The Biological and Technological Basis for Further Development of Artisanal Fisheries in the Caribbean Area[1]

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When I agreed to discuss resources and harvesting criteria for development of small-scale fisheries in the Caribbean area, the proceedings of the Seminar-Workshop on Artisan Fisheries Development and Aquaculture in Central America and Panama, held in Costa Rica in 1975 (Estes, 1976) had not been published. I had already separated the "resources/harvesting" aspect as a clearly discernible entity in the overall definition of artisanal fisheries without the benefit of information from those proceedings, which has just become available.

In the workshop proceedings, under the heading "Resources Availability Related to Artisanal Fisheries," J. Kesteven (1976) asked a series of questions which are worth repeating: (1) In what way and to what degree is the productivity of artisanal fishermen fixed by the resources they exploit? (2) Are those resources of a kind and magnitude that would permit important expansion in total production? (3) Are the resources of a kind such as to make them especially susceptible to overfishing? (4) Are the resources of a kind that lend themselves to effective intervention? (5) In what way would the future technology of these fisheries be determined by the nature of the resources?

What Kesteven asks is simply this, "Does the descriptor *artisanal* signify a resource boundary?" He concludes that it does so indirectly, but the primary denominator is technological. He then identifies three levels of fisheries based upon their technico-socio-economic situations: industrial, artisanal, and subsistence. His clearly defined separation of "artisanal" and "subsistence" fisheries helps to identify the requirements needed to raise subsistence (inadequate) fisheries to artisanal (successful) fisheries.

The Fisheries and Fisheries Resource of the Caribbean Sea by Fiedler et al. (1957) presents an excellent historical perspective of the Caribbean regional fisheries, which at that time were virtually all either artisanal or subsistence according to the above definitions. The conclusions of their report were: (1) The Caribbean is not a greatly productive area. (2) The most productive areas are the lagoons and estuaries. (3) Most areas can withstand limited expansion of effort but this added "strain" must be controlled. (4) Pelagic fish offer greatest

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development potential. (5) Other fishery resources are available, but in limited quantities.

Following these uninspiring conclusions came three decades of extensive development of industrial fisheries for shrimp, lobster, tunas, and snapper. In re-reading Fiedler et al. it is evident that too few changes have occurred for the better regarding artisanal fisheries. Following are some personal observations and thoughts that might contribute to planning for the improvement of our regional small-scale fisheries.

During the 1950s and 1960s, U.S. Fisheries Services conducted surveys of many reef areas and banks in the western Caribbean Sea. I frequently visited Serrana Bank off Belize because it provided an interesting fauna for biological collecting and a diversity of potentially available stocks of spiny lobster, snapper, and grouper. Serrana Bank is a small cluster of coral rock and sand islands, uninhabited, and best known as a sea bird rookery. Boats from Belize, the Caymans, and Jamaica were annually collecting hundreds of thousands of tern eggs. The largest islet on the banks scarcely exceeds a few hectares. Now large amounts of spiny lobsters and red snappers are taken from the Bank.

In 1957, the U.S. research vessel OREGON anchored on the south side of Serrana Bank. We observed a small, crude, driftwood shelter on one of the outer islets. When we went ashore we found in the shelter eight hawksbill turtles lying on their backs with front flippers tied to prevent escape. Realizing that we were inspecting private possessions, we returned to the ship. Shortly, two small dugout canoes appeared. There were two men in each canoe; the man in the stern was paddling, while the man forward was furiously bailing with coconut shells, barely keeping a freeboard of 2 or 3 inches. When the canoes reached the shelter of the home islet the men returned our waves of welcome.

We joined them ashore and learned that they were a "team" of fishermen from Old Providence Island. They explained that during the spring and summer months, an Old Providence company put parties ashore on various banks from carrier vessels. Their tour on Serrana Bank was for 30 days. Fishing was usually confined to depths of less than 10 m. They lived on dumplings, fish, lobster, and bird eggs. Salt brine for curing the catch was made by boiling down sea water. Their hooks were handmade from iron nails and their line was handmade hemp twine with a tensile strength of not more than 20 lb.

As their provisions were austere and limited we returned that evening with fresh food, circle hooks (recently introduced in the U.S. snapper fishery), and a 1,000 m roll of nylon twine. We learned that their dried catch was carried to and marketed on Old Providence Island. They were paid a fee or salary with no incentive for producing over a minimum catch. The profit incentive for undertaking such a tedious and precarious life came from the opportunity to catch hawksbill turtles, for the shell brought a good price. They captured beached females before egg laying because fresh hawksbill eggs were a prized delicacy and they could be sold or bartered.

