

AGENCY FOR INTERNATIONAL DEVELOPMENT
 WASHINGTON, D. C. 20523
BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

1. SUBJECT CLASSIFICATION
 A. PRIMARY
 Agriculture
 B. SECONDARY
 Fisheries

2. TITLE AND SUBTITLE
 The potential for fishery development in the Caribbean and adjacent seas

3. AUTHOR(S)
 Idyll, C.P.

4. DOCUMENT DATE 1971	5. NUMBER OF PAGES 16 p.	6. ARC NUMBER ARC
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7. REFERENCE ORGANIZATION NAME AND ADDRESS
 International Center for Marine Resources, University of Rhode Island,
 Kingston, Rhode Island 02881

8. SUPPLEMENTARY NOTES (*Sponsoring Organization, Publishers, Availability*)
 (Presented at Seminar on Issues of International Economic Development,
 University of Rhode Island, 1971)

9. ABSTRACT

This report begins with a brief geographical and political history of the area and then discusses at greater length the various kinds and characteristics of fish in the Caribbean. The best source of information about the fish resources of the Caribbean has been the extensive investigations of the Food and Agriculture Organization (FAO), United Nations Development Programme (UNDP) Caribbean Fisher Development Project. This project consisted of exploratory fishing, marketing, and training investigations, from 1963 to 1971. Exploratory fishing operations by the FAO/UNDP project uncovered no substantial new fishery resources. They have, however, increased greatly the knowledge of the stocks of demersal fishes off the Guianas, and have shown that these could be caught profitably by boats operating as far distant as Puerto Rico. The project vessels also have caught fish to be used in the marketing programs which emphasized demonstrations and improved methods for the handling and distribution of fish, both for domestic markets and export. The most difficult fishery problems of the Caribbean which still remain to be solved are social and economic. Another major problem is the shortage of trained people, not only to carry out the fishing and fish-marketing, but also administer fishery development programs and to perform the necessary research on conservation, fish processing, and related matters. The report concludes that the Caribbean people must be encouraged to commit their own time and money to the fisheries programs, and to develop their own skills and resources in this important field.

10. CONTROL NUMBER PN-AAB-913	11. PRICE OF DOCUMENT
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12. DESCRIPTORS Caribbean	13. PROJECT NUMBER
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14. CONTRACT NUMBER

CSD-2455 211(d)

15. TYPE OF DOCUMENT

THE POTENTIAL FOR FISHERY DEVELOPMENT IN THE CARIBBEAN AND ADJACENT SEAS

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A paper presented at the University of Rhode Island on March 16, 1971, at a seminar on Issues of International Economic Development

This is the first of a series of occasional papers in International Marine Resource Development sponsored by the

**UNIVERSITY OF RHODE ISLAND INTERNATIONAL
CENTER FOR MARINE RESOURCE DEVELOPMENT**

**OCCASIONAL PAPER SERIES IN INTERNATIONAL MARINE
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The Caribbean is a vast and beautiful area. Its geography is dominated by the sea, but its outlook, industry and life are controlled to a surprisingly small degree by the ocean. The peoples of the region have gone through storms of political and economic turmoil in recent years, and most of these upheavals are by no means settled, nor are the political groupings stabilized.

The Caribbean region is characterized by a history of colonialism, exploitation, slavery, and human degradation, and the reaction against these conditions has been angry and in some cases violent. Like many exploited peoples, those in the Caribbean are striking out vigorously for greater self-determination, better social and economic conditions, and political independence. In recent years many of these nations have become independent, or have gained some other form of political freedom, so that few colonies exist in the region which was formerly dominated by this system.

The Caribbean area has geographic unity but no uniformity. The unity comes from the similarity of geographical and climatic conditions over most of the region. The numerous islands are similar in appearance, and in the character of their fauna and flora. Diversity results from the wide differences in historical background, in pattern of political development, and in natural resources.

Almost none of the present peoples of the Caribbean are descendents of the original inhabitants. Caribs, Arawaks and other indigenous peoples have nearly been wiped out. They have been replaced by descendents of Europeans of many nationalities, and descendents of African slaves. In most countries at least 90 percent of the citizens are black and in some of the countries this proportion is much higher.

The population density in some countries of the Caribbean is among the highest in the world, with Barbados showing the third highest of any country. Food is therefore a problem, and this is made more difficult by the fact that the soil on many of the islands is not especially productive, and that a substantial proportion of the region is mountainous and unsuitable for growing food plants, and even more unsuitable for raising animals. As a consequence of this, and of the low level of buying power, animal protein, the scarcest and therefore the most expensive kind of food, is in damagingly short supply. The Caribbean people are relatively large consumers of fish and spend an important part of their scarce foreign exchange to buy fish from other nations.

Under these circumstances it is natural that great interest is evinced in the possibility of increasing the supply of animal protein from the sea in the form of fish and other seafoods. The enormous water areas seem to promise vast quantities of fish, and it appears unnecessary that substantial proportions of the supplies of seafood should be imported.

It is therefore of more than passing interest to examine the Caribbean region for its potential to produce greater supplies of food from the sea. Besides measuring this potential, it is necessary to pay attention to political,

social and economic aspects, since these determine whether whatever fish is available can be transported, marketed and purchased by the people of the region.

