INTERCIENCIA SYMPOSIUM ON MARINE SCIENCES IN THE AMERICAS

Panel I: Food Production and Aquaculture

SOME FISHERY OPTIONS FOR FOOD SUPPLY INCREASE IN THE CARIBBEAN ATLANTIC

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(*The opinions expressed in this paper are those of the author and do not necessarily represent the views of IDRC)

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SUMMARY

With increasing populations and greater demand for animal protein in human diets, more efforts have been made to enhance the supplies from the seas and available waters. In general, Central Americans consume less fish per caput than South Americans, and the trend has been to fish for higher value marine products like shrimp, redfish and spiny lobsters. Population increases show a projected demand for more fish. The increased territorial limits of sea jurisdiction now impose the need for maximum use of the available harvest from the seas, while developing mariculture and enhanced management measures. Some biological and technological opportunities are suggested and are illustrated by current IDRC assisted projects in the Caribbean Atlantic, with comparisons of similar experiences in other tropical countries where coastal aquaculture activities are well developed. The opportunity for collaborative research activities for developing these resources is indicated.

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INTRODUCTION

It is perhaps significant that this symposium on Marine Sciences in the Americas should have as its first panel, the theme of food production to be followed with those of ecology, education, extension and future perspectives. This selected sequence reflects the current areas of major concern, and indeed this, the first, suggests an imperative preference. During the past two decades, it has been recognized with varying degrees of urgency, that the population increase in our planet was putting severe strain on the food resources available, and that without the effective and rational use of the finite, and even the renewable resources of the planet, we (mankind) may outstrip our resource base.

This is a world-wide problem which has been compounded in several ways by the fuel crisis, inflationary economic trends, and disastrous climatic irregularities which affected all types of food production in various parts of the world. World fisheries have not been immune from these unstabling influences, and indeed, solutions are being sought everywhere for improved fish production as a major contribution for protein food supplies. This search for solutions to food shortages has involved international agencies and regional bodies, but basically, it devolves on the agreed policies of individual countries, and eventually upon their application by the various communities of the society. Perhaps some reflections on a few of these options may focus thinking somewhat on the challenge that marine scientists face in this region.

CURRENT RESOURCE USAGE

Population and Food Production:

Based on the projections and figures published in FAO's Provisional Indicative World Plan for Agricultural Development (1), some sobering realities are evident. During recent years, serious doubts have arisen about the ability of many developing countries to produce enough food to keep pace with rising population and economic demands. The plan projected a population increase in the less developed countries (LDC's) from 1500 million in 1965 to 2500 million in 1985. It was also predicted that between 1965 and 1985 the expected population increase of 60% in the LDC's, which population would in itself require an increase of almost two-thirds in food supplies over those twenty years in such LDC's, merely to maintain existing nutritional levels and patterns of consumption. Increased incomes and spending power also create additional demand for food. With these effects taken into consideration, the annual rate of increased demand was calculated to be about 3.9%. The problem is further worsened by the relative increase in the non-food producing population. In short, there will be a relative decline in the proportion of food-producers to non-food producers. The estimates for Latin America gave comparative figures for a rate of increase of such non-food producing populations of 3.6% per annum.

Fish Production:

The impact of the above projections may have, in part, contributed to the greater emphasis by most LDC's on the need for self-sufficiency in food supplies as regards fish. The following table (2) illustrates the position in regard to average annual production from continental Latin American countries in relation to what is used for direct human consumption, and that which is transformed into animal feeds or other purposes.

Table 1

Fisheries Commodity Balance in some Latin American Countries*

Country	Total Fish Production In Thousand Metric Tons		+Total Domestic Fish Supply In Thousand Metric Tons		Annual Fish Consumption per caput Kg
	For Human Consumption	For Animal Feeds	For Human Consumption	For Animal Feeds	
Argentina	223.3	54.5	157.3	35.8	6.3
Belize	1.6	-	0.5	-	4.0
Brazil	685.7	40.0	785.9	39.5	7.2
Chile	179.4	947.3	149.9	410.7	14.9
Colombia	110.0	-	110.0	15.0	4.8
Costa Rica	8.5	-	8.6	-	4.7
Ecuador	120.4	103.0	76.6	-	10.8
El Salvador	10.2	0.3	7.7	0.3	1.9
Guatemala	5.0	-	4.2	-	0.8
Guyana	16.6	-	19.9	-	20.2
Honduras	3.8	-	2.5	2.5	1.0
Mexico	312.3	89.4	248.1	225.4	4.3
Nicaragua	18.4	-	10.3	3.5	4.4
Panama	17.5	24.9	18.0	0.9	12.3
Peru	329.4	3,820.5	261.8	784.0	17.5
Uraguay	12.9	3.1	9.7	3.1	3.5
Venezuela	102.6	31.4	109.0	162.9	9.9
TOTALS	1,956.6	5,114.4	1,980.0	1,683.6	-

