CARIBBEAN FISHERIES SESSION

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Chairman – Jose A. Suarez Caabro
Commercial Fisheries Laboratory
Department of Agriculture
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Results of the UNDP/FAO Bahamas Deep Water Fishery Survey 1972 - 1975

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INTRODUCTION

The Bahamas Islands, between latitudes 20°N - 27°N and longitudes 72°W - 79°W, are located on approximately 16 shallow plateaus separated from each other and from Florida, Cuba, and Hispaniola by depths of 200-2,000 fm. These banks, totalling 45,000-60,000 square miles, form a chain approximately 760 nautical miles in length oriented along a northwest-southeast axis. Twenty-nine islands, numerous cays and rocks emerge from these shallow banks. Nearly all of the Islands are elongated and lie near the windward edge of the banks, thus providing sheltered fishing in the leeward areas.

Oceanographic Conditions

A limited amount of oceanographic, bathymetric, and ecological data which have direct bearing on the survey is summarized below. Sources of these data include U.S. Naval Oceanographic Office (1967), the Bahamas Meteorological Office, and personal observations.

Most of the bank area is from 0.5 to 5 fm deep, is rocky and covered by more or less stable sand which supports dense to sparse growths of turtle grass, coral heads, and patch reefs. The edge of the bank is composed of sand shoals; discontinuous barrier reefs, and lagoon complexes. Seaward of the edge, the sea floor dips gently to depths of 15 to 49 fm where a vertical overhang cliff normally occurs. On eastern (windward) edges the steep slopes (20° to 40°) continue to abyssal depths. On the western (leeward) margins the slope averages 10° or less.

The western edges are characterized by a talus slope extending to depths of about 150 fm grading downward to a smooth rock surface. It is often gullied and is covered with a thin veneer of sediment.

The predominant wind direction is east to northeast from October to April and east to southeast from June to August. Mean monthly wind speeds are high in winter and spring, November to May and lower in summer. Average wind speeds are low but periods of 2 or 3 days with northeast winds of 15 knots or more are not uncommon between October and March. The region is also exposed to hurricanes between the months of June and November.

Low waves predominate in all seasons but waves of 12 ft and over rarely occur.

Tides in the Bahamas are weak and variable and the mean tidal range is about 2.6 ft. Tide speed and direction may be attributed to several factors acting independently or concurrently; these are the northwest setting Antilles Current, the prevailing easterly winds and the funnel-like effect of the narrow passages between islands and cays.

There is little latitudinal difference in surface sea temperatures because of the presence of a dominant warm ocean current. The entire Bahamas lie between the 23°C and 25°C isotherms in February (winter) and between the 28°C and 29°C isotherm in August (summer). However, in cases of extreme cold or warm weather local temperatures may be appreciably higher or lower in shallow bank waters. U.S. Naval Oceanographic Office (1967) data indicate that waters at approximately 109 fm fluctuate between 21°C and 22°C with the highest temperatures occurring in February (winter).

Salinity varies between 36 and 37 ppt.

Because of the relatively calm conditions that prevail in the Bahamas, and because of the shelter offered by numerous islands and cays, small vessels can be worked successfully.

The UNDP/FAO Bahamas Fishery Development Study

During 1972-1975 the Bahamas Government, assisted by the United Nations Development Program and the Food and Agricultural Organization of the United Nations, conducted a project whose principal objectives were: (i) to carry out an exploratory fishing program to identify and evaluate commercial fishery resources; (ii) to demonstrate improved fishing techniques; (iii) to provide "on-the-job" training for fishermen; (iv) to provide advisory services and to demonstrate the handling, marketing, and distribution of fish; and (v) to advise the Government on necessary regulatory and conservation measures and on general questions relating to fisheries development.

This report deals with the exploratory fishing conducted for deep-water fishery resources.

DEEP WATER SURVEY METHODS

The vessel utilized for exploratory fishing was the **Fregata**, a 58-ft multi-purpose fishing vessel formerly operated by the UNDP/FAO Caribbean Fishery Development Project. The crew, normally six or seven men, included the FAO Masterfisherman, an engineer, and four or five fishermen. In addition, a fisheries biologist accompanied the vessel on all exploratory fishing cruises.

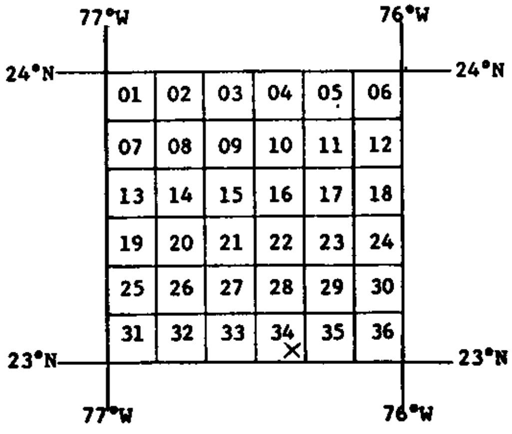
The gear used during the survey consisted of four electrically-powered fishing reels. Each line was fitted with six no. 7 tuna circle hooks that were usually baited with frozen Spanish mackerel. A 10-pound sinker (used Caterpillar track-pin) was attached to the bottom of the line.

The **Fregata** made 52 cruises during the period April 1972 to December 1975. The specific activity of these cruises is shown in Table 1. On a number of occasions part of a cruise was occupied in exploratory fishing and part in simulated commercial fishing and on other occasions partly on reel fishing and partly on trapping.

Table 1. Year, number, and type of cruises (April 1972 – December 1975)

		Activity			
Year	No. Cruises	Exploratory Fishing	Simulated Commercial Fishing	Crawfish Trapping	Scalefish Trapping
1972	8	6	2	-	-
1973	9	4	5	4	2
1974	22	17	8	1	4
1975	13	7	7	-	-

The vessel operated out of Nassau, New Providence. Each cruise was planned to cover a particular sector of the edge of the Bank. Venema (1973) outlined the survey procedures followed on deepwater fishing cruises. The area of the Bahamas was divided into 10-mile squares (grids) and each grid was identified in relation to the approximate latitude and longitude. The following diagram indicates the way in which this grid pattern was made.



X = grid #237634

The edges of the banks have a total length of approximately 2,500 miles. These were divided for survey purposes into 10-mile grids measured along the 100-fm depth contour. At a given area in each grid various depth zones (stations) were fished, namely: 30-60, 60-90, 90-120, 120-150, and 150-180 fm. Initially, wide-ranging areas were surveyed but in the latter part of the program fishing was concentrated in areas of greatest potential.

To ensure comparable data, a minimum of 15 min fishing effort with four reels was conducted at any one station. If any significant catch was made during that time fishing was continued up to 30 min per reel.

At each station the biologist onboard recorded the catch according to species, number of fish, and weight. On exploratory fishing cruises fish were also measured and the stomach content, sex and state of gonadal development were recorded. However, these data will not be analyzed in this paper.

Twelve simulated commercial type fishing cruises were conducted to demonstrate commercial feasibility. On these cruises no scientific personnel was taken and the vessel operated, as far as possible, as a commercial fishing vessel. The Master fishermen recorded data on area, time spent fishing, and number and weight of fish by species and/or species groups.

The regions covered by the survey are shown in Figure 1. A number of areas were not surveyed, in particular the eastern and southeastern Islands, the southeast edge of the Great Bahama Bank and the Cay Sal Bank. This was partly due to lack of time and distance from Nassau, but also because the characteristics of the coast and prevailing winds did not permit fishing in certain areas.

Data from the first four cruises of 1972 were not utilized in any of these analyses as the collection procedures were not standardized until the fifth cruise in 1972.

Sharks were caught at a number of stations but since they were not usually associated with a specific depth range (they were usually hooked near the surface) they were not recorded in the catch.

Seasonal collections were irregular. Therefore, data for all years were combined. For seasonal analyses the months of January, February, and March were classified as winter; April, May, and June as spring; July, August, and September as summer; and October, November, and December as autumn.

RESULTS

On exploratory cruises 1862 stations were fished. Stations were fished in 167 grids and the area surveyed represented approximately 70% of the total area. The total catch from exploratory fishing cruises was 14,620 fishes weighing 21,529.8 kg.

Approximately 30 species were collected during the survey. Scientific names and local common names for species that were identified are presented in Table 2. Of the species caught the yellowtail snapper, the mutton snapper, the Nassau grouper, hind, coney, rock hind, barracuda, margate fish, and white grunt may be regarded as species typically found in the shallow water of the Banks. The other species can be regarded as true deepwater or slope-dwelling species.