The Caribbean Sea (see map pages 8, 9) is a semi-enclosed part of the Atlantic Ocean. It has been called the "American Mediterranean" since it is bounded on the west and south by South America and is partly enclosed by the Antilles, an extensive island chain to the north and east. The term is not especially appropriate, however, since the Caribbean is by no means as enclosed as the Mediterranean, having many passages to the Atlantic between the islands. Furthermore, the deep water of the Caribbean is well oxygenated in contrast to that of the Mediterranean, where adverse bottom conditions reduce animal populations.

The Caribbean Sea is bounded by nine continental countries stretching from Mexico to Venezuela. For the purpose of the present discussion three other countries, Guyana, Surinam and French Guiana, are included since they are closely linked to the rest of the region economically and politically. Caribbean countries also include a very large number of islands of various sizes. These can be divided in several ways. The Greater Antilles in the northern part of the chain, including the large islands of Cuba, Jamaica, Hispaniola (containing Haiti and the Dominican Republic) and Puerto Rico. The Lesser Antilles, forming the eastern boundary of the Caribbean Sea, include a large number of relatively small islands. These stretch from the Virgin Islands to the east of Puerto Rico down a sweeping chain to Grenada. Below this chain are the islands of Trinidad and Tobago, adjacent to the Venezuelan coast. The Bahamas, while geographically outside the Caribbean, are often included in the region because of historical and economic ties.

The Lesser Antilles are divided into the Leeward Islands, from Martinique Passage north and east to the Virgin Islands, and the Windward Islands from the Martinique Passage south. In addition, islands stretch from Trinidad westward. These include some belonging to Venezuela and Colombia, and the Dutch Islands of Curacao, Bonaire and Aruba.

The Caribbean region is large, occupying from 800,000 to 1½ million square miles, depending on what is included. It lies between 60° and 92° west longitude and 8° and 24° north latitude and it is thus entirely in the tropics. Its length, east to west, is some 1,600 miles, and its width, north to south, varies between 400 and 800 miles. The countries of the Caribbean are characteristically mountainous.

The political history of the Caribbean is complex. Most of the continental countries of Central and South America adjacent to the Caribbean have been independent for many years. They are all of Latin American origin with the exception of British Honduras, and even this country exhibits a heavy overlay of Latin culture. On the other hand, many of the island countries have northern European or United States attachments, having been colonies of Great Britain, France or the Netherlands. Most of these have become independent in recent years.

Many of the former British colonies retain ties with Great Britain as members of the Commonwealth, but most are independent of foreign ties, and are members of the United Nations in their own right. Former French colonies like Guadalupe and Martinique have close relationships with France, and are actually Departments of the parent country, with representatives in the French

parliament. A similar kind of arrangement applies to former Dutch colonies: St. Maartin, Saba and St. Eustatius in the Leeward Islands; Aruba, Curacao and Bonaire opposite the coast of Venezuela; and Surinam on continental South America have representation in the Netherlands parliament. Islands which have been independent for many years include Cuba, Haiti, and the Dominican Republic.

The diverse cultural and political backgrounds of the countries of this region make it difficult to categorize, or to treat them as a social, economic or political unit. This makes any kind of development, whether of fisheries or of other sorts, more difficult.

The early history of the Caribbean region adds another complication. The Negroes of the region, the descendents of African slaves, do not have a sea-faring tradition; in many cases they dislike and fear the ocean, so that fishing is not a favorite occupation. This has had its impact upon the development of fisheries.

There are a few exceptions to this. For example, the inhabitants of the Cayman Islands are largely British, being descendants of sailors from British ships. These people are famous seamen and fishermen, and even today supply crews for merchant ships and fishing vessels around the world.

The shoreline of the Caribbean is typical of the tropics, consisting of long straight beaches backed by lagoons, extensive mangrove forests, and low-lying swampy regions. Offshore are coral reefs, some of them very extensive.

One of the characteristics of parts of the ocean with high production of fish is the presence of extensive areas of shallow water, since it is in the shallows that nutrients accumulate, and light can penetrate to support photosynthetic production of plant material. The Caribbean lacks extensive areas of shallow water. Half of the water area is over 2,000 fathoms in depth and four-fifths of it is over 1,000 fathoms. The deepest part of the Atlantic, the Puerto Rico Trench, plunging to 30,184 feet, is in the Caribbean.

Water temperatures in the area are high, with the overall annual average being about 27°C. The minimum occurs in February, at about 25.5°C and the maximum in September at about 28°C.

There are considerable gaps in our knowledge of the chemistry of the Caribbean region. The zone of maximum salinity is about 400 fathoms. The maximum zone of phosphates and nitrates, the principal chemical elements influencing production, occur between 300 and 500 fathoms, usually about 400 fathoms. The lowest phosphate concentrations at the surface of the sea are in the central area, and in this region they are less than 0.1 ug atoms/liter. These values are highest in the southwest and the east, ranging from 0.1 to 0.5 ug atoms/liter. Carbon values are estimated at 0.7 to 59 grams of carbon per square meter. Yearly net production of carbon ranges from something over 400 grams to about 1,000 grams of carbon per square meter in the bays; the values in the open ocean range from about 20 to 100 grams of carbon per square meter.

It is the opinion of some biologists that the overall phytoplankton production in the Caribbean Sea is greater than has been stated in the past. For example, the Australian phytoplanktologist, Ferguson Wood, who spent some years at the School of Marine and Atmospheric Science at Miami, states that the Caribbean is "as productive, or possibly more productive, than the Antarctic on an annual basis in terms of phytoplankton." However, since this

production is spread over the whole year rather than occurring in short seasonal blooms, it supports less zooplankton and other animals in the food chain at a given time, and as a consequence there are significantly smaller populations of exploitable fishes.

