

6. Females captured late in the egg-laying season frequently carry the reduced number of eggs. The waxy substance on the annulus ventralis, believed to be the spermatophore, is almost completely expended at the time of the second laying.

The number of eggs deposited by the Spiny Lobster *Panulirus argus* (Latreille) 1804 has been previously estimated by other scientists. Crawford and De Smidt (1922 p. 307) have estimated that a female with a carapace length of 3½ inches (about 10 inches total length) carried an estimated 500,000 eggs. Those having a 4 inch carapace length laid an estimated 700,000 eggs. Such a specimen would be about 11½ inches in total length. These results were obtained from Southern Florida specimens. Smith (1948, p. 15) states that the number varies with the size of the animal and that a 9 inch specimen laid about 500,000 eggs. These also were computations on Florida and Caribbean specimens.

My results on the Bermuda race of lobster vary from the condition stated above. Computations were made by counting the eggs in one gram (9988 eggs) and multiplying this by the total weight.

A spiny lobster 10 inches long produced 669,196 eggs at one laying. Another, 12 inches long, laid 1,118,656 and a third, 15 inches long, laid 2,566,916 eggs. A 13 inch female tagged spiny lobster known to have laid at least once, produced 1,008,788 eggs on the repetition or second laying, the number being less than at the first laying.

On the basis of the foregoing it would appear that a 15 inch female might lay in excess of 4,000,000 eggs in one season.

The smallest female observed carrying eggs was 9 inches long. During the trapping operations in July virtually all females of varied sizes carried eggs. This seemingly indicates that the females lay eggs annually instead of every other year as has been suggested by some students of the species.

The number of eggs produced by the various length groups has a direct bearing upon the conservation of the species. A conservation measure which would save one 15 inch female would be equivalent to saving four 10 inch specimens.

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The Marine Fisheries Of The Caribbean

GERALD V. HOWARD

Fisheries Division, Food and Agriculture Organization of the United States

INTRODUCTION

IT IS THE INTENTION of this paper to give a general picture of the marine fisheries of the Caribbean region. Attention is focused on the islands of the Caribbean (the Greater and Lesser Antilles), the territories of Central America, and the countries of South America bordering in the Caribbean Sea. The infor-

mation contained herein is based on published reports and information collected by staff members of the Fisheries Division of FAO. Most of the published material appears in papers of the United States Fish and Wildlife Service and the Development and Welfare Reports of the British West Indies.

The Gulf and Caribbean Fisheries Institute is concerned with the fisheries of the Gulf of Mexico and the Caribbean Sea. The two regions are characterized by differences in conditions of productivity. What is more important, their fishing industries are in different stages of development by reason of the wider use of mechanized equipment in the Gulf of Mexico. Problems faced by the two regions are not the same. Discussion here is confined to the Caribbean, the lesser developed of the two.

Prior to World War II, large quantities of fishery products, chiefly salt cod, were imported by countries of the Caribbean. During the war, as the result of shortages of shipping, unavailable European supplies, diversion of North American exports and reduced European production, imports fell off sharply. It was evident then that local production of foodstuffs was of great necessity. A great interest in the further development of their aquatic resources was manifested by these countries and this has continued in postwar years. Assistance was received from the agencies of the United States Government and the British Colonial Service in the form of rapid fact-finding surveys of the fisheries and the fishery resources. More recently, the Food and Agriculture Organization of the United Nations, or FAO as it is familiarly known, has been requested by some member governments to assist in surveys and in planning fisheries development.

Any improvement in the utilization of the fisheries resources in this region will be a further step toward increasing world food production. It will also improve the local diets which are often deficient in proteins and will offer new industries and additional employment.

FISHERIES RESOURCES

Oceanography of the Area

Tropical and sub-tropical waters are not generally considered to be as productive as those of temperate regions. However, much remains to be learned in this connection. It appears that the concentration of nutrient salts, particularly nitrates and phosphates in the upper or photosynthetic layer, limits production of phytoplankton. These microscopic plants are the basic link in the food chain of all living organisms of the sea. Surface layers may be replenished with dissolved nutrient salts, by annual convection overturns, which return rich lower waters to the surface, ocean currents, upwellings, and river waters.