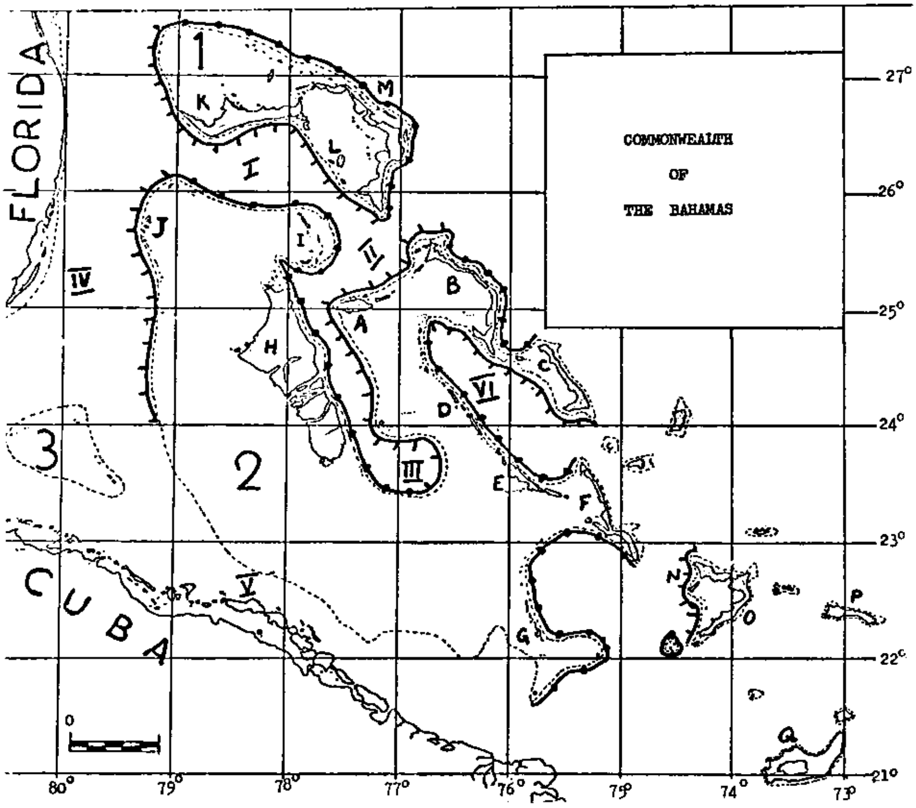


Figure 1. Map of the Commonwealth of the Bahamas showing regions covered by the survey. Solid dots = Predominantly Windward slopes, "Tic" marks = Predominantly Leeward slopes. 1 = Little Bahama Bank, 2 = Great Bahama Bank, 3 = Cay Sal Bank. I = Northwest Providence Channel, II = Northeast Providence Channel, III = Tongue of the Ocean, IV = Straits of Florida, V = Old Bahama Channel, VI = Exuma Sound. A = New Providence, B = Eleuthera, C = Cat Island, D = Exuma Cays, E = Exuma, F = Long Island, G = Ragged Island, H = Andros, I = Berry Islands, J = Bimini, K = Grand Bahama, L = Mores Islands, M = Abaco, N = Crooked Island, O = Acklins, P = Mayaguana, Q = Great Inagua.

In the analyses that follow, the hind, coney and the two species of amberjacks, the great amberjack and the almaco jack, are grouped together in terms of number and weights.

Distribution of Species by Occurrence and Depth

The number of times one or more fish was caught at a station was determined for each species (Table 3) as an indication of the distribution of species throughout the area surveyed. Frequency of occurrence by depth zone is given in Table 3. The blackfin snapper is the most widely distributed species as it occurred in 44.7% of the stations fished. This species was followed by silk snapper (41.2%),

Table 2. Scientific and common names of species caught during the deepwater fishing survey in the Bahamas

Scientific name	Common name
FAMILY: LUTJANIDAE	SNAPPERS
Lutjanus bucanella (Cuvier and Valenciennes), 1828	Blackfin snapper
Lutjanus vivanus (Cuvier and Valenciennes), 1828	Silk snapper
Apsilus dentatus (Guichenot), 1853	Black snapper
Etelis oculatus (Valenciennes) 1828	Queen snapper
Pristipomoides macrophthalmus (Muller and Troschel), 1848	Bigeye snapper
Ocyurus chrysurus (Bloch), 1991	Yellowtail snapper
Rhomboplites aurorubens (Cuvier and Valenciennes), 1929	Vermilion snapper
Lutjanus analis (Cuvier and Valenciennes), 1828	Mutton snapper
FAMILY: SERRANIDAE	GROUPERS
Epinephelus mystacinus (Poey), 1852	Misty grouper
Epinephelus morio (Cuvier and Valenciennes), 1828	Red grouper
Mycteroperca interstitialis (Poey), 1861	Yellowmouth grouper
Epinephelus flavolimbatus	Yellowedge grouper
Epinephelus striatus (Bloch), 1792	Nassau grouper
Epinephelus guttatus (Linnaeus), 1758	Hind
Cephalopholis fulva (Linnaeus), 1758	Coney
Mycteroperca venenosa (Linnaeus), 1758	Yellowfin grouper
Mycteroperca bonaci (Poey), 1860.	Black grouper
Epinephelus adscensionis (Osbeck), 1771	Rock hind
FAMILY: CARANGIDAE	JACKS
Seriola dumerili (Risso), 1810	Greater amberjack
Seriola rivoliana (Cuvier and Valenciennes), 1833	Almaco jack
Caranx lugubris (Poey), 1860	Blackjack
OTHER FAMILIES	
Sphyraena barracuda (Walbaum), 1792	Barracuda
Haemulon album (Cuvier and Valenciennes), 1830	Margate fish
Haemulon plumieri (Lacepide), 1802	White grunt
Malacanthus plumieri (Bloch), 1787	Shallowwater tilefish
Unidentified	Deepwater tilefish

bigeye snapper (37.5%), black snapper (15.7%), misty grouper (14.8%), and the amberjacks (11.6%). All other species occurred in less than 10% of the stations fished.

The blackfin snapper, silk snapper, queen snapper, bigeye snapper, misty grouper, and the amberjacks were the only species occurring in all depth ranges (Table 3).

Distribution was observed to be patchy. A species would occur in a given grid but not in adjacent grids. This patchy distribution probably results from a complex interaction of substrates, available food, seasonal migrations, and other factors.

Table 3. Frequency of occurrence of various species at stations by depth zones fished

Depth range (fm)	30–60	60–90	90–120	120–150	150–180	30–180
Stations fished (No.)	429	427	431	426	149	1862
Frequency of Occurrence	%	%	%	%	%	%
Snappers						
Blackfin	67.6	68.4	42.4	14.5	3.3	44.7
Silk	26.6	54.8	56.4	35.0	18.8	41.2
Black	38.2	23.6	5.3	0.9		15.7
Queen	0.7	3.0	12.8	18.3	18.8	9.5
Bigeye	7.0	19.0	50.6	64.5	63.7	37.5
Yellowtail	2.3	0.7				0.7
Vermilion	0.5	0.2	1.8	0.5		0.7
Mutton	0.9	0.5				0.3
Groupers						
Misty	3.7	9.8	18.3	24.4	23.5	14.8
Red	24.7	9.6	0.9	0.2		8.2
Nassau	4.2	0.7				
Yellowedge		0.2	0.2	0.9		0.3
Hind and coney	13.3	1.6	0.2			3.5
Rock hind	0.2					-
Yellowmouth	2.1	2.3	0.7	0.2		1.2
Yellowfin	2.5	1.2	0.2			0.9
Black	0.9	0.2				0.3
Tattler		0.2				-
Unidentified grouper	0.2		0.2			0.1
Jacks						
Amberjacks	15.8	19.9	10.2	4.2	1.3	11.6
Blackjack	7.0	3.5	2.1	0.5		3.0
Other families						
Barracuda	3.5	1.4	0.2			1.2
Margate fish	0.7	0.7				0.3
White grunt	0.5					0.1
Unidentified porgy	0.2					-
Shallowwater tilefish	0.7					0.2
Deepwater tilefish			0.2	1.2		0.3
Unidentified species	0.2			0.2		0.1

Catch Composition and Catch Rates

Table 4 summarizes catches from the various depth ranges and shows numbers, mean weight, percentage by weight of total catch, and the catch per unit effort of the species captured.