The general lack of seasonal maxima in phytoplankton production in the Caribbean is a consequence of thermal stability. Except in some isolated local areas, a warm layer of water persists above the thermocline, with cooler nutrient-laden water lying below. This stratification is not broken in spring and autumn as it is in temperate regions, and as a consequence nutrients are never brought to the surface where they can support the production of plants by photosynthesis.

Among the relatively small local upwellings the most pronounced occurs off the coast of Venezuela, particularly in the Gulf of Carioca. This is induced by tradewinds, which are most intense from December to April. Another upwelling occurs on the Campeche Bank.

Nutrients are supplied to the euphotic zone in the Caribbean to a significant extent by transport by surface currents. This is especially true in the eastern part of the region, where currents sweep past the Guianas and into the Caribbean Sea proper carrying loads of nutrients from the Amazon, Orinoco and other rivers.

The current system of the region has its roots in the South Equatorial Current which strikes the South American continent about at its easternmost extension. This current splits, with one part sweeping up the northern coast of Brazil and past the Guianas. The other part proceeds south as the Brazilian Current, carrying warm tropical water the full length of Brazil and to areas off Uruguay and Argentina.

Off Guyana, Surinam and Cayenne (formerly British, Dutch and French Guiana, respectively) the northern extension of the South Equatorial Current is joined by large quantities of fresh water from the Amazon and (to a lesser extent) the Orinoco River, sweeping past the coast and carrying nutrient material.

The Guiana Current, a branch of the South Equatorial Current, flows into the Caribbean Sea, entering mainly through three passes between Grenada, Trinidad, Tobago and the Venezuelan mainland. Some of the enrichment of the runoff from South American rivers and from the wind-induced upwelling off the coast of Venezuela influences the southern part of the region. Overturns of deep water, produced by islands or shallow banks, increase productivity in other areas, but for the most part standing crops are small.

Off Mexico a continuation of the North Equatorial Current pours immense quantities of water between the Yucatan Peninsula and the western end of Cuba. Depending upon the season, this either sweeps around Yucatan and flows west and north along the coast, or forms a large counter-clockwise eddy with its northern portion about off the port of Tampico. This surface water is not especially rich in nutrients.

Recently a massive undercurrent, comparable to the Cromwell Current of the Pacific, has been found flowing eastward in the Caribbean. About 30 million cubic meters per second pass from east to west.

In addition to their effect on mixing and thus on nutrients, winds have considerable direct effect upon the production of fish in the Caribbean. The region is characterized by strong northeast trade winds over much of the year

which affect the fishing activities of small vessels. Hurricanes occur from about June through October, and in many areas these effectively prevent fishing at that time of the year. Even if considerably larger vessels were used, their fishing operations would be restricted by these storms.

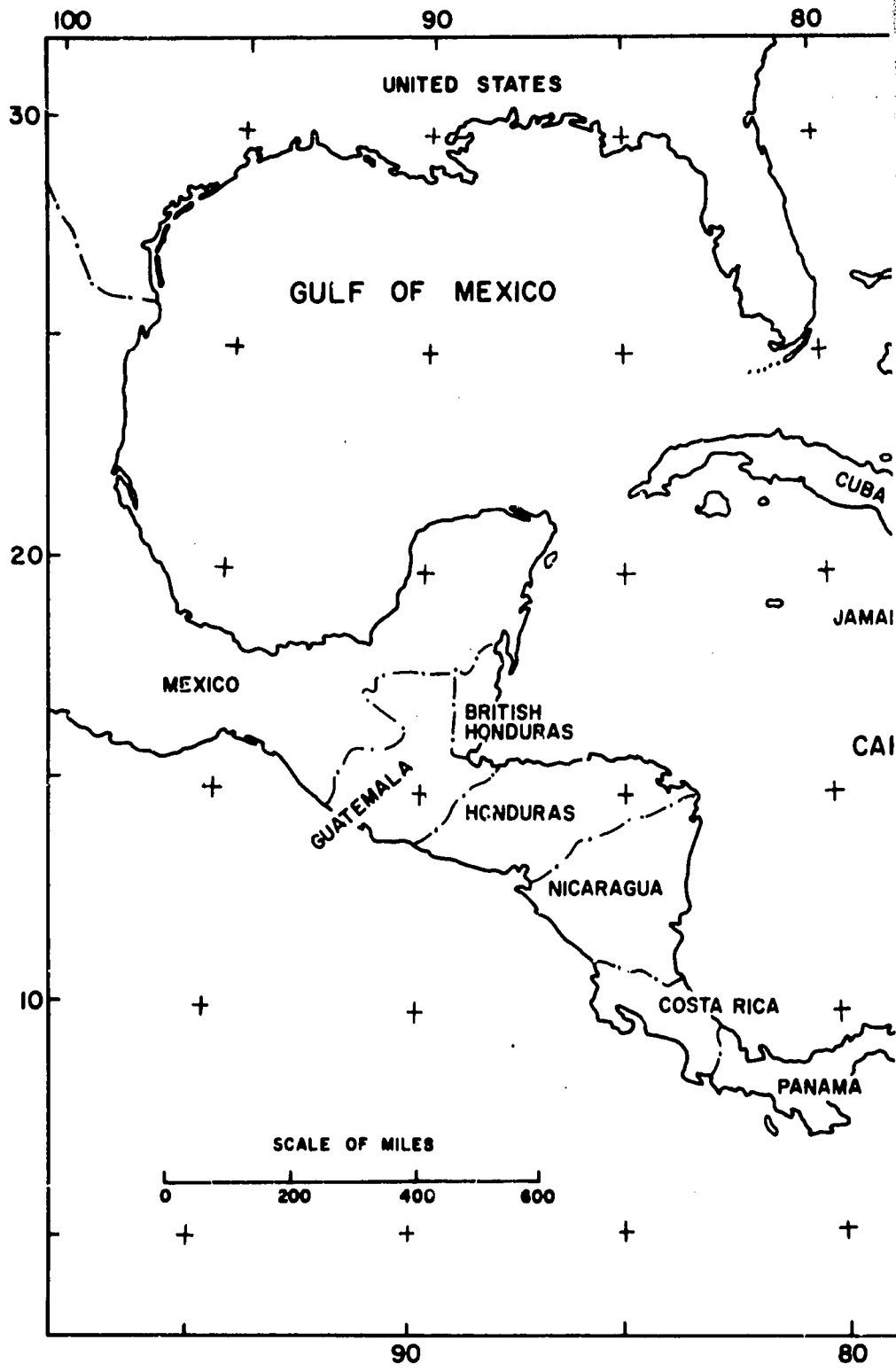
None of the countries of the Caribbean region is a major fishing nation. The estimated total production of fish from the Caribbean islands for the years 1964 to 1969 rose from 108,000 to 188,000 metric tons. The northern South American countries landed 175,000 metric tons in 1964 and 220,000 in 1969.