Note: *Extracted from the latest available FAO Fishery Country Profiles (1975-1977)

+The Export and Import figures which are not shown, when deducted from or added to, the total production, provides the figures of total domestic supply available.

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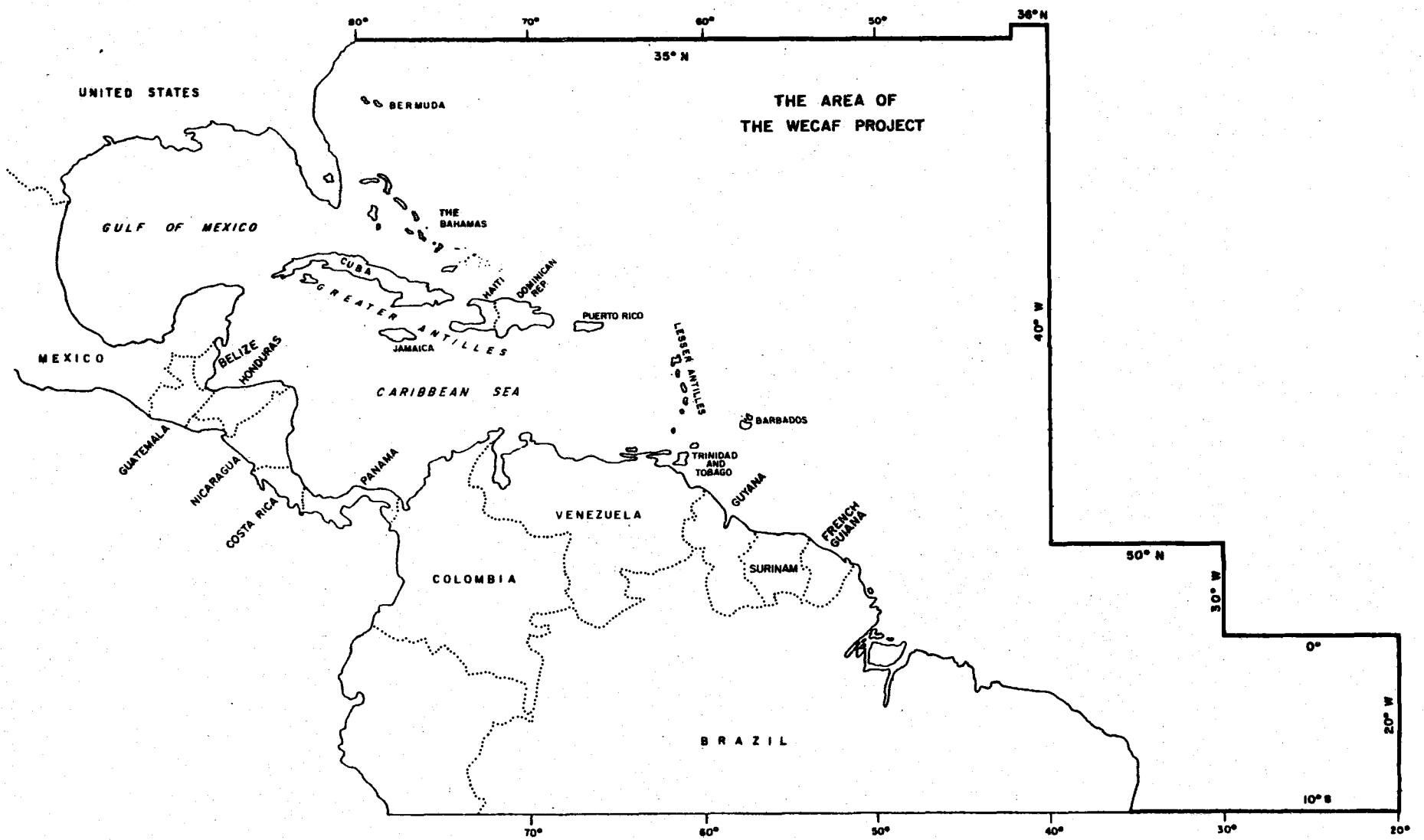
This table is compiled from the statistics cited in the latest available FAO country profiles. Omitting the details of the imports and exports, the data provide also total available domestic fish supplies and approximations of the average per caput annual consumption. It can be seen that in general, South Americans consume more fish than Central Americans. If however, the fish supplies for human consumption permitted an average/ annual consumption throughout Latin America of 10 kgs. per caput, it would require more than double the present human consumption figure of 2 million tons.