30 - 60 fathom depth range – Six species constituted 88.5% of the catch in this depth range (Table 4). These were the blackfin snapper (34.8%), black snapper (25.8%), red grouper (13.6%), silk snapper (8.2%) and the two species of amberjacks (6.1%). Approximately 26 species were caught in this depth range. Included among these were a number of species that can be classified as deepwater species as well as species that commonly occur on the banks in shallow water.

60 - 90 fathom depth range – Twenty-two species were caught in this depth range (Table 4) although 7 species accounted for 94% of the catch. These were the blackfin snapper (29.6%), silk snapper (25.0%), black snapper (16.0%), 2 species of amberjack (9.3%), misty grouper (9.1%) and the red grouper (5.0%).

90 - 120 fathom depth range – Eighteen species were caught in this depth range (Table 4). The silk snapper at 50.2% was the dominant species. The other major species comprising the bulk of the catch were misty grouper (14.6%), blackfin snapper (10.9%), bigeye snapper (9.2%) and amberjack (5.8%).

120 - 150 fathom depth range – Fifteen species were caught in this depth range (Table 4). The silk snapper was again the dominant species in the catch at 31.9%. This was followed by misty grouper (27.4%), bigeye snapper (25.8%), queen snapper (4.9%), black snapper (4.7%) and amberjacks (3.8%).

150 - 180 fathom depth range – Only 7 species were caught in this depth range (Table 4). The misty grouper (39.0%), bigeye snapper (37.7%), silk snapper (13.3%) and the queen snapper (7.1%) were the dominant species.

There was a decrease in the total catch rate with increasing depth (Table 4). This decrease is due to a number of factors, including variations in the number of lifts, the number of fish per lift and the mean weight of fish.

The number of lifts per reel hour (lrh) for the different depth ranges were: 30-60 fm, 5.50 lrh; 60-90 fm, 5.44 lrh; 90-120 fm, 4.84 lrh; 120-150 fm, 4.63 lrh; 150-180 fm, 4.14 lrh. The decrease in the number of lifts with increasing depth is related to the fact that the time taken for hauling and setting the line is inversely proportional to the depth of the water. Lines were normally only lifted when strikes were made or at the end of the alloted fishing period. The similarity in value of the lifts per reel hour for the various depth ranges as well as observations aboard the research vessels indicate that strikes were made in deeper water as regularly as in shallow water. The difference in the number of lifts therefore reflects the time taken to haul and reset lines at the various depths.

Kawaguchi (1971) indicated that the average total elapsed time for lowering line, hooking fish, retrieving line, and removing fish was 4.7 min. for electrically-powered reels fishing on the edge slope of the bank in the Caribbean. This equates with approximately 13 hauls per hour although as noted by Kawaguchi, line breakage, tangling, and other factors tend to reduce this figure to about 10 hauls per reel per hour. This compares with a maximum rate of 5.5 hauls per hour that was outlined in the 30-60 fm depth range in the Bahamas.

Table 4. Summary of catches giving number (#), mean weight ($\overline{w}$) in kilograms, percentage of total catch by weight (%) and catch per unit effort (CPUE, in kilogram per reel hour) of species captured in each depth zone

Depth Range (fathoms)	30 – 60				60 – 90				90 – 120				120 – 150				150 – 180			
Number of Stations	429				427				431				426				149			
Effort (reel hrs)	584.0				561.6				554.5				503.7				169.6			
Catch (#)	4146				4009				3314				2509				642			
Catch (kg)	6620.8				6089.9				4652.3				3290.9				875.9			
CPUE (kg/ reel hr)	11.3				10.8				8.4				6.5				5.2			
Mean Weight (kg)	1.60				1.52				1.41				1.32				1.37			
	#	$\overline{w}$	%	CPUE	#	$\overline{w}$	%	CPUE	#	$\overline{w}$	%	CPUE	#	$\overline{w}$	%	CPUE	#	$\overline{w}$	%	CPUE
Snappers																				
Blackfin	2314	0.99	34.8	3.95	1831	0.98	29.6	3.20	572	0.88	10.9	0.91	144	1.06	4.7	0.30	5	0.72	0.4	0.02
Silk	332	1.63	8.2	0.92	1114	1.38	25.0	2.71	1535	1.52	50.2	4.21	642	1.63	31.9	2.08	66	1.76	13.3	0.68
Black	843	2.02	25.8	2.92	473	2.05	16.0	1.73	99	2.46	5.2	0.44	6	1.20	0.2	0.01				
Queen	4	1.95	0.1	0.01	16	1.06	0.3	0.03	86	0.91	1.7	0.14	129	1.25	4.9	0.32	28	2.23	7.1	0.37
Bigeye	79	0.48	0.6	0.07	248	0.47	1.9	0.21	825	0.52	9.2	0.77	1387	0.61	25.8	1.68	489	0.67	37.7	1.95
Yellowtail	18	0.83	0.2	0.02	5	0.62	-	0.01												
Vermilion	5	0.82	0.1	0.01	2	0.90	-	-	21	0.78	0.4	0.03	6	0.06	0.1	0.01				
Mutton	4	4.65	0.3	0.03	2	5.70	0.2	0.02												
Groupers																				
Misty	19	8.61	2.5	0.28	57	9.74	9.0	0.99	101	6.72	14.5	1.22	160	5.62	27.4	1.72	42	8.12	39.0	2.01
Red	185	4.88	13.6	1.55	58	5.21	5.0	0.54	4	4.55	0.4	0.03	1	5.00	0.2	0.01				
Yellowmouth	10	1.21	0.2	0.02	11	1.40	0.3	0.03	3	1.00	0.1	0.01	1	0.90	-	-				
Yellowedge					1	6.03	0.1	0.01	1	5.00	0.1	0.01	4	5.42	0.7	0.04				
Nassau	23	4.37	1.5	0.17	3	5.43	0.3	0.03												
Hind & Coney	105	0.55	0.9	0.10	7	0.33	-	-	1	2.73	0.2	0.01								
Yellowfin	14	5.38	1.1	0.13	5	9.16	0.8	0.08	1	18.20	0.4	0.03								
Rock hind	1	9.90	0.1	0.02																
Tattler					1	0.10	-	-												
Unidentified grouper	3	1.70	0.1	0.01					1	7.70	0.2	0.01								
Jacks																				
Amberjack	114	3.53	6.1	0.69	147	3.86	9.3	1.01	51	5.31	5.7	0.49	21	6.03	3.7	0.25	2	10.9	2.5	0.13
Blackjack	41	3.63	2.2	0.25	18	3.73	1.1	0.12	9	3.44	0.7	0.06	2	3.30	0.2	0.01				
Other families																				
Barracuda	16	5.20	1.3	0.14	6	7.05	0.7	0.08	1	3.20	0.1	0.01								
Margate grunt	3	2.03	0.1	0.01	3	4.37	0.2	0.02												
White grunt	2	0.10	-	-																
Shallowwater tilefish	5	0.48	-	-																
Deepwater tilefish									1	0.70	-	-	5	0.66	0.1	0.01				
Unidentified species	2	1.60	0.1	0.01									1	1.90	0.1	0.01				

The number of fish caught per lift (fpl) decreased with increasing depth. The number of fish per lift caught in the various depth ranges were: 30-60 fm, 1.29 fpl; 60-90 fm, 1.34 fpl; 90-120 fm, 1.16 fpl; 120-150 fm, 1.08 fpl; 150-180 fm, 0.90 fpl. The decrease may, to a certain extent, indicate a decrease in relative abundance with increasing depth but most certainly reflects the fact that the number of fish escaping during the long hauls from the greater depths is greater than the number of fish that escape while being hauled from the shallower depths.

Table 4 indicates that the mean size of the total catch was greatest in the 30-60 fm depth range and decreased with increasing depth. The slight increase in mean size of fish caught in the 150-180 fm depth range over the 120-150 fm depth range is probably a result of the presence of substantial quantities of misty grouper (39% of catch) and queen snapper (7.1%) in the catch from the 150-180 fm depth range. The presence of these species served to offset, to a limited extent, the effect of increased occurrence of the bigeye snapper on the mean size of fishes in this depth range.

Some of the species showed a general tendency towards an increase in mean weight with increasing depth. These included the silk snapper, black snapper, queen snapper, and the red grouper. This trend was not shown by the misty grouper which had its greatest mean size in the 60-90 fm depth range.

Although not reflected in Table 4, observations onboard the research vessel indicated that for individual species the largest fishes were generally caught in the depth range where the species was most abundant. However, the frequency of occurrence of large individuals was not regular enough to significantly influence mean weights.