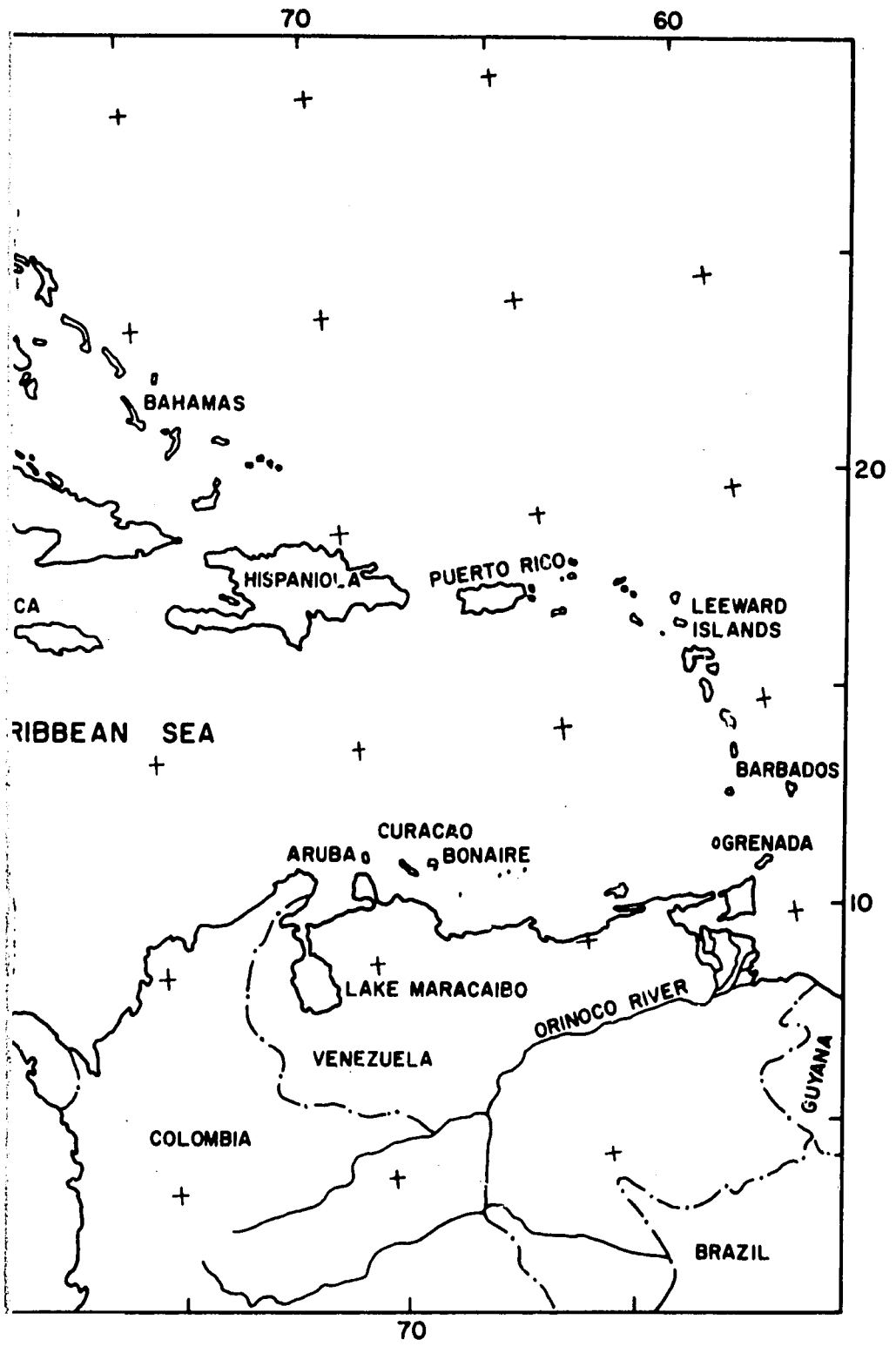
Fish landings for the region and for most countries within the region have risen slowly in the years recorded; however, no substantial gains in any part of the area have been recorded. The Caribbean area represents only 0.2 percent of the world fish production.