The next day we took the fishermen to their grounds on Serrana Bank in outboard-powered dories. Using the new hooks and lines, over 300 lb of snapper and grouper were quickly caught by the fishermen. They were not particularly pleased because they had reached the minimum quota and still had 20 days to

wait for the relief vessel. Our offer to return them to Old Providence was declined since it was still nesting season and perhaps more hawksbill turtles would appear.

A few years later, the R/V OREGON called at one of the larger Caribbean islands where there was an active beach seine fishery for thread herring. Due to unusually high availability, the normal ex-vessel price of U.S.$0.04 a pound was declining and the fishermen were about to go on strike. At that time we were engaged in exploratory longline fishing that required a large quantity of herring-like bait fish. The situation appeared to offer an opportunity to acquire a bait supply at a reasonable cost, and give the fishery a temporary financial boost. Through the local marketing system we offered to purchase all surplus thread herring catches over a 4-day period at $0.05 a lb, up to a maximum of 50,000 lb. A spokesman inquired if we were prepared to pay as much as $0.06 a lb. We agreed, but said we would then limit our purchase to 40,000 lb. We were then queried on $0.08 per lb and again agreed, but with a 30,000-lb limit. A following query at $0.10 per lb was rejected.

During the 4 days we were in port, the price on thread herring rose to $0.50 a lb, ex-vessel, without a single crew fishing or a single pound of fish landed. It was our understanding from local friends that the economics of thread herring production remained in chaotic condition for weeks after our departure.

It appears that technical assistance, while seeming to provide immediate improvements in the productivity of a fishery, may have results that are either trivial or even counter-productive if they negatively disrupt established systems; and financial incentives injected into established fisheries can do more damage to the entire system than the contributions of apparent short-term benefits. This also has been said by other researchers.

Small-scale fishermen are very knowledgeable about the types of fish found in their respective areas, and their seasonality and relative abundance. Time and time again, biologists have been excited with the capture of what was assumed to be a rare species, only to learn that local fishermen know the species well by common names. Many are produced for the local market. Ten years ago taxonomists studying western Atlantic jacks (Carangidae) were limited to two known specimens of the scad *(Decapterus macarellus)*. However, fishermen from St. Lucia, Dominica, and adjacent islands, had been producing catches of "robins" (scads) since the introduction of gill nets decades ago. Even with all of the sophisticated collecting systems of recent exploratory fishing and resource survey expeditions, many species are still to be found in local fish markets only.

It would add little here to identify and list the species and stocks that are sufficiently abundant and available to be considered for expanded production by Caribbean area artisanal fisheries. In broad terms, the larger components of the fish and shellfish biomass have already been identified (Klima, 1976). Many elements of these have been in some form of utilization in one area or another. Locally, where fishermen have been working traditional grounds for generations, there is probably little new information that can be provided to make significant contributions to knowledge on abundance and seasonal availability. One positive step would be to arrange the present data base in some semblance of order to permit greater use by both fishermen and managers.

Improvements to harvesting technology, appropriately linked to handling, processing, and marketing, offer a productive channel for developmental efforts. However, numerous "development programs" have demonstrated that increasing productive capacity by introduction of new methods and equipment does not in itself lead to increased production. As previously indicated, the results sometimes have been counter-productive socially and economically.

I view the biological and technological requirements and opportunities for assisting the regional artisanal fisheries from two perspectives: (1) The uniqueness of individual fishery units has to be recognized before much can be accomplished in bringing about constructive and meaningful changes. But the technological resources simply do not exist to do "something for everyone." It becomes, at least, a task of enormous proportions. (2) There are threads of commonality to some of these fishery units, and success or failure of technical or other forms of assistance can well depend upon how these are taken into consideration and acted upon.

Only marginal planned use has been made of a valuable biological asset of the region – the productivity of these warm waters where a dynamic biological flux produces many stocks that come and go with only one or two-year classes. When such resource elements have been identified with high market value and ready availability (such as penaeid shrimp and spiny lobster), development has been rapid, profitable, and quickly reaches an industrial level. We have not spent much time looking for developmental benefits that might be achieved through national and international management of other high-value species. Some of these might better apply to the small-scale fisherman.

