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Marine Fisheries and Fish Culture in the Caribbean

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Marine Fisheries

A FIRST GLANCE at the Caribbean area reveals that there is much water and little land, about 1½ million square miles of the former and about 90 thousand square miles of the latter. Therefore, to the uninformed it would appear as if people who live in such an environment should have no difficulty in securing most, if not all, their proteins from the waters surrounding them. This, however, is not so. The reasons for the relatively low fish harvest from Caribbean waters are well known. First, there are those which stem from the economics of the region. The level of technology is low and we are dealing with an area in which many different nationalities practice varied kinds of administration. Secondly, there is the ecology of fish stocks to be considered. Most of the area has deep open water and the concentrations of fish in such waters are not dense. Also it is not known where these concentrations are or, for that matter, whether there are any. The marine fisheries of the Caribbean, with a few exceptions, are reef or bottom fisheries. This immediately changes the picture and makes the ratios of land and, therefore, of people to available fishing areas far less favorable. This does not apply to one large island complex, namely the Bahamas. There is some reason to hope, however, that the open waters of the Caribbean can and will be exploited much more fully in the future.

If we look at the world's scale fisheries, such as the menhaden fisheries of the Atlantic coast, the herring fisheries of the North Sea and the salmon fisheries and tuna fisheries of the Pacific Ocean, it appears that the concentrations of fish at the place of capture far exceed anything we can find even on the best populated reefs. It has been estimated that in such fish schools the capture is made from concentrations of about five to seven thousand pounds of fish per acre. Estimates of reef fish density have been made in two widely separated areas, one in Bermuda (Bardach, 1957) and the other by Odum and Odum (1955) in the Pacific. In both cases, the standing crop on shallow reefs was found to be surprisingly high, namely between four and five hundred pounds per acre. This includes all fishes and comprises many of non-harvestible size, so that a translation of these figures into yearly growth estimates of commercial fish would become far less favorable. Still, some of the best estimates available to date indicate that the fish growth on shallow reefs amounts to somewhere between 150 to 200 pounds a year per acre of isolated shallow reef, between 10 and 30 lbs. thereof may be larger carnivores. It should be added that these are rough estimates indeed, based on relatively few facts and many conjectures.

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On second thought, however, dense fish populations are to be expected on shallow reefs because these are essentially self-sufficient communities which produce much organic matter in situ. Their productivity per unit area is considerably higher than in adjacent waters or, for that matter, of any open marine areas. Shallow reefs resemble shallow ponds because in both the incident radiation reaches the bottom and can be utilized by attached plants. In fresh water these are flowering plants or green algae; on the reef they are predominantly brown, but also red and some green algae.

There is another characteristic of reef fish stocks which prevents their methodic exploitation at a highly efficient level. In a reef environment highly mechanized methods such as scoops or trawls of any kind are not usable and bottom-based nets are also out of the question. Even if the Caribbean fisheries had boats to employ such tools they could not be used on the fishing grounds presently frequented. There are, in addition, as in all tropical environments, be it a rain forest or a marine area, a great number of species with a correspondingly small number of individuals, compared to a more northern climate. Thus, we are dealing with many different types of fishes of varying habits. This in itself makes a streamlining of operations difficult.

Other characteristics of reef fish stocks should also be considered here. The food chains are eminently demersal; very few, if any, reef fishes feed on plankton. Therefore, they are tied to the bottom very much more than other types of fish and are comparable to the true bottom fishes such as the soles, flounders and the halibut. But they cannot be trawled.

Tagging of fish in the shallow reef environment in Bermuda (Bardach, 1957a) revealed that a fairly sizeable proportion of the fish make any one reef area its permanent home. Some migrations back and forth between reefs or different reef areas occur, but the smaller the fish the more likely it is to have a relatively circumscribed home range.

Since all species of reef fishes are exploited over most of the Caribbean area and since at times, the individual fish in the catch are very small indeed, overfishing in a reef situation becomes a distinct possibility. Some preliminary investigations by the past fishery advisor for the Department of Agriculture and Fisheries of Jamaica on the Pedro Banks bear this out.