As a result of the factors mentioned above, catch rates are only a true indicator of relative abundance for areas of comparable depth. Figure 2 illustrates the catch per grid for areas fished during the survey. Fifty-three grids (31.7%) produced a catch rate of 0.0-4.9 kg/reel hour, 61 grids (36.5%) produced a catch rate of 5.0-9.9 kg/reel hour, 35 grids (21.0%) produced a catch rate of 10.0-14.9 kg/reel hour, 16 grids (9.6%) produced a catch rate of 15.0-19.9 kg/reel hour and 2 grids (1.2%) produced a catch rate of between 20.0-24.9 kg/reel hour.

Figure 2 illustrates that consistently high catch rates were obtained in the southern portion of the Tongue of the Ocean, on the edge south of Cat Island, on the edge east of the Berry Islands and on the edge south and southwest of Abaco.

The highest catch rate was 24.36 kg/reel hour obtained in grid 277731 on the northeastern edge of the Little Bahama Bank. However, this grid was only fished on one occasion for a total of 7.0 reel hours. Grid 247618 on the Tartar Bank, south of Cat Island, had a catch rate of 23.72 kg/reel hour and was fished on a number of occasions for a total of 24.0 reel hours.

Table 4 indicates that the catch rate was greatest (11.3 kg/reel hour) in the 30-60 fm depth range. The catch rate in the 60-90 fm depth range was 10.8 kg/reel hour, 8.4 kg/reel hour in the 90-120 fm depth range, 6.5 kg/reel hour in the 120-150 fm depth range and 5.2 kg/reel hour in the 150-180 fm depth range. The mean catch rate for all depths was 9.1 kg/reel hour.

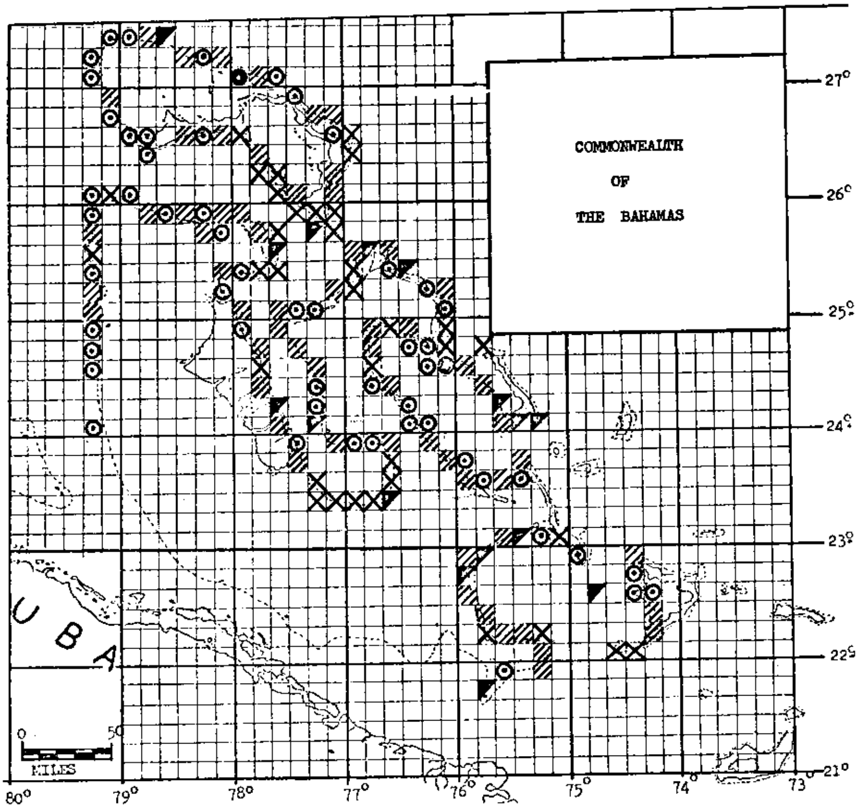


Figure 2. Map of the Commonwealth of the Bahamas showing catch per grid for areas fished during the survey. Dotted circle = 0.0 - 4.9 kg/reel hour, Slashes = 5.0 - 9.9 kg/reel hour, X = 10.0 - 14.9 kg/reel hour, Solid triangles = 15.0 - 19.9 kg/reel hour, Open circles = 20.0 - 24.9 kg/reel hour.

Kawaguchi (1971) reported catch rates on parts of the Jamaican shelf between 0.0 and 10.6 kg/reel hour at northwest Pedro Bank for an average of 3.34 kg/reel hour. Catch composition at Pedro Bank, according to depth and location, was 39-92% snappers, 3-19% jacks, 2-22% groupers and 2-35% other fish.

Results obtained by Munro (1974) for the "drop-off" and deep reef on Pedro Bank, Jamaica, were similar. Catch rates of 0.98 kg/reel hour for the 22-33 fm depth range and 1.22 kg/reel hour for the 55-66 fm depth range were obtained.

Catch rates for the entire Caribbean area (Kawaguchi, 1971) were 6.6 kg/reel hour with greater catch rates from the shelf area of Nicaragua, Guyana, and the banks of the northeastern Caribbean. The species composition of the overall catch was 51% snapper, 34% jack, 6% grouper, and 9.0% other mixed species.

The catch rate from Bahamian waters is substantially higher than the rate in the Caribbean. Composition of catch in Bahamian waters according to depth varied between 58.5 - 77.6% snapper, 15.8 - 39.0% grouper, 2.5 - 10.4% jacks and 0 - 1.8% other species. The total composition from Bahamian waters was 71.7% snappers, 19.9% groupers, 7.7% jacks and 0.7% other mixed species.

The differences in catch rates and species composition between Bahamian and Caribbean catches are probably a result of differences in effort at the various depth ranges and differences in fishing gear. However, topographical and ecological factors may also contribute to these differences.

Munro's data were based on the use of electric reels with up to five no. 5/0 or 6/0 straight or circle hooks and squid bait.

Kawaguchi's data were based on the use of electric or mechanical reels with three tuna-circle hooks no. 6-9 and bait of squid or mackerel.

During the Bahamian survey electric reels with six no. 7 tuna-circle hooks and mackerel bait were used.

Comparison of Catches from Windward and Leeward Slopes

The areas fished during the survey can be classified as predominantly windward or predominantly leeward slopes (Fig. 1).

Catches were analyzed accordingly and results are shown in Table 5. Mean weight of total catch and the catch per unit effort was higher for the windward slopes.

The blackfin snapper, black snapper, misty grouper, and amberjacks were slightly dominant in the catch from the windward slopes. The proportion of silk snapper caught on the leeward slopes was appreciably greater than that caught on the windward slopes. Species group composition for windward slopes was snapper 69.6%; grouper 20.8%, jack 8.8%, other families 0.8%. For leeward slopes the composition was 73.4%, snapper 19.1%, grouper 6.5%, jacks, and 0.6% other families.

Of the major species occurring in the catch, the blackfin snapper, silk snapper, black snapper, misty grouper, red grouper, amberjacks, and blackjack all showed a greater mean size on the windward slopes. The mean size of the bigeye snapper was slightly greater on the leeward slopes.

Reefs are better developed on windward slopes. This factor, combined with the gentleness of the slope (20° – 40°) probably contributed to the higher catch rates obtained from windward slopes. On all exploratory fishing cruises position of stations was maintained by use of the engine. It was easier to maintain position on the gentler windward slopes during normal weather conditions. Any contribution of reef development to increased abundance of fish would presumably be more significant in the shallower depth ranges. Catch rates by depth range for windward and leeward slopes are shown (Table 6).

Catch rates in the 30-60 fm and the 60-90 fm depth ranges were higher on the windward slopes.

Seasonal Variation in Catch Composition, Catch Rates, and Mean Weight

Table 7 summarizes catch composition by season for the species caught at all depth ranges during the survey.

Table 5. Comparison of mean weight ($\bar{w}$ in kg), catch composition (% of total catch by weight) and catch per unit effort (CPUE in kg/reel hour) for catches from windward and leeward slopes.