It would be worthwhile to take a specific example. Recently, the Atlantic hawksbill turtle was added to the International List of Endangered Species – and with good cause. In the United States there is an explicit, legislated goal to work towards the rehabilitation of hawksbill turtle (and other species) to the population level where they can be removed from the endangered species list. Despite the high value of this species for their tortoise shell, there is meager indication of concerned effort to reverse the trend of diminishing abundance of this species. "Does the responsibility for developing an appropriate conservation and management plan for Atlantic hawksbill turtles lie within this geographical area, or can the problem be left to the international conservation community?" Like so many other problem areas, the data base to address the question is most inadequate. It appears certain, however, that unless some measures are taken now, the wild population may be reduced to virtual extinction in the very near future. With hawksbill shell now valued at $20 per lb (Anon., 1977) on the world market (as compared to $1 to 3 per lb 25 years ago), who can question the motivation of a fisherman to take each turtle he can catch?

I find this problem very relevant to my discussion because the harvesting of hawksbills has been almost exclusively carried out by small-scale fishermen. Catch rates due to reduced availability are now at a level that most of what is produced is fully utilized by local artisanal craftsmen with little left for world trade.

There are increasing expressions of concern by the worldwide conservation community on the status of hawksbills. However, we might also ask "Who will

be the greatest loser?" or "Who could benefit most if the turtle stocks were rehabilitated and harvested at MSY?" It seems to me the answer would be "the artisanal fisherman." Another question is "Can we tackle the problem with some assurance of success?" My answer now is "I don't know." A final question might be "Is there a seemingly logical approach that can be adopted and followed under these circumstances and, if so, what is it?" I think there is a logical approach and I offer the following: At $40,000 per ton, hawksbill shell outclasses lobster tails 4 to 1 in value. Naturally, there would be limits to the global demand for the product but current markets show a substantial demand. Japan reported imports of 220 tons during 1971-75 (Anon., 1977). However, it must be remembered that *we are talking about an endangered species*. The approach I propose follows:

1) An internationally coordinated series of national programs in the Caribbean area that would: (a) impose immediate restrictions on all harvest or taking of hawksbills of any size; (b) establish educational programs directed at the total fishing community to explain the need for taking drastic conservation measures now, and describing the possibilities for long-term economic payoff; (c) plan for the establishment of a central regional export marketing consortium, through which the raw materials eventually to be produced will be channeled into world trade; and (d) reserve for the small-scale fisheries the exclusive rights to commercially produce hawksbill once the stocks have been brought back to a level where harvesting can be considered.

2) Establish a trans-Caribbean scientific program to work first on the problems of population enhancement, and then to monitor stocks and recommend levels of harvest, define fair and reasonable allocation, and provide further information as needed.

Some pragmatists might say "It can't be done," or "It won't be done." But it is a major problem and is representative of some of the realities that have to be faced.

I have discussed this problem with colleagues, who view the conservation of turtles as a matter of extreme urgency and alarm. There is a reluctance to consider a commercial future for this species. Nevertheless, the species has a high profit potential that can serve as an incentive to work on behalf of hawksbill stock rehabilitation to MSY.

I have found no records of attempted population modeling for hawksbills. As a result of green turtle tag and release studies over the past two decades, however, some preliminary opinions have been expressed on mortalities and survival, from which one can tentatively derive population extrapolations for stock rehabilitation and management plans. These are not presented here with any sense of fine tuning but more as a need to start somewhere.

In recent discussions on green turtle mortalities, it has been estimated that the range of survival from nested egg to sexual maturity would be in the range of 2 to 3%. Some estimates for population segments are as low as 0.1% where heavy nest predation occurs. With the present consensus that hawksbill stocks are declining rapidly, it appears that egg to maturity mortalities far exceed the 99.9% level. Using the presently cited maturity at 3+ years (Carr, 1952), the

three nestings per season of 150 eggs per clutch, a 0.1% survival through maturity still provides for a steady population increase that can be roughly extrapolated to be threefold every 5 years (Table 1). Obviously, that is not being achieved. On the other hand, if enhancement of survival through maturity can be made to account for a 3% rate that some believe may now be possible with green turtles, by insuring maximum hatch and release success, and elimination of baby turtle harvest, extrapolation of the observed biological parameters reveal a potential for a population explosion of impressive dimensions for the hawksbill.

Any serious management effort could quickly impact the deteriorating condition of stocks of this species, and within a reasonable time frame provide a valuable renewable resource that could be widely shared throughout the region.

From recent studies on the population accumulation rates of artificial reefs, there is reason to believe that culture and release programs for small islands could enhance and maintain populations that are typically diminished by exploitation throughout the year. An aspect of this is being examined in some areas with the conch *(Strombus gigas)*. Culture methods are achieving some encouraging success, and there are prospects for both repopulating habitats that have been decimated in the past as well as enhancement of presently exploited populations. Other encouraging possibilities exist for additional species. Some of the greatest payoffs can be for the artisanal fisheries.