Perhaps the most sobering fact which derives from these figures, is that fish for direct consumption totals less than 2 million tons, while the quantity transformed for animal feeds and other uses amount to more than 5 million tons, 67% of which is exported from the region.

WECAF Area: (see map illustration)

Turning now to the production figures of the more specific area of the West Central Atlantic, which only includes the fish produced in that statistical area designated by FAO, some other interesting statistics are evident. The international project for the development of fisheries in the Western Central Atlantic has recently published a series of studies (3) from which these figures are extracted. By species, the 4-year average catch figures provide the following information as indicated in Table 2.

The data illustrate the past pattern of species exploited in the WECAF area. The production emphasis has been on species of high market demand. Collectively, shrimp, oysters, tuna and redfish are slightly more than a third of the catch by weight. The herring-like groups, including menhaden, account for almost half the catch. The value of the products from menhaden etc., is however, vastly different, and the incentive for investments have been traditionally oriented towards the higher value food products which are in demand in the North American market. In this



Note: Extracted from WECAF Studies, No. 3
"A Review of the Fishery Resources in the Western Central Atlantic"

Table 2

Catch Figures in WECAF area by Selected Species Groups (3)
Average for Years 1970 to 1973

Item	Weight tons	Percentage
Total catch	1,487,000	100%
All Crustacea	218,200	14.7%
Shrimps	164,300	11%
All Molluscs	188,800	12.7%
Oysters	157,800	10.6%
All Marine Fishes	1,068,100	71.8%
Red fish	167,800	11.3%
Tuna	44,900	3.0%
Herrings, etc.	685,800	46.1%

area, total estimated potential yield for demersal stocks, by currently practised methods, is between 1.5 to 2.5 million metric tons, with pelagic stocks being between 2.5 to 3.5 million metric tons. These estimates refer to landed catch and exclude an estimated 900,000 tons of demersal fish caught at sea and discarded by the shrimp fishery. In the WECAF area the relative proportions of fish caught for human consumption and animal feeds is approximately typical of the trend in world production.

These facts illustrate some aspects of the overall picture, as well as a few more specific figures of the Caribbean Atlantic and WECAF area. The position must then be considered as to how best the food needs of fish supplies, now and in the future, may be satisfied most quickly and economically but with least ecological damage and greatest efficiency.

Law of the Sea Implications:

The United Nations Conference on the Law of the Sea (4), has resulted in the virtual implementation of new territorial limits with consequent responsibilities for the management of resources obtaining in the Exclusive Economic Zone. In our context, this refers particularly to the conservation of living resources. It also imposes a great obligation on the coastal states, as custodians of those subjacent natural resources, to ensure that by proper conservation and management measures, they maintain the populations of harvested species at their maximum sustainable yield. It is considered that much more scientific information will still have to be continuously collected, particularly for tropical multi-species demersal fisheries, before the most effective management policies can be realized and applied. However, while such data are being gathered, increasing supplies of food must still be provided. The choices seem to rest both through developing technological opportunities and applying biological opportunities for the maximum utilisation of the resource, while at the same time, alleviating some economic and social constraints to its efficient industrial exploitation. All these results must, however, be obtained within a framework of urgency which, in general, the exigencies of all governmental policies now require. In short, there is really not much time for hesitant action, or a laissez faire attitude in fisheries in any country of the world. What are then possible priority actions?

TECHNOLOGICAL OPPORTUNITIES

While the world's fish production has increased from 33.3 million tons in 1958 to 66 million tons in 1973, doubling in 15 years, there has been a relative decline in direct consumption of fish from 84% of the landed catch to 60%, with a comparative rise in industrial processing (for fish meal, etc) from 16% to 40%.