	Windward			Leeward		
Effort (reel hrs)	1084.9			1272.5		
Catch (#)	6491			8005		
Catch (kg)	10096.7			11196.3		
Mean Weight (kg)	1.56			1.40		
CPUE (kg/reel hr)	9.31			8.80		
	$\bar{w}$	% total catch	CPUE	$\bar{w}$	% total catch	CPUE
Snappers						
Blackfin	1.05	23.3	2.16	0.92	21.4	1.88
Silk	1.53	21.3	1.98	1.49	29.9	2.63
Black	2.26	15.8	1.47	1.87	11.3	0.99
Queen	1.20	1.3	0.12	1.22	1.7	0.15
Bigeye	0.56	7.6	0.71	0.60	8.8	0.77
Yellowtail	0.64	0.1	0.01	1.28	0.1	0.01
Vermilion	0.74	0.1	0.01	0.77	0.2	0.01
Mutton	6.80	0.1	0.01	5.30	0.1	0.01
Groupers						
Misty	7.17	13.2	1.23	6.70	11.4	1.01
Red	5.10	5.7	0.53	4.93	5.7	0.50
Nassau	3.98	0.2	0.02	4.29	0.7	0.06
Yellowmouth	1.22	0.2	0.01	1.37	0.1	0.01
Yellowedge	5.50	0.3	0.03	0.03		
Yellowfin	8.33	0.6	0.05	8.11	0.7	0.06
Hind and Coney	0.67	0.5	0.04	0.80	0.3	0.03
Black	0.09	-	-	5.22	0.2	0.02
Rock Hind				9.09	0.1	0.01
Tattler				0.01	-	-
Unidentified grouper	7.7	0.1	0.01	1.70	-	-
Jacks						
Amberjack	4.74	7.6	0.71	3.60	5.5	0.48
Blackjack	4.74	1.2	0.11	3.53	1.1	0.10
Other families						
Barracuda	5.21	0.7	0.06	6.10	0.5	0.05
Margate grunt	4.75	0.1	0.01	2.42	0.1	0.01
White grunt	0.10	-	-			
Shallowwater tilefish	0.50	-	-	0.50	-	-
Deepwater tilefish	1.65	-	-	1.80	-	-
Unidentified species	1.65	-	-	1.80	-	-

Table 6. Number of catch rates by depth range for windward and leeward slopes

Depth Range (fm)	Windward Slopes CPUE(kg/reel hr)	Leeward Slopes CPUE (kg/reel hr)
30 - 60	12.06	10.85
60 - 90	13.55	9.02
90 - 120	6.72	7.90
120 - 150	6.46	6.60
150 - 180	5.25	5.11

Snappers made up 69.5% of the catch during winter, 77.6% in spring, 71.1% in summer, and 68.2% in autumn. Groupers made up 22.8% of the catch in autumn, 21.0% in winter, 19.0% in summer, and 16.8% in spring. Jacks contributed a high of 9.5% of the catch in summer and a low of 4.7% in spring.

The silk snapper was the highest individual contributor with 32.1% in the spring. The black snapper contribution was highest in the summer at 19.1%. The misty grouper had significantly high contributions to the catch in winter (14.4%) and in autumn (13.5%).

Sylvester (1974) noted increased abundance of silk and blackfin snappers during April-June in the Virgin Islands. This contrasted with Wolf and Chislett (1974) who noted an overall reduction in catch rates during May-July in the Caribbean and adjacent waters.

Table 8 shows seasonal variations in catch per unit effort and average weight for the total catch as well as for the important species in the catch in the depth ranges fished during the present study.

The highest total catch rate (10.18 kg/reel hour) was obtained in the spring. This was followed by summer (9.18 kg/reel hour), winter (8.86 kg/reel hour), and autumn (8.35 kg/reel hour).

The highest total catch rates in the 30-60 fm and the 60-90 fm depth ranges occurred during the summer. The greatest total catch rates for 90-120 fm and the 150-180 fm depth ranges occurred during spring. The highest catch rate for the 120-150 fm depth range occurred during the winter.

The highest catch rate for the blackfin snapper, the silk snapper, and the bigeye snapper occurred during the spring. The black snapper was most seasonally abundant in the catch during the summer and the misty grouper was most seasonally abundant in the winter.

Results obtained during the present study were similar to those obtained by Sylvester (1974). It should be noted, however, that fishing during the present study was done exclusively with electrically-powered fishing reels. 92% of fish collected by Sylvester were caught using electric reel and 8% were caught using traps. Results obtained by Wolf and Chislett were for fish caught exclusively by traps.

This would indicate some seasonal differences in behavior of fish towards lines and traps.

Table 7. Species composition by season for the 30 - 180 fathoms depth range

Season	Winter	Spring	Summer	Autumn
Total catch (kg)	6339.0	5665.1	3615.4	5955.3
	%	%	%	%
Snappers				
Blackfin	23.3	22.8	21.4	20.6
Silk	24.6	32.1	21.7	23.6
Black	11.5	12.0	19.1	14.0
Queen	1.5	1.7	1.1	1.8
Bigeye	8.4	8.6	7.2	8.0
Yellowtail	-	0.1	0.1	0.1
Vermilion	0.1	0.1	0.1	0.1
Mutton	0.1	0.2	0.4	
Groupers				
Misty	14.4	11.0	8.2	13.5
Red	5.1	4.2	6.9	7.1
Yellowmouth	0.1	0.1	0.2	0.1
Yellowedge	0.2		0.5	0.1
Nassau	0.3	0.5	0.9	0.6
Tattler				-
Hind and Coney	0.2	0.4	0.5	0.2
Yellowfin	0.5	0.5	1.7	0.1
Black	0.2	0.1	0.1	
Rock hind				0.9
Unidentified grouper				0.2
Jacks				
Amberjack	7.5	3.3	8.2	7.2
Blackjack	0.8	1.4	1.3	1.3
Other families				
Barracuda	0.9	0.7	0.2	0.4
Shallowwater tilefish				-
Deepwater tilefish	0.1	-	-	
White grunt		-	-	
Margate grunt	0.1	0.1	0.1	
Unidentified species		-	0.1	

Table 8. Seasonal variations in catch per unit effort and average weight. A – all species, B – blackfin snapper, C – silk snapper, D – black snapper, E – bigeye snapper, F – misty grouper. $\bar{w}$ – mean weight (kg), CPUE – catch per unit effort (kg/reel hr)

Depth (fathoms)	Winter		Spring		Summer		Autumn	
	$\bar{w}$	CPUE	$\bar{w}$	CPUE	$\bar{w}$	CPUE	$\bar{w}$	CPUE
A								
30 - 60	1.53	10.60	1.55	11.44	1.75	12.37	1.63	11.46
60 - 90	1.54	9.92	1.39	10.07	1.71	14.54	1.48	8.98
90 - 120	1.26	6.30	1.47	11.53	1.27	6.17	1.55	7.81
120 - 150	1.47	7.10	1.19	5.45	1.17	4.45	1.30	4.88
150 - 180	1.42	1.03	1.49	2.14	0.91	0.81	1.39	1.87
30 - 180	1.46	8.86	1.42	10.18	1.52	9.18	1.47	8.35
B								
30 - 60	0.97	3.74	1.05	4.61	1.00	3.22	0.85	4.03
60 - 90	0.95	3.26	0.95	3.74	1.10	3.76	0.97	2.38
90 - 120	0.84	1.08	0.91	0.99	0.93	0.81	0.91	0.75
120 - 150	1.23	0.46	0.94	0.37	0.82	0.11	0.01	0.20
150 - 180	0.90	0.02			0.73	0.09	0.50	0.01
30 - 180	0.96	2.07	0.99	2.33	1.04	1.96	0.96	1.73
C								
30 - 60	1.71	1.18	1.65	1.09	1.16	0.49	1.66	0.76
60 - 90	1.14	2.22	1.45	3.45	1.30	2.98	1.30	2.47
90 - 120	1.41	3.10	1.56	7.04	1.35	3.12	1.67	3.64
120 - 150	1.60	2.60	1.77	2.15	1.59	1.74	1.60	1.65
150 - 180	1.80	1.04	1.74	1.07	2.10	0.25	1.66	0.36
30 - 180	1.50	2.18	1.57	3.27	1.36	1.99	1.53	1.99
D								
30 - 60	2.12	2.85	1.98	2.66	2.02	3.98	1.97	2.63
60 - 90	2.16	1.14	1.99	1.68	2.26	2.77	1.87	1.73
90 - 120	2.12	0.12	2.68	0.66	2.58	0.36	2.34	0.62
120 - 150	1.80	0.01	1.60	0.03			0.73	0.01
150 - 180								
30 - 180	2.11	1.02	2.05	1.22	2.13	1.75	1.96	1.18
E								
30 - 60	0.57	0.13	0.45	0.05	0.30	0.01	0.35	0.04
60 - 90	0.51	0.33	0.51	0.13	0.42	0.16	0.40	0.17
90 - 120	0.51	0.82	0.54	0.93	0.52	0.72	0.50	0.61
120 - 150	0.61	1.55	0.62	2.18	0.58	1.65	0.62	1.48
150 - 180	0.66	1.56	0.67	2.26	0.38	1.80	0.72	2.04
30 - 180	0.57	0.74	0.60	0.88	0.55	0.66	0.59	0.68
F								
30 - 60	6.79	0.34	12.05	0.17	14.30	0.30	9.96	0.29
60 - 90	8.63	1.08	10.24	0.72	13.28	0.30	8.77	0.92
90 - 120	6.89	1.32	6.58	1.58	7.48	0.49	6.55	1.25
120 - 150	5.86	2.39	5.73	1.55	5.85	0.87	5.22	1.79
150 - 180	8.26	1.65	8.34	2.90	6.80	0.82	8.09	2.14
30 - 180	6.73	1.28	7.09	1.12	11.66	1.01	6.65	1.14