The Caribbean Sea, like the Mediterranean, consists of a number of more or less independent deep basins. The Caribbean consists of two deep basins with half the total area having depths of 2,000 fathoms or more and about four-fifths deeper than 1,000 fathoms. Fiedler et al. (1947) state that there is no regular overturn and that the water in the basins is static and stable. The flow of water into the Caribbean is restricted. Water from the Atlantic must flow through the narrow and shallow (in comparison with the Caribbean itself) passages of the Antilles. There are no great rivers flowing into the sea. Supplies of nutrient salts are obtained principally from the South Equatorial Current which sweeps along the coast of Brazil and the Guianas, picking up rich waters from the outpourings of the great rivers of this region. It flows into the Carib-

bean mainly through the channel between Trinidad and Tobago and continues along the coast of Venezuela, making this area of the sea productive. However, on reaching the central and western region of the Caribbean, its productivity decreases.

The continental shelf with depths of 100 fathoms or less is restricted to narrow coastal strips and small offshore banks. This limits the area available inshore for demersal species. Traditionally, the world's greatest fisheries have been carried on within the limits of the continental shelf.

Commercial Species

Species taken in the inshore waters include bottom fishes and also some pelagic species during certain times of the year. It is likely that the main populations of the latter are not within reach of the present fishing operations.

As is typical of tropical and sub-tropical waters, there are a multitude of species present in the Caribbean. Of more than 300 species which are taken commercially, 50 to 100 are commonly found in the fish markets. The relative importance of the different species varies from country to country, but the more important groups, in all countries, include groupers, sea basses (Family *Serranidae*), croakers (F. *Sciaenidae*), snappers, yellowtail, muttonfish (F. *Lutianidae*), and jacks (F. *Carangidae*).

The clupeoid or herring-like fishes occur in numbers, too, and are known to occur in large quantities close to shore. The only important fishery for these species now takes place along the coast of Venezuela where they appear to be most abundant.

Various other pelagic species, including members of the Scombriformes (tunas and mackerels), are taken in small quantities. They make up less than 10 per cent of the total catch in Cuba and the Dominican Republic. In Venezuela, the proportion is somewhat higher. The types of gear used do not capture great numbers. Flying fish (F. *Exocoetidae*) contribute largely to the catches of the Windward Islands of the British West Indies.

Of the mollusks and crustaceans, spiny lobsters (*Panulirus* spp.) and shrimps are the more important. The former occur practically throughout the Caribbean from the Cayman Islands catch them in the greatest numbers, though they are with considerable quantities taken in Cuba. Turtles are also present; fishermen fished throughout the area.

There are many indications that the fisheries of the Caribbean can be expanded despite the fact that the waters may be less productive than those of the temperate regions of the world, and the suggestion that certain preferred species have become less abundant in some localized areas. Recent increases in the Venezuelan landings (see Table I), which come principally from the inshore waters, indicate that these waters will produce substantially greater yields. While fairly intensive fishing may be carried on in some regions inshore, larger catches appear possible by opening new grounds and by making a greater range of species available. Present operations tend to concentrate on the preferred species. In addition, greater advantage could be taken of the seasonal abundance of certain species such as jacks and kingfish. These and other species occur in large schools close to shore for limited periods of time.

As present operations in the Caribbean take place within the confined area of the continental shelf, the offshore waters appear to offer great prospects for future development. In addition to sardines and anchovies, bluefin tuna, yellowfin tuna, skipjack, albacore, little tunny, bonito, frigate mackerel, mackerels, wahoo, marlin, swordfish and sailfish are reported. One FAO observer (U.N.