Since the whole region lies within the tropics, the species of fish and shellfish caught are typical of tropical seas. The species are similar all the way from Florida to Brazil. The fish present are reef fishes, estuarine species, or "blue water" pelagic species. On the reefs, a bewildering variety of fishes exist, and many of them are caught for food: wrasses, triggerfish, squirrelfish, angelfish, grunts, moray eels, groupers, jacks and many more. In the estuaries the catches consist of croakers, weakfish, grunts, catfish, groupers, snappers, mojaras, snook, mullet, jacks, barracuda, and pompano; and clupeids such as anchovy, sardines, thread-herrings, and tarpon. Sharks are common and are harvested in some areas. In the open sea, some albacore, bonito, bluefin and yellowfin tuna are captured, as are sailfish and marlin. In some areas flying fish, Spanish mackerel and king mackerel are caught. Shrimp and spiny lobsters are among the most valuable of the marine resources of the region; and clams, oysters, arc shells and a few other molluscs are harvested as are a small quantity of octopus and squid.

The information about the fish resources of the Caribbean has increased greatly in recent years. The most fruitful source has been the extensive investigations of the Food and Agriculture Organization (FAO), United Nations Development Programme (UNDP) Caribbean Fishery Development Project. Since its establishment in 1963, other UNDP projects have come into operation, including the Central American Regional Project and those in Mexico, Venezuela and Colombia. The Caribbean Fishery Development Project was approved by the UNDP Council as a four-year project in 1963. The project did not become operational until 1965 because of delays in securing approval by the numerous member governments. The UNDP supplied over \$1¼ million for the project, while funds from the participating countries were nominal. The project was to have been completed by August 1969, but when it became apparent that the work could not be finished, the time was extended for two years. The project consisted of exploratory fishing, marketing and training investigations.

The exploratory fishing was designed to test the extent to which fishery resources could be exploited if proper techniques were used. For this purpose five vessels were planned, but inadequate funds reduced this number to three. Two of these, the *Calamar*, which is based in Bridgetown, Barbados, and the *Alcyon* in Kingston, Jamaica, are 82 feet long and were built in Japan. The third, a 56-foot vessel, the *Fregata*, also based in Bridgetown, was built in Britain. These combination-style vessels are used for several kinds of fishing.





Among the extremely varied fishery resources shrimp is by far the most valuable. These are caught in substantial quantities off some of the countries of Central America, off Colombia, and off the Guianas. The latter grounds constitute some of the most productive shrimp grounds in the world. They have been fished by American vessels since the 1960's, and at present fleets from Japan and Cuba are also operating there. In 1965 over 50 million pounds were harvested and in recent years catches have been even larger. The very extensive Guiana shrimp grounds occupy the continental shelf between the Orinoco and the Amazon Rivers.

Shrimp support the most valuable fishery in Venezuela. Most catches are made in Lake Maracaibo and the Gulf of Venezuela; 134 trawlers and about 2,000 small boats take part in these fisheries; 4,780 metric tons were produced in 1967. The Venezuelan shrimp fishery began in 1958, and after high catches encouraged a doubling of facilities in 1965, production dropped. The stocks may be overfished, and in addition there is some alarm over the possibility that cutting the sill between the Gulf of Venezuela and the lake may adversely affect the extensive nursery grounds in Lake Maracaibo.

Apparently no large stocks of shrimp remain undiscovered in the Caribbean region, and nearly all the present fisheries are operating at their maximum level.

Great interest was evinced during the 1950's in the possibility of establishing major tuna fisheries in the Caribbean. This hope has not been fulfilled, although a small industry exists in Venezuela, and Puerto Rico constitutes a major center of tuna canning. Annual landings of tuna in the Caribbean now average about 29,000 metric tons. Most of this is caught on longlines, by Japanese and Venezuelan vessels; yellowfin, bluefin, and bigeye tuna, and albacore are caught. Large Japanese longline vessels operate for short periods in the Caribbean but this fishery apparently cannot be conducted on a sustained basis.

In the Venezuelan tuna fishery about 40 vessels operate. Yellowfin tuna constitutes 60 percent of this catch. The source of these fish seems to be the Atlantic, and individuals spill into the Caribbean intermittently and unpredictably. Catch rates have fallen in recent years, and it is believed that the maximum sustainable yield can be harvested by about 10 million hooks, or half the recent fishing effort.

A second type of tuna fishery operates near shore, principally from Cuba and some of the Lesser Antilles. Species which are labelled "bonita," but which are really skipjack and blackfin, are caught by trolling and by live-bait jackpole fishing.

Additional local fisheries could be sustained on blackfin tuna, which are moderately abundant in the area. They are found throughout the Archipelago of the Antilles, especially on Pedro Bank, Seranillo Bank, and off Jamaica and Haiti.