There was no outstanding seasonal difference in the mean weight of the total catch (Table 8). This was also true for the blackfin snapper, the black snapper, and the bigeye snapper. However, misty grouper were largest in the summer, particularly in the 30-60 fm and 60-90 fm depth ranges. Also, silk snappers caught during the summer were consistently smaller than those caught at other times of the year.

Lunar Periodicity

Munro et al. (1971) noted a depression in catch rates after the quarter moons at ages 8-10 and 23-24 for fishes caught by using traps in Jamaican waters. Chislett[1] (personal communication) also noted increased catch rates around full moon on exploratory fishing cruises conducted by the UNDP/FAO Caribbean Fishery Development Project, and because of this, cruises were scheduled to ensure that these days were spent fishing. Senta et al. (1973) noted poor catch rates for line-caught fishes on the slopes in the South China and Andaman seas several days around the 6th day of the lunar month. Senta et al. (1973) also noted that during spring tides and a few days after the second spring tide the catch fluctuated remarkably from day to day.

Figure 3 illustrates variation in catch per unit effort (No./reel hour) with moon age for survey data from 30-180 fm depth range.

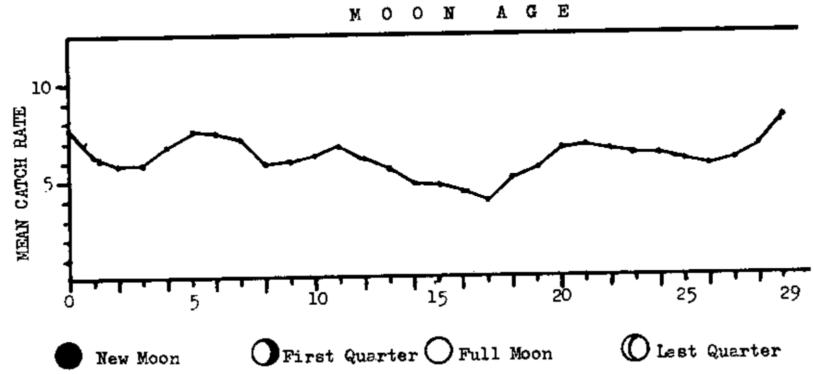


Figure 3. Variations in catch rates (No. per reel hour) with moon age for fishes caught during exploratory fishing cruises (Number of fishes = 14,620).

The data are smoothed by the method of sliding means and because of the cyclic nature of the moon, data for day 0 were obtained by using data for days 29, 0, and 1. Similarly, data for day 29 were obtained by using data for days 28, 29, and 0.

[1] Geoffrey R. Chislett, communication in 1969, while Mr. Chislett was employed by the UNDP/FAO Caribbean Fishery Development Project in Jamaica.

Depressed catch rates were observed around moon ages 2, 8-9, 17, and 25-26. Generally catches were high around new moon (days 28-0), between new moon and full moon (days 10-14) and between full moon and the last quarter (days 20-23).

Munro et al. (1971) correlated the depression in catch rates in Jamaica to the period at which tidal currents reach their minimum velocity. Two of the periods of low catch rates during the present study occurred around the quarter moons (at days 8-9 and 25-26) when tidal activity is low. The other periods of depressed catch rates occurred after the new moon (day 2) and after the full moon (day 17) when tidal velocity is near maximum.

Figure 4 shows variations in mean weight of total catch with moon age for survey data from 30-180 fm depth range. Data show that mean weight was highest between days 11-18, around the full moon and again between days 27-1, around new moon.

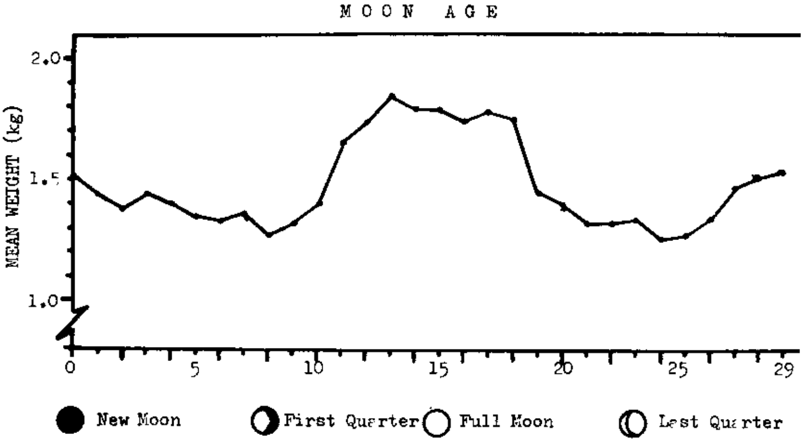


Figure 4. **Variations in mean weight (kg) with moon age for fishes caught during exploratory fishing cruises (Number of fishes = 14,620).**

Effect of Time of Day on Catch

Fishing was generally done between 0600 hr and 1900 hr. For analytical purposes the day was divided into 4-hr periods and catch rates were inspected for each period during which fishing was done to see whether there were any appreciable differences in mean weight and catch rates for the various time periods. No reel fishing was attempted during the hours of darkness. Results are summarized in Table 9.

Results indicated that fish caught between 1400 hr and 2000 hr were smaller than those caught earlier in the day and that fishing was best during the 0400-0800 hr time interval. Catch rates decreased as the day progressed and were substantially lower in the afternoon than in the morning.

Table 9. Variation of mean weight ($\overline{w}$ in kg) and catch per unit of effort (CPUE in kg/reel hour) with time of day for various depth ranges

Time of Day (hr)	0400 - 0800		0800 - 1200		1200 - 1600		1400 - 2000	
Depth range (fm)	$\overline{w}$	CPUE	$\overline{w}$	CPUE	$\overline{w}$	CPUE	$\overline{w}$	CPUE
30 - 60	1.63	12.40	1.62	12.53	1.58	10.51	1.50	8.95
60 - 90	1.37	7.38	1.56	11.35	1.56	12.17	1.34	7.96
90 - 120	1.37	8.01	1.49	9.80	1.41	8.14	1.13	5.55
120 - 150	1.33	11.28	1.39	7.13	1.24	5.48	1.24	5.40
150 - 180	1.30	5.25	1.44	5.82	1.32	4.49	1.20	4.34
30 - 180	1.50	10.41	1.52	9.84	1.47	8.94	1.30	6.65

In a multipurpose fishing venture it may therefore prove more profitable to reel fish in the morning and then switch to another type of fishing in the afternoon.

DISCUSSION

Estimates of Total Potential Yield

Gonzalez-Alberdi (1975), utilizing the results of the first 35 cruises of the UNDP/FAO Bahamas deepwater fishery survey, estimated the annual potential yield of the slope between 30 and 180 fm at approximately 4,000-5,000 metric tons (mt) and the standing crop at between 12,000-15,000 mt. Potential yield figures were arrived at by converting catch rate to density per square mile and then calculating the area of the slope. Potential yield was considered to be between one half and one quarter of the standing crop.

As indicated by Gonzalez-Alberdi, there are a number of limitations that will make it possible to catch only a part of the above mentioned potential yield. These include: (a) In calculating potential yield it was assumed that unexplored sectors will give similar catch rates to the average found in the regions surveyed. (b) The stock is spread over a large geographical area, some of it very far from the main consumption centers. Fishermen will therefore only harvest fish close to these centers. (c) Most of the commercial fishing will probably be done in the 30-120 fm depth range as this produces higher catch rates. (d) With increasing fishing effort the catch rate will decrease.