Mission to Haiti, 1949) has reported schools of pelagic species in various parts of the Caribbean; another states that purse seines are not used in the Venezuelan sardine fishery because they take too many fish for the capacity of the present industrial plants. Brown (1942), writing of the fisheries of Trinidad and Tobago, is optimistic of the commercial possibilities of schools of bonito which occur off the coast of Tobago. He also states (1945) that fishermen of the Windward Islands take species of tuna incidental to flying fish catches and that greater use could be made of the tuna group. Similar reports come from other parts of the Caribbean. Unfortunately, relatively nothing is known as to the size, regularity of appearance, and behavior of these schools. Much has to be learned about the distribution and abundance of the pelagic species before their future potential can be predicted.

COMMERCIAL FISHERIES OPERATIONS

Development

The history of fishing in the Caribbean shows, with few exceptions, that the methods used by the majority of the fishermen have not changed appreciably during the last several decades. Variations in the dug-out canoes, which range up to 30 or 35 feet in length, and the "dori" or keeled double-end canoe are the most common craft. Canoes are slowly being replaced by sailboats of approximately the same length but of greater beam, and to a lesser extent by powered craft. Most of the gear employed includes pots, weirs or traps, various types of gill nets, beach seines, dip nets, cast nets, and hook and line combinations—principally the single hook and line.

Cuba and Venezuela have more powered and larger sized craft than the other countries. Of Cuba's total fleet of 12,000 vessels, approximately 2,500 are engaged in full-time fishing (Fiedler et al., 1947, and Martinez, 1948). About one-third of the 2,500 are powered and the remainder use sails. One-tenth of the full-time craft are more than 5 tons. Several motor vessels of modern design have been introduced in Cuba within the last few years. Cuba also has a fleet of 50 or more vessels with an average length of 100 feet. Until recently, the latter vessels fished principally off the Mexican coast.

Venezuela has a program in progress, which began in 1947, to improve her fishing fleet and other sections of the fishing industry. The work is being carried on by the Venezuelan Development Corporation, a government agency. One of the first projects was to issue credits for the motorizing of 750 of the fleet which included 4,300 craft in 1947. Motors being installed in 1947 ranged from 9.8 horsepower outboards for the smaller craft of 12 to 18 feet to 42 horsepower marine engines for vessels of 40 to 50 feet. The program has now expanded to include the construction of larger craft and cold storage plants. Its purpose is to aid where it can in the development of the fishing industry. A private non-profit organization, the Basic Economy Corporation, is also assisting in this field.

The Caribbean countries fall into two groups with respect to the importance of the fishing industry in their economy. Fishing in Venezuela and the island territories contributes appreciably to the food production. The organization of the industry is more advanced in Cuba and Venezuela than it is in the other countries of this group. The second group, which includes Colombia and the Central American states, have few fishermen and have shown until recently little activity in developing their aquatic resources. Costa Rica is presently investigating the possibility of establishing a fishing industry.

Although all the Caribbean countries do not collect fish production statistics, the situation in this regard is better than most people realize. Many of the

countries supply estimates of production to FAO, while the Dominican Republic and Venezuela each report their catches by species. Cuba reports the Havana landings, which are the most important, by species.

Table I shows the most recent estimates of production available for each of the Caribbean countries, along with the average annual pre-war landings for some of them. Statistics for half the countries are based on information obtained by FAO and reported in the fisheries section of the preliminary draft of the Joint ECLA/FAO Working Party Report on Agricultural Requisites (1949). ECLA refers to the United Nations Economic Commission for Latin America. Where FAO statistics were not available, the writer used estimates given in various other publications. The reader is cautioned that production figures may include minor quantities from freshwater areas. Landings given for those countries which border the Pacific as well as the Caribbean include catches from both waters.

The island territories are the chief importers of salted cod and other products in the Caribbean. After the outbreak of World War II, imports became negligible. As these imports contributed largely to the total amount of fish consumed and because the island areas could have used more fish, it might have been expected that local production would increase. Although the over-all Caribbean production did become greater, increased landings were mainly limited to the two countries with the better organized industries: Venezuela and Cuba (see Table I). Fishing equipment used in the island areas was not capable of greater production and the number of fishermen did not increase. Venezuela and Cuba were able to increase their catches because they had organized industries, and a number of larger craft and more modern gear. Canning and salting absorbed the increased production. The most remarkable expansion has taken place in Venezuela. Ten years ago, most of the catch was eaten fresh. In 1947, about 17,500 metric tons, or less than 25 per cent of the total catch, reached the fresh market, the remainder being canned or salted.