Systematic exploration by the National Marine Fisheries Service, using airplanes and surface vessels, made sightings of 27 schools of various kinds of tunas in six days between St. Lucia and Trinidad in one period, and 52 schools in 18 days between March and April west of St. Vincent in Grenada on another occasion. It is the opinion of these biologists that the resource is large enough to support a commercial fishery. However, fishing trials for tuna by the Fishery Development Project have been disappointing. Longline

catch rates have averaged about 1.5 fish for 100 hooks, which is much lower than rates in commercially successful fisheries. In addition, considerably larger vessels would be necessary, and it is highly unlikely that these would be financed unless prospects were better. Longlines do not work for skipjack which is the most abundant tuna in the area nor for most other species. Finally, longline fishing is being abandoned worldwide because of the high labor cost, so it does not appear to be a promising industry in the Caribbean.

Snappers, groupers and grunts provide a fishery common to nearly the whole region. These species are relatively easy to catch using inexpensive gear—hook and line and traps. Consequently, nearshore banks have been overexploited, and their yield is now small in many cases. Considerable potential for snappers and groupers exists, however, offshore and in deeper water.

The most abundant species are the Caribbean red snapper, *Lutjanus purpureus*, blackfin snapper, *L. buccanella*, and the silk snapper, *L. vivanus*. These are most abundant in depths of 50 to 70 fathoms, and they occur up to 150 fathoms. In shallower water the *L. synagris* and the yellowfin snapper, *Ocyurus chrysurus*, and many species of groupers and grunts occur.

In the early 1960's an FAO master fisherman, Erling Oswald, showed that primitive gear fished from dugout canoes was not exploiting the snapper and grouper resources except in shallow water. He introduced mechanical reels, pots, and trotlines and showed that catches could be increased substantially. He introduced the idea of mother-ship operations, where a vessel 60 to 70 feet long carried fishermen with smaller boats to a promising fishing ground, collecting and icing their catch for return to port. Several banks south and west of Jamaica, including Pedro Bank, Walton Bank and Rosalind Bank had been relatively unexploited until this time. Since then the FAO/UNDP project, using the exploratory fishing vessel *Alcyon*, has experimented with mechanical reels and other devices, as well as an extension of the mother-boat technique, to banks around Jamaica, the Dominican Republic and other areas. Five to ten times the present catches of snappers and groupers are believed possible in Jamaica, and even higher proportional increases in the Dominican Republic and Puerto Rico. The total potential for the Caribbean region of these species is estimated to be 41,000 tons compared to a small fraction of that at the present time. These populations are subject to rapid overfishing however, and careful control of the exploitation is required.

Roller-rigged trawls have been tested successfully in some limited areas for the catch of snappers and groupers, and mid-water trawls might be used for the silk snapper. Areas where these gears are possible are the Honduran-Nicaraguan shelf, off the Colombian coasts, and off the banks south of Cuba.

Recent exploratory fishing cruises by the FAO/UNDP vessel *Alcyon* from August to October 1970 off the Honduras and Nicaraguan coasts averaged 2,800 pounds per fishing day. The catch consisted mostly of yellowtail snappers and of jacks. From October to December 1970 the FAO/UNDP vessel *Calamar* conducting exploratory fishing off the northeast coast of South America, from Guiana north to Trinidad and Tobago made substantial catches with electrical-powered snapper reels. Eighty-one percent of these were of snappers, mostly the Caribbean red snapper, *Lutjanus purpureus*, and 15 percent of groupers. An experienced snapper fisherman from west Florida termed the potential of this area excellent.

Sardines, thread-herrings and other species of clupeid fishes offer the most substantial untapped resource of the Caribbean. At present only Venezuela has an established fishery for these species. The catch of sardines, *Sardinella anchovia*, in eastern Venezuela, constitutes the largest fishery of that country in tonnage caught, comprising 30 to 40 percent of the nation's landings by weight. The average catch of the last several years has been about 40,000 tons a year. This catch has been mostly in the Gulf of Carioca, one of the major regions of upwelling in the Caribbean. Peak fishing months are usually from January to April, but there is much variation in this. The fishing method used is the beach seine, a primitive but efficient gear. It yields an average per man of about 200 metric tons per year. The fish are mostly canned and are marketed in Venezuela which is the fourth or fifth largest producer of canned sardines in the world.

There appears to be a good possibility of increasing the yield of this fishery, perhaps with improved fishing gear. Some trials have been made with purse seines but as yet the results are inconclusive. It may be using lights with purse seines will prove efficient.

According to many observers there are very substantial populations of other species of clupeids in the Caribbean, now largely unexploited. These fishes are widespread in occurrence, they exhibit rapid growth, and they are basic plankton feeders. Thus they represent an opportunity to exploit lower levels of the food chain in the Caribbean waters.

The principal genera include *Opisthonema*, *Sardinella*, *Harengula*, *Cetengraulis*, and *Anchoa*. Small quantities of clupeids are caught in many parts of the Caribbean by beach seine. But on many of the islands there are very few beaches which permit beach seining. The National Marine Fisheries Service vessel *Oregon* tried night lighting and fish pumping. Submerged lights of 1,000-watt power in one to four units were used to attract the fish, after which they were pumped aboard in a 6-inch diameter pipe with a 1,500 gallon-per-minute fish pump. It was found possible to attract several species to the light if appropriate intensities were used. Some jacks respond in a similar fashion. Intense concentrations accumulated, and the fish could be pumped aboard the vessel. The highest rate of catch was near Grenada, where 234 pounds per hour of anchovies and sardines were captured on one occasion.