This means that the current trend is to convert to fish meal, almost the equivalent quantity of fish (26.2 million tons) as was directly consumed by man 15 years previously (28 million tons). The agonizing corollary of this is that the increased catch converted into fish meal has come largely from the oceans adjacent to protein-deficient developing countries, and sold to feed the livestock of the affluent nations of the world in other regions.

As the tabulated statistical data in Table 2 shows, the present fish harvesting practices in the WECAF area are highly selective and result in an emphasis on high-value demersal species, with the majority of pelagic species being converted to animal feeds. Additionally, an estimated 0.9 million tons of fish are discarded at sea in the Gulf and Caribbean Atlantic. This is referred to as the "by-catch" since it is caught simultaneously during shrimp trawling operations, but is thrown back overboard.

Guyana By-catch:

Because it is difficult to accept that such fantastic waste occurs, the complexity of the problem should be clearly explained. The vessels are designed with a refrigerated hold capacity of 15 to 30 tons of shrimp. They have a crew of three to five, are highly powered (450 HP engines) and are increasingly costly to operate. The capital cost of such vessels varies from US $150,000 to $250,000 with operating costs and crew payments depending on catch, efficiency and location. Some shrimp trawlers operating off Guyana, for example, may gross annual earnings equivalent to the initial investment on the vessel. This can be done (with resulting profits to owners and crew) only if the hold is filled with shrimp, not fish! Various factors such as temperature of the hold, crew size and time at sea, are designed exclusively for handling shrimp.

Further, the great bulk and variation of the fish that are caught make it impractical to accommodate the total by-catch with the present system.

The market value of this fish (about 10¢/lb) compares adversely with the minimum wholesale price of shrimp (at least $1/lb). The fish is therefore thrown overboard in its stunned condition. It is eaten then by sharks, gulls and scavengers.

The problem is not only economic, but also technological. In the tropical seas as many as 50 fish species may be caught in a trawl. They vary in size, chemical content (white or oily) and some may even be poisonous. The quantity of fish caught will vary with the place (bottom type, depth and currents), time of day (fish are generally more active in daylight than shrimp) and time of year (the rainy season causes outflows from distant estuaries that affects the availability of fish). As some species of fish become mature and gravid, the chemical composition of the flesh and even its palatability varies. Generally, the weight of shrimp caught is between 10% and 30% of the total catch landed. This mixed bag of fish would be difficult to process without some sorting between oily and white fish types. However, the fishing operation is generally done at night, the crew is too small and there is too little time between the landing of the twin trawls.

From the point of view of operational efficiency, only major quantities of acceptable market fish can be considered for collection aboard or easy processing ashore. Assessments along the Guyana shelf estimated that about 200,000 tons of edible fish, consisting of eight major white flesh types, could be obtained annually from the fleet of between 175 and 210 trawlers. Yet the countries of the Caribbean import the equivalent of 150,000 tons of fresh fish annually!

What may be done about this on a regional basis is perhaps best illustrated by the objectives and activities of the project in Guyana, from where about 200 double-rigged shrimp trawlers seek to harvest pink and brown Penaeid shrimp (5). A small IDRC project supports this practical investigation. (Illustrated by slides).

To test the practicality of using this fish, the Guyanese government required each shrimp trawler coming to the Port of Georgetown, to land its last few days' by-catch. This totalled about 2,400 tons a year. However, the sudden volume of fish brought into the market created problems in handling, processing, cold storage, sales and distribution.

Since early 1973, IDRC has been supporting the Guyanese Government's efforts to solve these problems. Experiments in processing the mixed bag of edible varieties of fish use deboning machines which produce extruded fish flesh, quite free of bones, scales and skin. The waste (comprising of fish bones and skin) can be converted to fish meal, while the comminuted fish flesh is now a new raw-material. Tests have been conducted with the project to make dried, spiced or salted products which are stable at normal temperatures, and can be packaged in sealed plastic bags and sold at low cost.

Additionally, the project plans to make products of higher market value. That portion of the catch that comprises fish of higher consumer demand can be processed as fillets or specialty products. These are intended to contribute appreciably to defraying the processing costs, thus permitting the bulk preparation of lower-cost stable fish products that are within the reach of rural communities where refrigerated storage is not widely available.