The Central American countries have few fishermen in normal times. During the war, fishermen often found more remunerative employment in other industries. As the countries had adequate supplies of food from their agricultural resources, the fishing activities did not change.

Some of the Problems Involved in Future Development

Most of the countries are potentially capable of expanding their fishing industries. Recent developments in Venezuela and Cuba testify to this. However, it will be a slow process and many problems will have to be solved.

Generally, the people of Latin America are not by nature fishermen. The fishermen of the Cayman Islands are notable exceptions. The fact that the people are not traditionally seafaring retards fisheries development.

Trained personnel is required in all phases of fisheries, from fishermen to research workers. This basic requirement can be met by the organization of a small number of training centers, preferably within the area. As an immediate substitute, students can be sent to study in countries which have had more experience in fisheries matters. Such an arrangement should be temporary.

Marketing and distribution methods must be improved if greater catches are to be absorbed. Better transportation and storage facilities are required along with retail markets. Elaborate and expensive refrigeration plants are not suggested, but the wider use of crushed ice in the shipment of fresh fish could be of great advantage. Increased processing of fishery products would offer a

TABLE I
ESTIMATES OF PRODUCTION
OF THE FISHERIES OF THE COUNTRIES OF THE CARIBBEAN.
WEIGHTS IN METRIC TONS

| | Average Prewar (1935-39)** Weight | Year | Weight | Source for specific year |
|-------------------------|---|-------------|-----------|---|
| Bahama Islands | ..... | 1939 | 800 | Frank (1944) |
| Barbados | ..... | 1940 | 450 | UN Interim Commission on Food & Agriculture (1945) |
| British Honduras | ..... | 1942 | 230 | Fiedler et al. (1947) |
| Cayman Islands | | No estimate | | |
| Colombia | 1,600 | 1947 | 1,600 | ECLA/FAO** |
| Costa Rica* | 1,500 | 1947 | 2,200 | " |
| Cuba | 18,000 | 1947 | 21,100 | " |
| Dominican Republic | 330 | 1947 | 470 | " |
| French West Indies | ..... | 1940 | 400 | UN Interim Commission on Food & Agriculture (1945) |
| Guatemala* | 135 | 1947 | 135 | ECLA/FAO** |
| Haiti | 1,500 | 1947 | 1,500 | " |
| Honduras* | 135 | 1947 | 135 | " |
| Jamaica | ..... | 1944 | 5,500 | Thompson (1945) |
| Leeward & Windward Is. | ..... | 1945 | 6,900 | Brown (1945) |
| Netherlands West Indies | ..... | 1940 | 450 | UN Interim Commission on Food & Agriculture (1945) |
| Nicaragua* | 100 | 1947 | 100 | ECLA/FAO** |
| Panama* | 700 | 1947 | 700 | " |
| Puerto Rico | ..... | 1942 | 1,300 | Fiedler et al. (1947) |
| Trinidad & Tobago | ..... | 1941 | 850 | Brown (1942) |
| Venezuela | 17,800 | 1947 | 64,500*** | ECLA/FAO** |
| Virgin Islands (Br.) | ..... | 1945 | 200 | Brown (1945) |
| Virgin Islands (U.S.) | ..... | 1930 | 280 | Fiedler et al. (1947) |

* Estimate includes Pacific coast landings.

** Data presented in the preliminary draft of the Joint ECLA/FAO Working Party Report on Agricultural Requisites (1949).

*** Excludes canned fish production, mainly sardines. Lacking an accurate conversion factor, it is estimated that 8,000 to 10,000 metric tons of raw material were used for canning. Fish were first canned in Venezuela in 1943.

further means of absorbing larger catches. Processed products which are inexpensive and adapted to the tastes of the people should be developed.