But to turn to the restrictions of technology rather than those of biology: At present Caribbean fishermen have access only to areas relatively close to shore; rarely do they reach reefs deeper than 30 fathoms. Table 1 reveals that an extension of boat range to the 100 fathom line would, indeed, benefit the reef fisheries of many Caribbean islands. The exploitation of depths to 100 fathoms becomes possible with inboard diesel powered launches and, therefore, one might employ a power take-off for the setting of traps and perhaps for the operation of automatic snapper reels. When boat improvement reaches this level a fairly untapped reef fish resource will become available.

Government sponsored fishery developments are to be found on almost all Caribbean islands. They concentrate on improving existing conditions. Where innovations are introduced simultaneously, this is done with caution rather than speed. Improved boats would not only open up further reef areas but they would also make pelagic fisheries possible. By pelagic fisheries one need not necessarily envisage trips of one to several weeks. Under existing conditions they would more likely turn out to be trips of one to several days. That there is considerable fisheries improvement to be gained by opening up a new pelagic environment in the Caribbean is clearly shown by the recent test fishing in

Haiti. Where bottom configuration could cause upwelling, stocks of tuna were encountered.

At the same time the successful catches strongly pointed to one of the most serious problems of Caribbean fisheries, namely that of distribution and marketing. Some kind of refrigeration is a necessity for holding over catches of a ton or more. Such facilities are almost nonexistent in most islands.

The answer here most likely lies not in deep freeze facilities, or at least not in their early establishment, but rather in small scale ice factories which could distribute ice to fishermen, as well as in some investigations of cheap insulating materials. Such installations are not as costly as deep freezes and there are several engineering concerns in France and Great Britian which have specialized in small scale ice plants.

Even this much change in marketing and distribution facilities is not immediately necessary to improve the present situation. The development of fishery cooperatives in Jamaica is a good case in point. Some regional fishing centers have developed there and more will develop under the present fisheries expansion plan. But it should be added that Jamaica is a cooperative-conscious island. Such regional fishing centers or cooperatives do not only facilitate distribution, they also are a great benefit to the fishermen in many other respects. The acquisition and repair of fishing tools and materials is made easier and the problem of education and improvement becomes much more manageable. The trend of development in the French island of Martinique bears this out very strongly.

Fish Culture

Fishery officers and their administrative superiors must search for all possible means of improving the protein supply to the people of their administrative units. It is not surprising, therefore, that in some islands they have experimented with the development of fish culture. A glance at Table 1 again reveals that such developments could become very important if fish culture can fulfill the promise it seems to hold. In other parts of the world harvests of two thousand pounds per acre and more have been realized. It is obvious that the development of fish culture becomes attractive in areas which have no sea fisheries or where the presently used marine fishing grounds, (the reefs in our case), hold little further promise. Fish culture means production of proteins with control of genetic stocks, the possibility of controlled nutrition as well as controlled harvest.

The islands in which fish culture has developed to some extent are Haiti, Jamaica and Trinidad. But even in these three islands fish culture is still in the government operated stage. It is inherent in the nature of a highly intensive food raising endeavor that some scientific and central control should perhaps never be relinquished.

In the government hatcheries of Haiti carp ponds have yielded two thousand pounds per acre and more. The situation is comparable in the tilapia ponds of Jamaica. The ultimate advantage of fish culture in the Caribbean would be in the scattering of many small ponds over the islands. Problems of marketing and distribution would, thus, be minimized.

In Haiti, the location of the oldest established fish cultural installations, such a situation has arisen in some districts. The regional agricultural agent and the fish culturists of the Department of Agriculture cooperate closely. Local residents with average holdings of less than an acre construct their own ponds, very frequently by manual labor. Most of them are not larger than 100 square

TABLE 1

COMPARISON OF LAND AND REEF FISHERY AREAS IN THE CARIBBEAN*

Island(s)	Population	Land square miles	30 fa. reef square miles	100 fa. reef square miles	People per sq. mile of reef 30 fa.	100 fa.
Bahamas	87,000	4,375	40,000+	53,400+	2.1	1.6
Cuba	6,000,000	44,164	20,000+	30,000+	300	200
Jamaica	1,500,000	4,411	765	1,600	2,000	940
Hispaniola	5,500,000	29,800	45,000	77,000	120	71
P. R. & Virgin Islands	2,500,000	3,635	2,500	4,250	1,000	590
St. Croix to Martinique	800,000	1,790	8,500	11,500	95	70
Dominica to Grenada	580,000	1,250	3,500	4,500	166	139
Trinidad & Tobago	700,000	1,980	4,000	11,000	173	63