The bottom living species around the islands of the Caribbean can only be caught by handlines or pots, relatively inefficient kinds of gear. Most of the species in these regions feed on sandy and grassy areas adjacent to reefs and shelter in the reefs during the daytime and other non-feeding periods. Many of these populations are local and self-contained and therefore quickly overexploited.

The demersal stocks of the continental shelf of South America constitute a far larger potential. They are dominated by the family Sciaenidae, the drums. This group includes the seatrouts, corvina, croakers and several others, and the catch is likely to include a large variety of fishes. This is in marked contrast to fisheries of some temperate regions, where the catch may be entirely of one species or overwhelmingly so. This simplifies the handling and marketing of the catch. In tropical fisheries much sorting has to be done, and many of the species are of small market value.

The richest fishing area of the Caribbean region is the shelf off the shoulder of South America, opposite the Guianas. Not only do substantial populations

of fishes exist there but the smooth, shallow bottom permits trawling, an inexpensive and efficient method of capture. The trawlable region extends from east of Trinidad southward at least to the mouth of the Amazon. This region is strongly influenced by continental freshwater runoff from the Amazon and the Orinoco, and at least ten other significant rivers.

Investigations began on the trawlable stocks as early as 1943, when White-leather and Brown carried out investigations on behalf of the Caribbean Commission to discover populations of fish which could be used by local inhabitants during the war. Exploratory cruises since then by American, British, Dutch, Venezuelan and other investigators have shown the region to be highly productive of commercial species. The FAO/UNDP project in later years has worked to extend the knowledge of these demersal fishes, and to carry out commercial trials to determine the extent of the resource and to catch fish for marketing. For example, from June 1957 to August 1958 cruises by the *Calamar* from eastern Venezuela to French Guiana caught sizeable quantities of marketable fish by trawl. Forty percent of this catch was of sea-trout, *Cynoscion virescens*, averaging 3½ pounds apiece; 10 percent was of croakers, mostly *Micropogon furnieri*, of 1 pound average; 18 percent was a mixture of a very large number of species. Catch rates were best off Surinam and second best off Guiana. These and other cruises have shown that a substantial resource exists out to about 25 fathoms.

Other trawlable areas in the Caribbean region are so small as to be insignificant. A few trawl fish are caught in the Gulf of Venezuela, and in very limited regions elsewhere in the Caribbean. Hence the Guiana Banks are the only areas where substantial quantities of fish can be caught by Caribbean boats. Countries as far away as Puerto Rico could operate profitable fisheries on these stocks. Despite its relatively large size, this resource is smaller than the big temperate water fisheries. The resource is presently underexploited, but it is not unlimited, and study of the population dynamics of the species supporting it is required before intense fishery endangers the stocks.

One of the grossly underexploited resources of the Caribbean is squid. There are six species of commercial value in the region, as well as four species of octopus. Squids are presently caught only incidentally. No specialized gear is employed and no market has been developed. It is believed that very large stocks of squid exist for which methods of fishing and markets could probably be developed.

Sea turtles were once an important fishery resource of the Caribbean. Countries like the Cayman Islands were commonly visited by vessels to replenish their stocks of fresh meat with turtle meat. It has been a great many years, however, since any substantial turtle fisheries have existed in the region, and some species are now in serious danger of total extinction. Over-exploitation is leading to rapid disappearance of the green turtle, *Chelonia*. The principal remaining spawning beach at Tortuguera, Costa Rica, showed one sixth the number of spawners in 1968 as in 1965, the "cycle year." The only other nesting area of any importance is Aves Island off Montserrat. Attempts have been made to restore green turtle populations by release of hatchery-raised animals, but so far no positive results have been noted. Unless some aggressive action is taken to protect the spawning turtles in Costa Rica it seems likely that this resource will disappear entirely.

Mollusc resources of the Caribbean are not large. The queen conch is of local importance in some areas, including the Bahamas, but the total yield is

insignificant. Edible oysters, *Crassostrea rhizophorae*, usually called mangrove oysters, occur throughout the Caribbean. These are so small that they are not very useful commercially, although they are eaten locally. A culture industry for this or other species of oysters is possible, however. This has been tried in Venezuela with inconclusive results. The mussel, *Perna*, is another shellfish resource, now of minor importance, which could be encouraged. Mussel culture, based on the Spanish method, has been tried in Venezuela, but so far it has been a failure, apparently for mechanical reasons. The rafts supporting lines on which small mussels were attached for growing were destroyed by marine borers. There is a market in some countries of South America for mussels which would justify their culture.

The pearl oyster supported the famous pearl fishery, now nonexistent, on the island of Margarita near Venezuela. The decline is the consequence of over-fishing and the collapse of the market for natural pearls, following the success of artificial culture in Japan. It is possible that an artificial pearl industry could be developed in Venezuela, although the market does not encourage this. This oyster is edible and a small fishery could be developed to exploit it.

The spiny lobster, *Panulirus argus*, is one of the most valuable and highly sought species in the Caribbean. The largest fisheries for spiny lobsters are in the Bahamas, Cuba, British Honduras, Nicaragua, Puerto Rico, and Jamaica, although small quantities are caught in nearly every country of the region. The market for these is so strong that continuous efforts are being made by buyers to find new sources. It appears that no large unexploited populations of spiny lobsters exist in the area, however, unless there are some off the Caribbean coast of Panama or off some areas of Colombia.