The indigenous people of the Caribbean countries generally do not care for fishery products. They prefer meat. This is particularly true in Central America. Consumer education programs sponsored by the governments are necessary to encourage these people to eat more fish. Advertising programs of this type have proved successful in other regions of the world in increasing the domestic consumption of fishery products.

Present fishing methods and equipment can be improved. According to the ECLA/FAO report cited, the 6,300 fishermen of Iceland catch considerably more fish than the 135,000 or more in Latin America. Granting that the north temperate waters are richer in resources, the wide use of non-mechanized gear in Latin America is largely responsible for this great difference. The introduction of better craft and gear involves an outlay of capital beyond the means of most ordinary fishermen. Governments may be able to offer financial assistance in the form of credits or loans. Evidence of the effectiveness of such schemes has been shown, for instance, by the Venezuelan Development Corporation which has been instrumental in increasing fish production in Venezuela. Experimental fishing investigations would be extremely profitable in the determination of the most suitable craft and gear. International cooperation in such work would be beneficial and would avoid duplication of effort and keep

costs at a minimum. Any introduction of improved craft and gear must be gradual in order that the increased catch can be absorbed.

The effective expansion of fishing operations to include the offshore pelagic species, such as the tunas, involves large investments for mechanized boats and gear. Such enterprises cannot be expected until there are assured markets for the catches. Nevertheless, this field offers great possibilities. Government assistance and outside help in the form of technical knowledge and capital appear necessary before offshore fishing operations become extensive.

MANAGEMENT OF THE RESOURCES

Problem

The greatest need in the Caribbean is development and exploration. Agencies responsible for fisheries matters should give these problems the highest priority. They must be attacked with energy and imagination. The Caribbean people have the necessary talents. Recent advances in Venezuela testify to this.

Although development is the first essential, management plans must keep abreast with the former if the present and future fisheries are to maintain sustained yields. From the biological point of view, ideal management controls exploitation to allow recruitment and growth to be equal to the catch. Replacement would be equal to the catch. No fishery in the world operates under such an ideal situation. However, there are management programs which have permitted once depleted fisheries to rebuild and successfully maintain increased yields. Further research will probably determine the optimum yield. Theoretically, most fishery biologists are working toward such a goal. However, the approach is not always the desired one. It is unfortunate that many research programs become academic rather than practical.

Some of the Caribbean countries have agencies for fisheries matters and some issue regulations governing fishing practices, such as prescribing types of gear to be used and fishing seasons. Many of the regulations are probably useless and perhaps even harmful. Regulations formulated without proper knowledge of a fishery's requirements usually serve no useful purpose.

None of the Caribbean countries concerns itself, to any effective degree, with biological research. The fact that three countries collect landing statistics is encouraging. It is hoped that others will follow their good example. Venezuela, Cuba and Puerto Rico conduct some technological research. The initiation of developmental programs, particularly in Venezuela, testifies to the fact that the countries of the Caribbean realize their importance.

Immediate Requirements

Proper management programs cannot be instituted without recommendations based upon investigations by trained personnel. The basis of management is a knowledge of the relationship between recruitment and growth and the catch, and a knowledge of the life history of the species involved. The former should be given the highest priority. With numerous closely related species of the same families, neither phase of the problem will be simple in the Caribbean.

Although it is usually impossible to measure in numbers the magnitude of various populations of commercial species, it is possible to determine whether the population is increasing or decreasing. This can be determined by a system of catch statistics together with a record of the fishing effort required to take the catch, the area fished, and adequate sampling of the landings to determine size and age compositions.

Although neither the management nor the development of fisheries is easy,

as more advanced fishing nations have discovered, there is nothing involved which is beyond the capacities of the Caribbean people. The fisheries of the Caribbean have made an important contribution towards obtaining a balanced local diet. They are capable of much more. The exploitation and proper management of the resources of the sea offer a challenge to man's ingenuity.

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