Apart from an innovative processing system and development of new products, other approaches are needed to solve this problem because this is one of the largest quantities of commestible fish in the WECAF area which can be immediately available for human use without any additional fishing effort or pressure on the resource. It would however, require some adjustment and modifications for future design and operational systems of shrimp trawlers, and the more rigid observance of an objective for human food supplies, and not merely a profit motivation. But the rewards would be magnificent. It would virtually double the fish supplies for human use in the WECAF area!

Such a waste of edible fish is unacceptalbe, and solutions for its satisfactory use are being sought throughout the tropical world. These approaches are considering ways of handling the fish at sea, systems for collecting and transportation from shrimp trawlers, and the processing of a mixed bag of species.

The development of shrimp-fish separator trawls has shown promise. Alternatives include the use of detached floating cod-ends (nets), and refrigerated sea water (RSW) tanks on the decks of trawlers in which the day's catch can be held. Both systems require the retrieval of the catch by a collection vessel operating along with the shrimp trawling fleet. The vessels with RSW systems used by the Pacific herring fleet off British Columbia are considered sufficiently adaptable for the exercise. However, until the bulk handling of the by-catch is proven practical and efficient, industrial scale processing ashore will not be readily applicable, since the landed cost of the fish will be too high, even before processing, for low-income consumers, who are the target population.

With the new focus on self-sufficiency in food in the developing world, a more humane perspective is required by the advanced technologies of the industrialized world. Such a perspective should lead to concerted efforts to prevent such unacceptable waste of the valuable by-catch from tropical shrimp trawling as a valuable source of food for man.

It is suggested then, that in the WECAF area, the most immediate, convenient, and available supply of fish could be provided by this way. It is a challenge to technology for the design of vessel, gear, handling and processing systems designed to yield valuable commestible products, and not animal feeds or pet foods. Should this approach be successful, then its application can result in a more rational harvesting of fish resources, permitting greater food availability without extra fishing effort.

BIOLOGICAL OPPORTUNITIES

Coastal Aquaculture:

This panel has given particular emphasis to the prospects of mariculture. Other contributions will no doubt, enlarge on its potential application. The largest number of IDRC's fishery projects deal with aspects directly concerned with aquaculture and the opportunities which this system provides will again be illustrated by some projects supported by IDRC.

The shallow waters of tropical seas, on the leeward side of reefs and within atolls, offer particular attraction for marine floating culture systems where operations are protected from storm conditions. The fast growth rates which can be achieved is specially valuable when applied to organisms of the lower trophic levels. Accordingly, sedentary filter feedings animals, such as oysters, mussels, clams, and other edible molluscs (6), recommend themselves, as well as many sea weeds for which there is an increasing demand. In principle, the next category of non-sedentary filter feeders such as the larger herring-like fishes, also offer good prospects, but in practice, many of these like *Mugil* spp. present technical difficulties in culture. The use of herbivorous marine species is still in the experimental stages in this region, though industrial operations are widespread in Asian countries.

Oyster Cultivation:

Tropical oysters have generally not been effectively cultured to large size, mainly because of their almost year-round reproduction. The spatfall and clustered setting of young oysters crowd the substratum with

many small oysters. They not only compete for food, but provide no space for their full growth potential. If the growth rate that is obtainable in isolation, or without fouling, can be obtained practically on an industrial scale, yields of about 6 to 10 times may be possible. The oysters must have enough opportunity for ample food and growth to realise their full potential, but their natural reproduction needs to be inhibited. The strategy that has been tested in Sierra Leone, through an IDRC sponsored project, was to locate areas where suitable salinity, temperatures, currents or other physical or ecological parameters permit the oysters to grow well, but not to reproduce.

When effective growth and industrial-scale production is obtained, the sanitation and pollution problem can be tackled simultaneously. However, the consumption patterns of oysters in some Asian tropical countries show a preference for steamed and dried products and not raw or half-shell oysters, thus avoiding the very considerable problems of oyster sanitary controls in temperate countries. It will be necessary to apply appropriate measures in our region.

The resolution of this problem may permit an extensive application of such systems for the production of bivalves in vast areas of tropical estuaries, lagoons and protected seas of this region. Simultaneously, improved management of such ecosystems will result.

The successful efforts at cultivation of the cupped mangrove oyster, *Crassostrea rhizophorae* and other species, are now spreading across the tropics. Projects supported by IDRC now assist such endeavours in Sierra Leone, Malaysia, and Jamaica. But it is interesting to see the results achieved by others in Cuba (7), Brazil, India and the Philippines. (Slides of personal observations illustrate the current practices).