Gonzalez-Alberdi therefore concluded that the portion of the potential yield exploitable on a sound profitable basis was between 2,000-2,500 mt annually. Based on observed catch rates it was estimated that 17-20 vessels fishing four reels, 10 hr per day for 200 days per year would catch this amount of fish.

Klima (1976), using the Gonzalez-Alberdi data and a slightly different method of calculation, estimated the standing stock for the deepwater slopes in the Bahamas at 11,000 mt.

It should be noted that both estimates are based on catch rates and do not take into consideration biological and ecological factors.

Simulated Commercial Fishing Cruises

During the course of the project, 12 simulated commercial fishing cruises were carried out. The duration of these cruises was 59 days or an average of 4.9 days per cruise. The cruises, in most cases, were made to areas that had been fished previously during the regular survey and had shown high catch rates. Figure 5 shows the areas that were fished during the simulated commercial fishing cruises. Fishing was done in 20 grids. Allowing one day for steaming to and from the fishing grounds on each cruise, then the actual time spent on the fishing grounds was 47 days or an average of 3.9 days per cruise.

A summary of catch data (Table 10) indicates that a total of 9928 fish weighing 16846.2 kg was caught at a rate of 15.69 kg per reel hour. Snappers made up 80.16% of the catch with the black snapper (32.97), the silk snapper (22.71%), and the blackfin snapper (21.35%) as the dominant species.

The average catch per day on the fishing ground was 358.4 kg (788.5 lbs). The average effort per day on the fishing grounds was 22.8 reel hr and the time spent fishing per day was approximately 5.7 hr. Fishing activities were conducted only during daylight hours (roughly 12.5 hr per day). Therefore only 45.6% of the available daylight hours was spent fishing. The remainder of the time was usually spent steaming between stations in search of fish.

Feasibility of Commercial Deepwater Fishing

Using the results of the **Fregata** cruises, a feasibility study on a commercial deepwater fishing venture can be attempted. The aim of this study is to determine the ability of the operator of the vessel to meet his costs and to earn a reasonable renumeration for himself. Expected catch and earnings from deepwater fishing are also compared with catch and earnings presently realized by successful shallow water commercial fishing operations.

It is assumed that the vessel will make cruises of 10 days duration and will fish either four or six reels. It is also assumed that the vessel will fish 9 days on a 10-day fishing cruise.

Table 11 summarizes the expected catch and landings for vessels using four and six reels. Catch figures were obtained by using the catch rates and species composition realized on the simulated commercial fishing cruises of the **Fregata**. It is envisaged that approximately 95% of the catch would be marketable. This would include 21.35% blackfin snapper, 22.71% silk snapper, 32.97% black snapper, 2.76% bigeye snapper, 0.3% queen snapper, 13.6% grouper, and approximately 1.24% of the jacks and other species caught. The remaining 5% of the catch will have little market value and could be discarded at sea.

It is assumed that all species landed, with the exception of the black snapper, will be gutted and gilled. A weight loss of roughly 10% was observed in **Fregata** landings of fish that had been gutted and gilled and stored on ice. The black

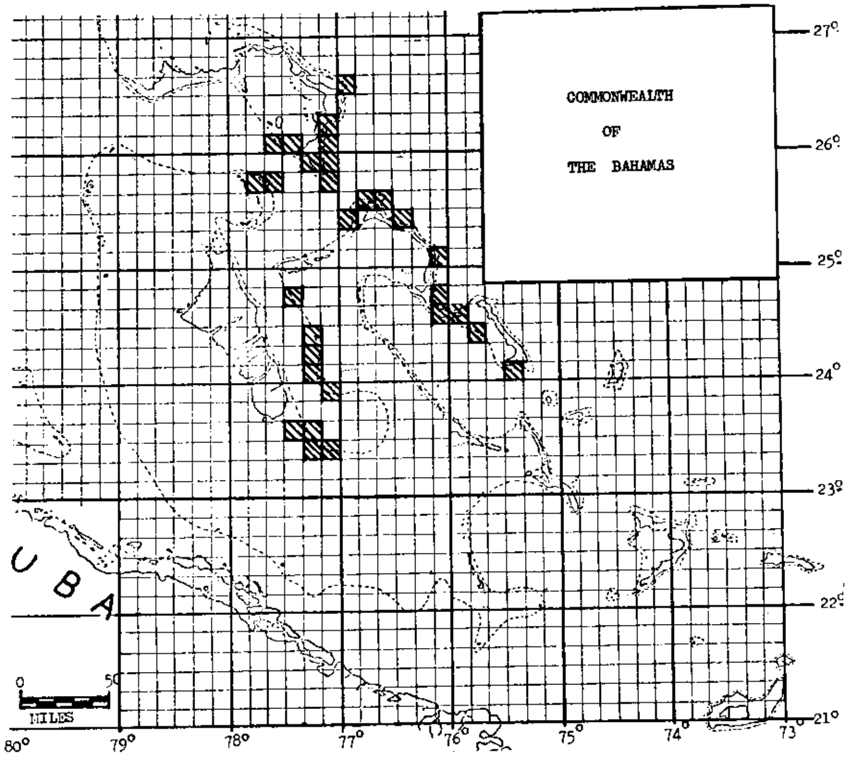


Figure 5. Map of the Commonwealth of Bahamas indicating grids fished on simulated commercial fishing cruises during the survey.

snapper has a tough skin and talks with the local fish processors indicate that its most marketable form would be as boneless, skinless fillets. The yield of black snapper fillets would be approximately 33%. The processors would prefer the gutted and gilled snappers to be landed as iced fish and not frozen.

Value of Landings

It is assumed that the catch will be sold directly to fish processors and that the existing time-consuming market practice of selling fish retail at dockside will not be utilized. Processors in Nassau have indicated that they can pay the following prices for a first class product:

Snapper fillets	$1.10 per lb. ($2.42 per kg)
Snapper (gutted and gilled)	$0.70 per lb. ($1.54 per kg)
Grouper and other species (gutted and gilled)	$0.40 per lb. ($0.88 per kg)

Table 10. Summary of catches from simulated commercial fishing cruises giving number #, Weight w(kg), mean individual weights $\bar{w}$ (kg), percentage composition of catch and catch rates, CPUE (kg/reel hr).

Depth Range	15 - 180 fm (Mostly 30 - 120 fm)				
Effort (reel hr)	107.5				
CATCH Species or Species Group	#	w	$\bar{w}$	Percentage by weight of total catch	CPUE
Blackfin snapper	3919	3596.1	0.92	21.35	3.35
Silk snapper	1936	3825.6	1.98	22.71	3.56
Black snapper	2548	5554.0	2.18	32.97	5.17
Bigeye snapper	738	464.8	0.63	2.76	0.43
Queen snapper	52	62.2	1.20	0.37	0.06
Grouper	405	2292.1	5.66	13.60	2.14
Jack	197	829.1	4.21	4.92	0.77
Other species	133	222.3	1.67	1.32	0.21
TOTAL	9928	16846	1.70	100.00	15.69

At these prices the value of landings in Table 11 will be $3,308 for a vessel using four reels and $4,964 for a vessel using six reels.

Costs: (Calculated for a vessel operating six reels)

(a) Capital Costs

Cost of Vessel – A suitable vessel for this type of fishing would have the following major specifications: wooden or fibre glass hull; 50-60 foot overall length; 6 foot draft, a 200-250 h.p. engine, 1x8 Kw generator, crew accommodations for eight, 6-hydraulic fishing reels, 3,000 gallons fuel capacity, 1,500 gallons freshwater and a fish hold capacity of 10,000 pounds.

The vessel would lack major pieces of equipment such as trawling gear and this should result in a corresponding reduction in purchase price. Either a new or a used vessel would be suitable. No estimate of vessel purchase cost is given.

(b) Annual fixed costs

(1) *Loan repayments and interest charges* – These will depend on the vessel purchase arrangements and therefore no estimate is included for this item.

(2) *Insurance of vessel* – This again will depend on the cost of the vessel. An annual fee of 5% of vessel cost should cover this item.

(3) *Maintenance and repair* – $10,000. These costs will depend upon type and age of vessel. However, for purpose of this exercise, an annual figure of $10,000 is budgeted.

(4) *Wages of crew* – $44,000. It is suggested that some kind of share arrangement be operated. However, since we need to ascertain the ability to meet fixed costs it is assumed that the vessel operator will have to meet a wage bill each year.

