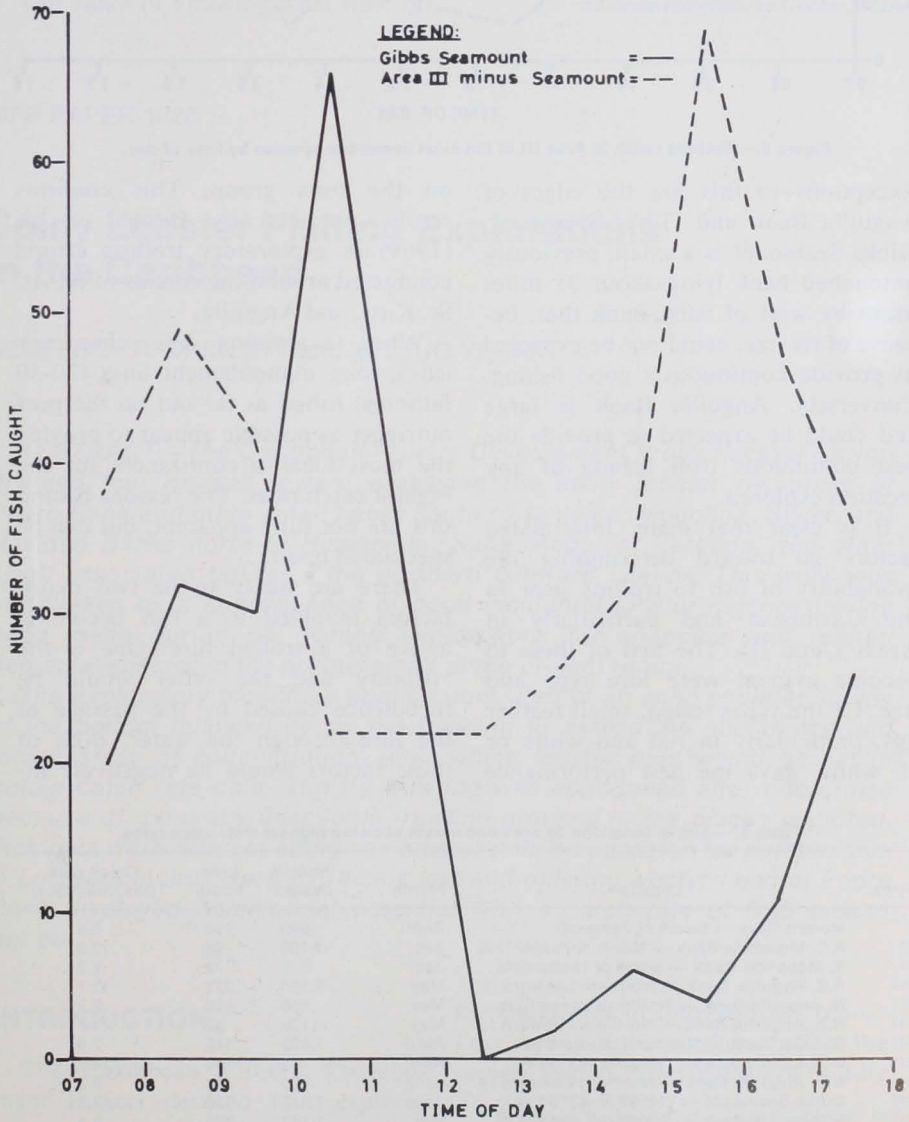

Figure 5.—Trolling catch for June 1971 in Area III.

Vessel speed

No direct observations were made of the effects of vessel speed on catch. Incidental trolling was always conducted at the vessel's cruising speed, while regular exploratory trolling was all done at about 6 knots. This speed was considered adequate for tuna species, but not so fast as to preclude catching other species.

Time

On all trolling cruises in 1971, detailed records were kept for the time of day when fish were caught. Through these observations, it was established during what period(s) of the day the greatest fish biting activity was encountered. It would be presumptuous to state the periods of greatest fish activity for all areas due to the sparseness of data taken as to time of day; however, Area III (northern Leeward Islands) appears to have enough data to produce a reliable picture of greatest fish activity.

As can be seen in Figure 4, there are two periods of increased fish biting during the day; one in mid to late morning and another in mid to late afternoon, which is more pronounced. This pattern appears during all the months shown except the line representing the month of June. This variation can be explained by observing the fish catch from Gibbs Seamount separately from the remainder of Area III. Gibbs Seamount is a small bank located at lat.16°33'N, long.63°56'W or approximately 37 miles south-southwest of Saba Bank. The distance to this area from the nearest land is too great for fishermen in the adjacent islands to utilize the bank; consequently, little or no fishing had been done there previous to our explorations. Two days of continuous fishing were accomplished there during June. The catch rate on the first day of fishing reached 108.2 pounds/ship hour, but dropped to 67.8 pounds/ship hour on the second day. This considerable drop in catch rate over such a short period of time indicates that the Gibbs Seamount area might be fished

out rapidly. Figure 5 shows a picture of Gibbs Seamount data with greatest fish activity in the morning between 1000 and 1200 hours. Area III is also plotted on this graph minus the Gibbs Seamount data. When the June data are plotted without the Gibbs Seamount data, the pattern of fish catch again becomes similar to that of the other months.