*Land and Population data from West Indies and Caribbean Yearbook 1954/55 (Skinner & Co.; London EC2). Reef areas from U. S. Hydrographic Office Charts.

meters with a depth of 50 centimeters to one meter. Peasants receive the fish from central distribution centers and do little more than wait until they reach harvestable size. Without additional food, this takes place in seven to nine months. One has the impression that in the rural section of Léogane, where about 80 such ponds, recently stocked, are scattered over several square miles, a very great potential improvement in the protein supply has taken place.

There are, however, several reasons to subdue optimism. First of all, the yearly growth in such private ponds is far less than that realized under experimental conditions. It is difficult to estimate how much less, but to be realistic one should probably not expect over 500 pounds per acre per year. It was mentioned that the average peasant holding is less than an acre. In some cases, it is very much less and the establishment of even a small pond may become a problem because of the need for stomach filling crops regardless of nutritional value.

Three hundred ponds have been built in Jamaica since 1953, many of them by government workers. A projection of this development into the future suggests that it is not unlimited. First, there is the difficulty inherent in small land holdings by individual farmers. There are not too many of them, since most people who do agricultural work, are employed on plantations. The one or, at best, two-crop system of large plantations, often with absentee landlords, is not conducive to widespread fish pond construction either. In some regions, though not in Jamaica, there might even be problems of water supply.

These obstacles can be overcome but they will certainly restrain the rate of development beyond the present level. Furthermore, the servicing of over three thousand ponds, rather than three hundred, would involve so much work that no department of agriculture could assume this under the present, or even slightly improved future, conditions. It has already been mentioned that some control over the genetic stock is not only desirable but essential to keep up fish cultural yields and, therefore, central installations and distribution facilities would be taxed greatly by a substantial increase in ponds to be stocked.

If one were to assume the conservative yield of 500 pounds per acre and one acre ponds throughout, 150,000 lbs. of Jamaica pond fish might soon be harvested. But marketing of pond-grown fish, even on a restricted and local scale, has hardly begun. The ocean fisheries of the island yield probably close to 15 million pounds per year according to T. W. Burdon, of the Department of Agriculture and Fisheries at Kingston, Jamaica. A ten fold increase in ponds would be an ambitious, but not an impossible goal. Ponds would then produce about one tenth of what Jamaican marine fisheries yield now.

In Jamaica and Trinidad, where experimental tilapia culture has made fair strides, the trends of development are towards mono-sex culture (stocking of male fish only). This implies continuous restocking and it is difficult to imagine that local operators could quickly and easily learn and perform all the operations that are necessary for this advanced fish cultural method.

Some Caribbean islands, Trinidad, for example, have large fresh water or brackish water swamp areas. In these regions a more extensive type of fish culture can be practiced. Fish can be stocked and left to their own devices. If they are prolific enough, as seems to be the case with tilapia, chances are good that they will greatly augment the take of the professional fishermen who habitually harvest these areas. It is very probable that such developments could be extended to other islands as well.

Mr. Dudley Wiles, Fisheries Officer of Barbados, has given a very persuasive

and impassioned plea for developing a Caribbean fishery on a more or less regional scale at the meeting of the Gulf and Caribbean Fisheries Institute in 1956 (Wiles, 1957). His speech was an optimistic one. He suggested that the first step in fisheries improvement in the Caribbean was the realization of determined programs of fishery development. It is hard to decide whether such determined programs should arise at a very local or at a more regional level. The immediate problems are almost always local and it seems, therefore, most probable that the soundness of the local development plan is the key to the situation.

Another question inherent in such developments is that of their finance. From what has been said about the marine fisheries it appears that they must remain extremely versatile, even if the pelagic environment is opened up sooner than seems possible. Furthermore, in most cases fishermen will only own one boat rather than several. With the exception of high-cash crops like lobsters, the investment of outside capital is, therefore, not very likely to hold much economic promise for the investor. The need for fish on the island is so great that export is hardly feasible even if stocks and methods would permit this.