Table 11. Expected catch and landings from a commercial fishing vessel on cruises of 10 days duration and using 4 or 6 fishing reels.

Species	Four Reels		Six Reels	
	Expected catch (kg)	Landings (kg)	Expected catch (kg)	Landings (kg)
Blackfin snapper	688.7	619.8	1033.0	929.7
Silk snapper	732.5	659.2	1099.0	989.1
Black snapper	1063.5	350.9	1595.2	526.4
Bigeye snapper	89.0	80.1	133.5	120.1
Queen snapper	11.0	9.9	17.9	16.1
Grouper	438.7	394.8	658.0	592.2
Jack	158.7)		238.0)	
	)	3.1	)	4.5
Others	45.6)		63.9)	
TOTAL (kg)	3225.6	2117.8	4838.4	3178.1
(lbs)	7096	4659	10644	6992

Captain	$ 7,500)	
Engineer/Fisherman	$ 6,500)	$44,000
Six crew	$30,000)	

Total Annual Fixed Costs = $54,000 + loan repayments and vessel insurance charges.

(c) Variable costs per trip

(1) *Fuel and oil* – $850. Based on 100 gallons/day for 10 days at $0.80 per gallon = $800 per trip. Oil and filters, $50 per trip.

(2) *Dock charges* – $24. Vessel is expected to be in port four days between trips at a cost of $6.00 per day for berthing space.

(3) *Water and ice* – $410. Water at $5.70 per 1,000 gallons = $10 per trip. Ice at 10,000 lbs per trip at $4 per 100 lbs = $400 per trip.

(4) *Food* – $320. $4 per man per day.

(5) *Gear losses/trip* – $100. Based on gear losses (line and sinkers) on simulated commercial fishing cruises of **Fregata** a figure of $100 is used.

Total variable cost per trip	= $1,704
Total revenue per trip	= $4,964
Revenue per trip less variable cost per trip	= $3,260

(d) Break-even

The number of contributions necessary to cover annual fixed costs (not including loan repayments and vessel insurance costs)

$$= \frac{54000}{3260} = 16.6 \text{ trips}$$

(e) Likely number of trips

Assuming that one month will be spent in port for dry docking, holidays, and other activities and that the vessel's turn around time is 14 days, then the vessel can make 24 trips per year. The contribution from the additional seven trips will therefore be $22,820. This is the amount available for repaying loans and for paying vessel-insurance costs. Profits will also have to be deducted from this sum.

Comparison of Deepwater Fishing with Bank Fishing

The Bahamian fishing industry is primarily a "bank" or shallow water fishery with most fishing activity taking place in less than 5 fm of water.

The commercially important species caught are the crawfish, conch, turtles, and species of scalefish families such as groupers, snappers, jacks, and grunts. Most of the motor vessels fish for crawfish during the open season and fish for scalefish during the close crawfish season extending from 1 April to 31 July. Scalefish are caught either by netting or by spearfishing on these motor vessels. Crawfish are caught by spearfishing. Some motor vessels also fish exclusively for scalefish. The sailing sloops fish almost exclusively for scalefish and/or conch.

Catch summaries for motor vessels engaged in the various types of fishing are presented below:

(1) *Crawfish vessels* (9 vessels surveyed)

(a) *Operation during crawfish season (1976)*

Vessel size	– 50′ - 90′ overall length
Number of dinghies	– 5
Number of men	– 14
Duration of fishing trips	– 18 days
Average landings per trip	– 11,800 pounds (mainly crawfish tails and scalefish)
Value of landings	– $43,700
Catch per day at sea	– 658 pounds
Value of catch per day	– $2,434
Catch per man per day at sea	– 46 pounds
Value of catch per man per day	– $169

(b) *Operation during the crawfish closed season April 1 to July 31 (1976)*

(i) *Netting vessels* (3 vessels surveyed)

Number of dinghies	– 4
Number of men	– 14
Duration of trips	– 6 days
Average landings per trip	– 8,600 pounds
Value of landings	– $4,700
Catch per day at sea	– 1,400 pounds
Value of catch per day	– $783
Catch per man per day at sea	– 100 pounds
Value of catch per man per day	– $56

(ii) *Spearfishing vessels* (6 vessels surveyed)

Number of dinghies	– 4
Number of men	– 14
Duration of trips	– 16
Average landings per trip	– 20,300 pounds
Value of landings	– $12,800
Catch per day at sea	– 1,269 pounds
Value of catch per day	– $800
Catch per man per day at sea	– 90 pounds
Value of catch per man per day	– $57

(2) *Scalefish vessels* (1976)

(a) *Vessels using fish traps* (8 vessels surveyed)

Vessel size	– 38′ - 62′
Number of dinghies	– 2
Number of men	– 6
Duration of fishing trips	– 6
Average landings per trip	– 1598 pounds
Value of landings	– $1,650
Catch per day at sea	– 219 pounds
Value of catch per day	– $226
Catch per man per day at sea	– 36 pounds
Value of catch per man per day	– $38

(b) *Vessels using seine nets* (6 vessels surveyed)

Vessel size	– 36′ - 52′
Number of dinghies	– 3
Number of men	– 9
Duration of fishing trips	– 3-5
Average landings per trip	– 2,893 pounds
Value of landings	– $1,902
Catch per day at sea	– 826 pounds
Value of catch per day	– $599
Catch per man per day at sea	– 92 pounds
Value of catch per man per day	– $62

(3) *Deepwater fishing* (Estimated catch per vessel using six reels)

Vessel size	– 50′ - 60′
Number of men	– 8
Duration of fishing trips	– 10 days
Average landings per trip	– 6,992 pounds
Value of landings	– $4,964
Catch per day at sea	– 699 pounds
Value of catch per day at sea	– $496
Catch per man per day at sea	– 87 pounds
Value of catch per man per day	– $62

This comparison shows that crawfish operations at a gross revenue of $169 per man per day at sea realize at least two and one-half times as much revenue as any of the other fishing activities. Scalefishing during the crawfish closed season and seine netting year round for scalefish all produce a gross revenue of approximately $56-$62 per man per day at sea. Calculated revenue from deepwater fishing is also comparable to shallow water scalefishing at $62 per man per day at sea. The low returns from scalefish trapping ($38 per man per day at sea) is not an indication that this method is less efficient than the others, but is a result of the number of traps fished by these vessels. Vessels only fish an average of 10-15 traps.

The present fishermen are already skilled in the methods used to exploit the shallow water fisheries resources and, as the above comparison indicates, would not significantly increase their income by changing to deepwater fishing. If the change is made, they would also have to install electric or hydraulic fishing reels and would have to learn the methods associated with deepwater fishing. It therefore seems that under the present circumstances the possibilities of developing a deepwater fishery in the Bahamas are not very good.

Pesca de Pargo y Cherna con Carrete Eléctrico en las Bahamas, 1971–1975

RESUMEN

Un estudio de pargos de aguas profundas fue conducido por la UNDP/FAO durante el período 1972–1975. Se realizó una pesca exploratoria en áreas de 10 millas cuadradas en 1862 estaciones, a una profundidad entre 30 y 180 brazas. Aproximadamente un 70% del borde total fue examinado.

Se capturaron 14,620 peces que pesaban 21,529.8 kg., estando representadas aproximadamente unas 30 especies. La captura total fue de 71.7% pargos, 19.9% chernas, 7.7% crevallé (*Caranx* spp.) y 0.7% otras especies. La proporción de captura fue mayor en el rango de 30–60 brazas de profundidad a 11.3 kg. por hora de carrete. La proporción de captura promedio para todos los rangos de profundidad fue de 9.1 kg. por hora de carrete.

La comparación de las capturas en los taludes de barlovento y en los taludes de sotavento indicó una ligera proporción mayor en los primeros y algunas diferencias en su composición. Las variaciones son probablemente debidas a lo escarpado del talud y al desarrollo de los arrecifes.

Se notaron variaciones en la composición de la captura, en la proporción de las capturas y en los pesos promedios. Los pargos con un 77.6% fueron los más abundantes durante las capturas de primavera; las chernas con un 22.8% en el otoño y las crevallés con un 9.5% durante el verano. La mayor proporción de captura total de 10.18 kg. por hora de carrete se obtuvo en la primavera. El peso promedio de la cherna de lo alto, *Epinephelus mystacinus* (Poey), fue mayor en el verano y los pargos de lo alto, *Lutjanus vivanus* (Cuvier) capturados durante el verano fueron menores que los obtenidos en otras épocas del año.

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