When these data are examined for the three major species in the catch, the pattern remains constant except that the two tunas appear to provide the bulk of the high afternoon catches (Fig. 6).

Incidental Trolling

During Phase II of the project incidental trolling was conducted during all cruises as it had been during Phase I. Incidental trolling usually consisted of two or three 30-fathom lines towed during daylight hours while the vessel was passing to or from other fishing areas. When a vessel was rigged for multiple line trolling it usually used all lines when in passage.

Only one instance of incidental trolling was noteworthy during Phase II. In September 1969, *Calamar* caught 10 yellowfin tunas weighing over 500 pounds in aggregate at lat.7°41'N, long.56°14.5'W or about 130 miles north-northwest of Paramaribo, Surinam. Many more larger fish were reported lost.

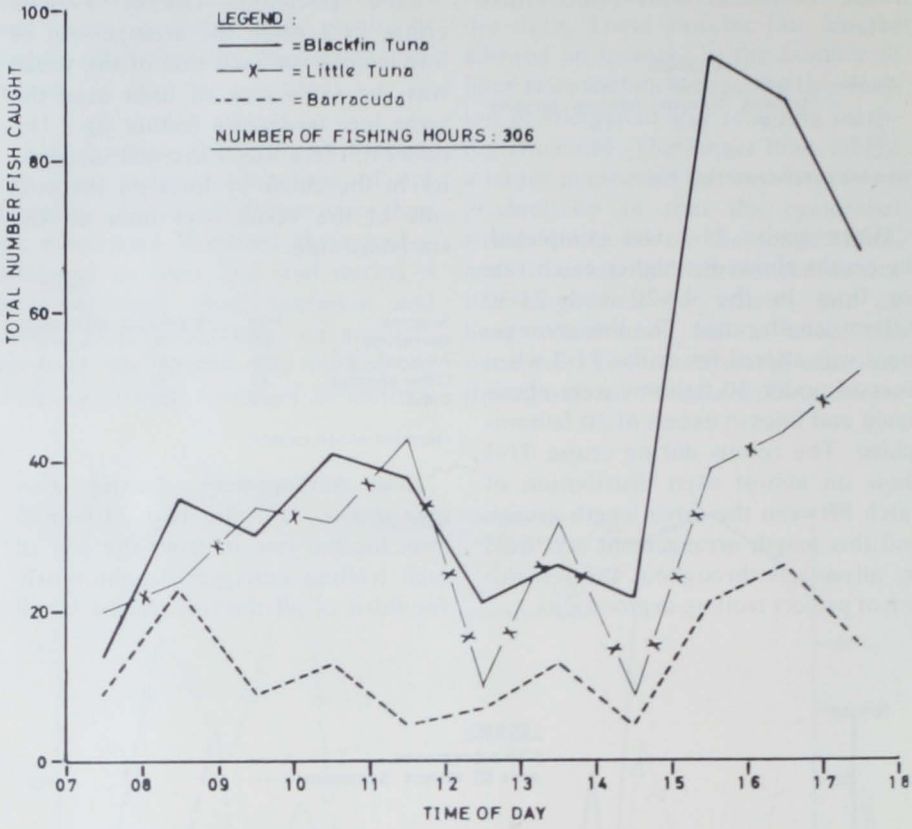

Figure 6.—Trolling catch in Area III of the most numerous species by time of day.

DISCUSSION AND CONCLUSION

An examination of the area catch rates indicates that only in Area III, and then only during April and May, was troll fishing considered capable of supporting independent offshore fishing by a vessel large enough for extended voyages of a week or more. These catch rates were calculated by averaging all locations explored during a cruise; however, there were places where the rate was higher. Specific locations where catch rates in excess of 5.0 pounds/line hour were observed are given in Table 6. It should be remembered however, that in most cases each of these locations displayed its high catch rate only on the occasion noted and did not display the same rates during other visits. Exceptions to this are the edges of Anguilla Bank and Gibbs Seamount. Gibbs Seamount is a small, previously untouched bank lying about 35 miles south by west of Saba Bank that, because of its size, could not be expected to provide continuously good fishing. Conversely, Anguilla Bank is large and could be expected to provide the best continuous troll fishing of any location explored.

It is clear that many interrelated factors go toward determining the availability of fish to trolling gear in the Caribbean and particularly in Areas I and III. The first of these to become evident were lure type and size. Of the types tested, small feather jigs, particularly in red and white or all white, gave the best performance on the tuna group. This confirms results obtained by Oswald et al. (1969) in exploratory trolling efforts conducted around the islands of Nevis, St. Kitts, and Anguilla.