IWP Estimates (1), based on the assumption that natural production is fully exploited and cultivation of molluscs is brought to the level of that in Japan and U. S. A., have put the feasible world production at

20 million tons or 10 times the 1967 production. Judging from results in the warm Caribbean seas, these bi-valves offer a specially attractive prospect for food production enterprise.

Mariculture in Enclosures:

The attainment of objectives of fish for food by culture rather than capture may supervene progressively as the efficient development of tropical territorial seas become imperative. Such culture and husbandry practices will consciously improve ecosystem management, since they will be closed systems for intensified operations. Research inputs, particularly if internationally coordinated, could hasten the trend in this direction.

The utilisation of atolls, embayments and estuaries in Asia for such cultivation systems for plankton feeding fish in eutrophic waters and for high value predatory species such as groupers in Philippines, Singapore, and Hong Kong, may give some indication of the new dimensions that low-investment systems of aquaculture can attain. In 1976 marine cageculture systems in Hong Kong produced only 750 tons of fish, but with a value of over $6 million! (8).

It is worthwhile reflecting that from the humble beginnings somewhere in Egypt thousands of years ago when someone decided to domesticate a migratory duck, has sprung poultry husbandry. Aquarium hobbyists dabble with species selection and breeding. Asian aquaculturists have traditionally subsisted on yields from fish ponds rather than massive harvests of the seas. In this part of the world, the great diversity of attractive species offer a particular biological opportunity and scientific challenge for economical and efficient aquaculture enterprises.

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SOCIO-ECONOMIC CONSIDERATIONS

Many coastal communities in Latin American countries have traditionally depended upon the resources of the sea, deriving employment as well as food from fisheries. However, the numbers, with few localised exceptions, generally reflect a small percentage of their populations. The general food preferences of consumers for meat and the gradually increasing consumption patterns of fish have been affected in most areas by inflationary fuel costs and rising prices. The application of coastal aquaculture production systems should therefore, permit remunerative returns from valuable species and yet can be labour intensive for coastal communities. The recreational conflicts which deploy skilled fishermen from the production industry into charter boat fishing and sport fisheries, may also reduce the available skilled manpower which is not, unfortunately, being replaced by trained, younger fishermen. There are also alternative, attractive, stable jobs which offer industrial competition for the best skilled manpower. In general, it seems that despite many efforts, there is still considerable need for greatly increased inputs of skilled human resources available for increasing production rationally, at all levels.

While biologists urge that this is particularly important for the management monitoring and data requirements of the current fishing operations, it is equally necessary to provide for future developments which require considerable inputs of people with versatile resource production and operational capabilities. This will, undoubtedly, be dealt with in subsequent panels, but the emphasis suggested here applies particularly to the skills in the two categories of by-catch processing and mariculture, to which this paper has referred. Such investments in human resource developments will undoubtedly benefit from mutual exchanges and international collaborative efforts in this region, if purposefully pursued.

CONCLUSION

Among the most challenging aspects of scientific endeavour, are the multiple problems of efficient harvesting of food from the seas. Concerted efforts of marine scientists may help provide effective answers in this region of the world through innovative measures as well as adaptive research techniques which have been found valid, in principle, elsewhere. With increasing populations, improved nutritional and living standards, the demands for fish have imposed an urgency for the increased fish production which has been further heightened by recent economic inflation and marine jurisdictional circumstances. The above-mentioned two general areas of action are suggested for the more immediate provision of available fish, involving technological applications of the by-catch of shrimp trawlers and the development of coastal aquaculture systems for bi-valves and fish. Since these fishery activities can be implemented in most countries of the region, there is the obvious possibility of collaborative research exchange of experiences and training of personnel. This naturally leads to more effective management of mutually harvested resources, and strengthening management measures while improving food supplies. Environmental conservation will be enhanced, while the humane perspective of more food for direct consumption, harvested from the seas, will be realized.

INTERCIENCIA would seem to be a most appropriate forum and continuing channel for the pursuance and promotion of these and other ideas expressed in this panel in practical and tangible projects. Organisations such as IDRC will be receptive to programmes which permit such regional goals to be attained.

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(Slide illustrations presented with this paper, are taken from the author's collection on fisheries activities in various countries)

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