Exploratory fishing operations by the FAO/UNDP project have uncovered no substantial new fishery resources. They have, however, greatly increased the knowledge of the stocks of demersal fishes off the Guianas, and have shown that these could be caught profitably by boats operating as far distant as Puerto Rico.

The project vessels have also caught fish to be used in the marketing programs which placed emphasis on demonstrations and improved methods for the handling and distribution of fish, both for domestic markets and export. Marketing problems in various countries differ greatly. In Trinidad, Guyana, and Surinam, for example, it is largely a question of providing distribution facilities for trawl fish. In other areas one must deal with seasonal gluts and encourage trade between groups of countries to promote a more constant level of supply. Export possibilities seem to be good for flying fish, and certainly for shrimp and lobster.

The project attempted to show how profitable operations could be established and run by private investors. Demonstrations of commercial operations were conducted. In Barbados a project was organized and operated for six months through the Barbados Marketing Corporation to show how monthly landings from *Calamar* or fish from the Guiana Banks could be handled. It showed that consumers were willing to buy iced fish from retail outlets, contrary to the tradition that iced fish were unacceptable in this region. As a result trawlers come into Barbados to supply the market on a regular basis, although in recent years political problems have interrupted this trade.

Attempts to promote and encourage marketing in Trinidad were largely unsuccessful because of the complete lack of facilities on which this kind of

work must be based. Before marketing can expand in Trinidad, and in a large number of other islands in the region, marketing machinery must be established.

One of the handicaps the Caribbean faces in developing its fisheries is the lack of cooperation among the several governments. Some years ago cooperation was attempted on a large scale with the establishment of the Federation of the West Indies, a group of former British colonies. Cooperation could not be sustained, however, and the federation dissolved in 1962. In recent years the Caribbean Free Trade Association, CARIFTA, has been organized, and this may have a considerable impact on trade in fish as well as other commercial exchanges among the countries of the region. The new tariff regulations will enable free landings of fish among member nations, and this may break down some of the barriers which prevented development of the fisheries in the region.

One of the major objectives of the FAO/UNDP Fishery Development Project is the training of fishermen and fishery officers. Master fishermen were to be trained in modern fishing technique, in handling and navigation of larger vessels, in the operation and maintenance of engines, in the manufacturing and maintenance of fishing gear, and in fish handling. The training of fishery officers was to include instructions in exploratory fishing, fishing methods, preservation, transportation and marketing, and was to emphasize the practical aspects of development. Training was to take place aboard the exploratory fishing vessels and through shore-based course work. It was hoped that the trained fishermen would be able to return to their own countries and apply their knowledge to particular fisheries problems.

Soon after the project started, however, it was apparent that it was not realistic; an eight-month training period was far too short to attain the master fisherman or skipper proficiency hoped for. As a result, the training of fishermen became the objective. But it was found difficult and inefficient for both purposes to use vessels for training while they were attempting to conduct exploratory fishing trials. Fishing operations were hampered by having the novices aboard, and the men themselves did not gain the necessary experience. Furthermore, training at sea has not provided the type of experience the fisherman is likely to need at home.

Standards for trainee acceptance were lowered to get representation from all the countries and territories participating in the project, and nominations by participating governments were sometimes inadequate. The training operation has therefore had to be recast, and it is hoped in the future to train more young men on commercial fishing vessels and separate exploratory work from training to increase the efficiency of both operations.

The Caribbean countries are now pushing hard for the continuation of fishery development after the termination of the FAO/UNDP project in 1971. The United Nations staff has prepared several proposals involving assumption of responsibility for the work by the countries themselves. The countries would like major responsibility and financing to be continued by the United Nations or other outside agencies, and it is doubtful that UNDP will agree to this.

Because the Caribbean area has enormous expanses of water does not mean that it automatically has very large stocks of exploitable fishes, enough to support major commercial fisheries. Thus, the major question asked of the

FAO/UNDP project seems to have been answered in the negative. This means that major commercial fisheries, such as those that exist in temperate zones, cannot be sustained, with the exception of the existing trawl fisheries off the Guianas.

Nonetheless, localized fisheries of economic importance can be supported, and these will supply local regions with additional quantities of food and income. The new information supplied by the FAO/UNDP project and by other investigations will not only increase the ability of fishermen in the regions to make these catches, but perhaps even more importantly will encourage the development of marketing machinery and the use of fish in the region.

The most vexing fishery problems of the Caribbean which still remain to be solved are social and economic. Money and effort have been wasted because the region lacked the necessary marketing and other social structures to make the best use of its resources. Most of the countries are too small to develop efficient, workable systems by themselves, and any scheme which encourages development of cooperative marketing distribution programs will be of great benefit. Transportation and communication among the countries of the Caribbean is difficult and only careful planning can overcome this.

One of the principal problems is the shortage of trained people, not only to carry out the fishing and fish-marketing functions, but to administer fishery development programs and to perform the necessary research on conservation, fish processing and related matters. The FAO/UNDP project has made a good start and any future programs would be wise to concentrate on these aspects.

The old aid pattern of supplying transient foreign experts has proved ineffective; future work will require long-term, on-the-spot residency by whatever visitors are brought into the region. Even the training of local peoples in areas outside the region should be carried on sparingly. It would be preferable to conduct the training in the home country.

It is important for the future to encourage the people of the Caribbean area to commit their own time and money to the fisheries programs. It is from development of their own skills and resources, rather than from outside technical assistance and money, that lasting benefits will accrue.