On the basis of present knowledge, the problems of enhancing artisanal fisheries do not seem to have immediate impediments in either lack of resources or in the potential for development of harvesting technology. I will conclude my comments with a brief listing of the resource prospects that seem most promising.

Demersal and pelagic sharks continue to offer opportunities for small-scale fishery development. Due to deficient statistics, we cannot evaluate the numerous small shark fisheries that are now in various developmental phases. In both the offshore and coastal waters of the region we have several species of small tunas and bonito that are virtually unexploited. These include the little tuna *(Euthynnus alletteratus)*, blackfin tuna *(Thunnus atlanticus)*, the skipjack tuna *(Euthynnus pelamis)*, and others. All are suitable for canning or fresh-frozen marketing throughout the region. The meager efforts to utilize these remain enigmatic.

Other pelagic or oceanic species groups remain largely underexploited. Oldtimers of the GCFI can recall the excitement of the Barbados flying fish fishery development. Their potential is far from realized. At the other extreme, it has been demonstrated that the Caribbean is a major spawning area for swordfish – virtually unexploited by the surrounding countries.

Although the coastal reef fish communities are undergoing increasing exploitation, experimental fishing on continental slope depths indicates unexploited populations of deep-water grouper, tilefish, and other species. In the inshore areas, there are both large (but poorly defined) stocks of coastal migratory predators, such as Spanish mackerel, and quantities of smaller forage-type schoolfish, such as anchovies, dwarf herring, and silversides. Experimental purse seining for thread herring off Cartagena in the mid-1960s was discontinued

Table 1. Theoretical green turtle population increase

Year	Number Adults (♀)	Number Eggs Produced	3% Survival to Maturity	Total Turtles
1	1	450	13	14
5	13	5,850	175	255
10	522	235,000	7,050	13,450
15	43,000	19,000,000	570,000	1,529,000
20	2,700,000	1,200,000,000	36,000,000	69,000,000

because the individual sets were small, 5 to 10 tons per set, but many schools were seen.

In summary, the problems and challenges in doing something meaningful to assist the local and small-scale fisheries of the region will not be handicapped by the inherent productivity potential of this region, by its species composition, or their availability. The biological requirements are there.

Fundamentos Biológicos y Tecnológicos para Fomentar el Desarrollo de la Industria Pesquera Artesanal en el Area del Caribe

RESUMEN

A pesar del desarrollo extensivo de la pesquería industrial en el área del Caribe de camarón, langosta espinosa, atún y pargo, se han efectuado muy pocos cambios para el mejoramiento de su pesca artesanal.

Basado en ejemplos específicos, parece que la asistencia técnica, que aparentemente mejora la productividad pesquera, ha dado resultados negativos al interrumpirse el sistema existente; además, la ayuda financiera dada a las pesquerías existentes, puede ocasionar más daño al sistema que los beneficios a corto plazo que ofrece.

Cuando la productividad de estas aguas templadas es identificada con altos valores del mecado y adquisición inmediata, su desarrollo aprovechable y rápido hace que alcance el nivel industrial en poco tiempo. Hasta el momento no se ha insistido suficientemente en las ganancias que se pudieran obtener mediante la administración nacional e internacional de otras especies de gran valor. La pesca artesanal pudiera ser usada para algunas de estas especies.

La rehabilitación de la tortuga "hawksbill", considerada en peligro de extinción beneficiaría especialmente al pescador artesanal ya que su pesca se lleva a cabo casi exclusivamente por los pescadores de pequeña escala.

Se aconseja la creación de una serie de programas nacionales en el Caribe que estuvieran coordinados internacionalmente con el fin de: (1) hacer cumplir la veda de la tortuga

"hawksbill", (2) establecer programas educacionales que explicarían la necesidad de las medidas de conservación, y su beneficio económico a largo plazo, (3) planificar el establecimiento de una sociedad central regional de mercado que comerciaría los productos crudos, y (4) reservar el derecho exclusivo a los pescadores artesanales a la pesca comercial de la tortuga "hawksbill", tan pronto se estime aconsejable su explotación.

También sería beneficioso el establecimiento de un programa científico trans-caríbeo, que se dedicara primero a los problemas del aumento de la población, y luego al control de las reservas y a la recomendación de diferentes niveles de colecta. Entre los recursos que ofrecen oportunidades a los pescadores artesanales se encuentran los tiburones, tanto demersales como pelágicos, algunas especies pequeñas de atún y bonito, el pez volador, la cherna de aguas profundas, la sierra, anchoas y sardinas.

La productividad potencial del Caribe, su composición de especies y su disponibilidad no serán impedimentos para ayudar su pesca local y artesanal.

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