When examining line characteristics, long monofilament lines (20-30 fathoms) fished as far out on the port outrigger as possible appear to provide the most ideal circumstances for the highest catch rates. The reasons behind this are not fully apparent, but can be speculated upon.

There are likely to be two major factors involved in a fish becoming aware of a trolled lure. One is the visibility and the other would be turbulence caused by the passage of the lure through the water. Both of these factors would be negatively in-

Table 6.—List of locations by area and month showing highest troll catch rates.

Area	Location	Month	Pounds caught	Line hours	Catch rate (lbs./line/hour)
I	Morant Cays — South of Jamaica	Sept.	693	108	6.4
II	S.E. Mouchoir Bank — North of Hispaniola	Jan.	1,100	90	12.2
II	S. Mouchoir Bank — North of Hispaniola	Jan.	512	72	7.2
III	S.E. Anguilla Bank — Northern Leeward Is.	May	5,196	378	13.7
III	N. Anguilla Bank — Northern Leeward Is.	May	656	66	9.9
III	N.E. Anguilla Bank — Northern Leeward Is.	May	702	60	11.7
III	N. Saba Bank — Northern Leeward Is.	April	1,099	140	7.9
III	Gibbs Seamount — (16°32'N.-63°55'W.)	April	149	10	14.9
III	N.E. Anguilla Bank — Northern Leeward Is.	June	850	91	9.3
III	Gibbs Seamount — (16°32'N.-63°55'W.)	June	1,617	126	12.8
III	N. Anguilla Bank — Northern Leeward Is.	Mar.	1,183	220	5.4

fluenced by the effects of vessel and screw turbulence. The positive factors which appear to affect catches all have the effect of minimizing turbulence in the area of the lure. With longer lines fished farther out, the effect is obvious. Why catches should be better on the less turbulent port side of the vessel is not obvious until the effect of a right hand turning propellor creating more turbulence on the right or starboard side of the vessel is remembered.

The idea of less turbulence—more opportunity for fish biting—is strengthened by the inboard lines during a turn tending to catch more than the others because they are inside the vessel's turning circle and wake and the resultant turbulences. This is so established that our trolling vessels often zigzag when in a school to increase catches.

The value of knowing what time of day the fish are most likely to be caught trolling could be applied if trolling were to be combined with some other fishing operation, i.e., handlining or trap fishing, which could be conducted during the off peak trolling time.

In summary, troll fishing has displayed only slight success in harvesting the surface pelagic resources of the project region. Only the banks of the northern Leeward Islands, and these only during April and May, provided catch rates considered high enough to support troll fishing as an independent effort. As the method is already known in the West Indies and relatively inexpensive, if a vessel must travel to suitable offshore grounds for other types of fishing, it can be a good secondary method during slack periods of handlining (mechanical reel) and trap fishing for snapper and related species.

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MFR PAPER 1086

Spiny Lobster Fishing Explorations in the Caribbean

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ABSTRACT—The Caribbean Fishery Development Project vessel Alcyon *devoted four cruises toward assessing the spiny lobster resources of Pedro Bank and other small banks south of Jamaica; Mouchoir, Silver, and Navidad Banks north of Hispaniola; Saba, Anguilla, Barbuda, and other small associated banks in the northern Leeward Islands. This work was undertaken as a consequence of good incidental lobster catches having been made during pot fishing explorations for snappers and related demersal species in the northern half of the project region.*

The exploratory technique applied consisted of an echo sounder survey of the bottom followed by try net trawling to assess the abundance and locate areas of concentration, after which lobster pots would be set to obtain catch rate data. The try trawling was abandoned after one cruise because of generally unsuitable trawling grounds in the places explored. Fish pots were also set alongside lobster pots on occasion for comparison.

Lobster catches were extremely low and only the western end of Pedro Bank displayed commercial potential with a catch rate of 0.45 lobster per pot.

INTRODUCTION

The Caribbean Fishery Development Project devoted four exploratory/experimental cruises to assessing the abundance of spiny lobster[1] (*Panulirus argus*) in the northern half of the project region, from February to July 1971. Good incidental catches of lobsters during fish-pot fishing explorations in these areas and the high economic demand for their meat were the primary reasons for this work, but the high success of recent exploratory fishing surveys off Honduras and Nicaragua (Yesaki and Guidicilli[2]) was also considered. It was decided that the exploratory techniques (including echo sounding, trawl netting, and pot fishing) used during this latter work would be experimentally attempted in our project region.

Some exploratory lobster fishing had been conducted earlier in other parts of the project region. During a general resources survey of Trinidad and Tobago by MV *Fregata* in 1968, a total of 144 lobster pot sets and 8 ice-can sets were soaked an average of 52 hours but yielded no lobsters.

[1] Referred to hereafter as spiny lobster or lobster.

[2] Yesaki, M., and M. Guidicilli. Summary of exploratory fishing operations of the RV *Canopus* in the western Caribbean Sea to June 1970. UNDP/FAO Central American Fishery Development Project, 46 p. (Unpubl. manuscr.)