The most promising type of fishery development for any Caribbean island appears to be a gradual and slow change to better boats and gear with education of fishermen at the same time. Any improvement of storage and marketing conditions should at present be aimed at the relief of short-termed accumulations. These gluts occur seasonally in all Caribbean fisheries and are the most urgent problem of uneven distribution (flying fish in Barbados, jack and mackerel in Bermuda, to mention only a few). At the same time fresh and brackish water fish culture should be developed, like in Trinidad, Jamaica, and Haiti; Puerto Rico and Martinique especially, would benefit by such developments. It would be wrong, however, to place on fresh water fish culture the hope that it could do more than assist and augment the protein supply within a reasonably foreseeable future. The fact that Israel could establish a very intensive, highly successful fish culture in a few decades does not imply that the same thing can be done in the Caribbean. Some reasons for this have been given before.

The primary interest of workers engaged in the management and improvement of fisheries in the Caribbean is to increase and improve the extremely low protein supply of the 18 million people who inhabit this area. Many promising beginnings have been made, the most outstanding probably is the fisheries development of Barbados.

At the same time island populations increase at an alarming rate and with the expected improvement in health and sanitation this rate will go up rather than down. It is obvious, therefore, that even the most successful developments beyond present hope and belief, such as more than doubling existing harvests, can never satisfy the needs of the people of the Caribbean unless they and their leaders realize that the main and paramount problem in the area is not how to increase proteins but how to decrease population growth.

REFERENCES

BARDACH, J. E.

1957. The summer standing crop of a shallow Bermuda reef. MS in preparation.

1957a. On the movements of certain Bermuda reef fishes. Ecology; in press.

ODUM, H. T. AND E. P. ODUM
1955. Trophic structure and productivity of a windward coral reef community on Eniwetok atoll. Ecol. Monogr., 25(3): 291-320.

WILES, D.
1957. Developing a Caribbean Fishery. Proc. Gulf and Carib. Fish. Inst. 9th Session: 150-153.

New Research on the Relationship of Fats, Blood Cholesterol and Heart Disease

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IN THE PAST FEW YEARS we have witnessed two rather extraordinary developments which have commanded much more than usual attention because of their possible significance in the health and well-being of major populations. The first was occasioned by reports of numerous investigators that cigarette smoking and lung cancer are closely associated. Despite all warnings—some quite strongly and even harshly worded—cigarette sales have continued to zoom upward, many, however, with assists from sundry filters.

The second began through the association of blood cholesterol with atherosclerosis. Our citizens have not shrugged off this latest warning. Instead, heart associations, doctors, and scientists have been deluged with inquiries as to the facts concerning diets. The reason for these distinctly opposed attitudes is not hard to find. In the first place, heart disease is the number one killer in this country and accounts for more than three and a half times as many deaths annually as all forms of cancer combined, while lung cancer is only one of these many forms. Thus, most American families have had some experience with coronary problems and, of course, the illness of the President two years ago placed the entire subject in sharp focus.

A few newspaper headlines are adequate indications of the widespread interest in the subject and the very considerable differences of opinion among the experts as to the exact relationship between dietary fats and coronary heart disease. "Heart Ills in U. S. Tied to Fat Food;" "Fat Strongly Condemned;" "Saturated Fats—Newest Dietary Whipping Boy?" "Are You Eating Your Way to a Heart Attack?;" "Dairy Foods Not Main Coronary Troublespot;" "Less Heart Disease on Protein Foods;" "Blood Fat Tied to Job Stress." It is only necessary to glance at these headlines to see that opinions have shifted rapidly and that there is lack of unanimity among the experts as to relationship of fat nutrition to blood cholesterol and coronary heart disease. A small group firmly advocates sharply reduced fat consumption, especially saturated fats, but the great majority of scientists urge moderate use of all dietary ingredients and express doubt that final analyses will justify any substantial overhauling of the more or less standard American diet.

Until about 1925 fats were not recognized as having any diet functions beyond their high density caloric values. Then, at first, certain essential fatty acids were looked upon as the only added nutritive components; as the years passed many new activities were discovered, among them improved palatability, in-