

CARIBBEAN MARINE RESOURCES MANAGEMENT
CHARACTERISTICS, PROBLEMS AND PROSPECTS

Prepared For

EASTERN CARIBBEAN NATURAL AREA MANAGEMENT PROGRAM

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CARIBBEAN MARINE RESOURCES MANAGEMENT CHARACTERISTICS, PROBLEMS AND PROSPECTS

By

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In a somewhat unconventional attempt to deal with the rather difficult task of summing up the characteristics, problems and management prospects of Caribbean marine resources, I have elected to provide the standard introductory description of the hydrographic features of the region and other similar kinds of academic material as the Annexes to this paper, where you can review them at your leisure. I prefer to begin with a press clipping (page 2) regarding Barbados dated January 24, 1979, which is an instructive harbinger of what lies ahead in Caribbean marine resource management for all the independent states, the dependent territories and, to a lesser degree, the region as a whole.

The clipping contains just enough code words to make it useful as a primary text, of sorts, for this session of the workshop; I have numbered the paragraphs as a convenience and ask your indulgence while I read the eight short paragraphs. Pick out, and write down, what you think are the key words as I go along.

The announcement, which is no longer news, refers to an area that is 48,800 square miles, more than three hundred times larger than Barbados, which has 166 square miles with 66 miles of coastline. The implications for exercising control over such an area are formidable. In one fell swoop, Barbados has multiplied its resource base and its resource management option responsibilities by a factor of approximately 300 -- not percent but 300 as a multiplier. It is simultaneously extending its territorial boundary to twelve miles, as is increasingly common among nations.

This is no idle exercise in map modification, however, for Barbados is seeking gains and benefits from resources -- "the rich resources that surround it." There is legislation to protect these unspecified resources and severe penalties for offenses (including pollution) against those resources which are now part of the national patrimony (and no longer Res Communis under law).

Eight other islands are "affected" and the Ministry of Foreign Affairs is concerned about security. I should hope so!

Think of it -- nearly forty-nine thousand square miles of sea bed and ocean, and all the fish, minerals, corals, and whatever else is contained therein. It is an impressive addition. But let us

SOURCE: The Daily News of the U.S. Virgin Islands
January 24, 1979

Barbados Moves To Control 200-Mile Maritime Zone

BRIDGETOWN, Barbados, (AP) -- Barbados has moved to the control of a designated 200-mile economic zone in the Atlantic and the Caribbean, it was announced Monday. (1)

IN BRIEF

With the International Territorial Waters Act and the Marine Boundaries Jurisdiction Act now (2)

in force, the Adams Administration joined other Caribbean governments in extending its territorial sea limit from three to 12 miles and establishing an exclusive 200-mile economic zone, a government spokesman explained.

The legislation passed by Parliament here represents an attempt by the Adams Administration to make sure that Barbados gains "the greatest possible benefit from the rich resources that surround it," the spokesman said. (3)

Offenses covered in the legislation include pollution, drug trafficking, and illegal fishing. If found guilty, those charged could be fined up to \$5,000 and sentenced to serve jail terms up to five years. (4)

The measures bring Barbados in line with developments in International Maritime Law, a foreign ministry statement said. (5)

In the Caribbean where islands are so closely strung together and the new economic zone overlaps those of other islands, the division will occur at the half way point between the land area, the statement said. (6)

The islands affected include St. Lucia, St. Vincent, The Grenadines, Grenada, Trinidad and Tobago, Dominica and Martinique. (7)

The Foreign Ministry said the new legislation is expected to put increased pressure on island security, but Britain promised earlier this month to help establish a Coast Guard and a Fisheries Protection Service which will also cover St. Vincent and St. Lucia, both of which are British Associated States. Barbados, an independent nation, was once a British protectorate. (8)

consider, for a moment, the monumental task of effectively controlling and maximizing the benefits of all the resources situated between the Barbados coastline and the outer boundary of this exclusive economic zone (hereinafter abbreviated EEZ).

What is there?

Where is there?

Who is there (and when and why?)?

Who else cares?

(and lastly) How?

Let us take these one at a time.

What is there -- in this vast combination of coastal waters, shelf, deep sea bed, and the entire water column -- a three dimensional storehouse of resources, both living and non-living? It is an ecosystem/resource assessment task of no mean proportions, an enormously complex undertaking.

Where is there? Lacking boundary posts and fences, this offers some problems, for example, for fishing vessels belonging to other states.

Who is there (today) and gone tomorrow? Who else uses this space -- cruise ships, submarines, tankers, fishing boats, sea birds, whales?

Who else cares (in addition to the eight islands sharing somewhat the outer boundary)? CARICOM re fisheries? IMCO, OAS re oil spills and tanker traffic? IUCN/WWF re wildlife? PAHO/UNEP re pollution?

How will it be managed and by whom? What ministry can properly and responsibly deal with the shipping, oil spills, coral reefs, whales, fisheries, mining, boating, wildlife, benthic ecology, and pollution, to touch but a few variables in the equation

Resources + planning + eco-management = eco-development.

Now replicate the above tasks in each Caribbean state or territory, link them all up conceptually with ongoing regional strategies for fisheries (WECAFE), trade and shipping (CARICOM), the environment (UNEP/ECLA), conservation (CCA), and so on. G. Carleton Ray was right when he made reference to the "marine revolution". It has reached the Caribbean, which is what I would like now to turn to regarding EEZ's.

As is readily obvious from the data in Table 1, some states will fare rather better than others. Some, like Anguilla -- for which figures are not yet available, will do very well because of its ex-

Table No. 1

SELECTED EEZ DATA (CARIBBEAN)

Nation	Total Land Area (Square miles)	Total Area of 200 mile (Sq. nautical miles)	Total Land Area and of 200-mile (square nautical) combined
1. Bahamas	4,404	221,400	225,804
2. Barbados	166	48,800	48,966
3. Dominica	290	5,800	6,090
4. Dominican Republic	18,704	78,400	97,104
5. Jamaica	4,411	86,800	91,211
6. Trinidad and Tobago	1,980	22,400	24,380

Source: UN/OETO "Development and Management of Resources of Coastal Areas". 1976.

posed position, whereas Montserrat and Dominica will not be so fortunate.

The implementation of the EEZ concept raises several obvious and general questions for each state.

1. How large an area will a state get?
2. What are its boundaries?
3. What resources are contained therein?
4. Who is using them and will be allowed to continue to do so under what regional controls?
5. What are the resources worth?
6. How to manage the area and its resources, in combination with the associated coastal zone and territorial sea?
7. How to deal with regional coordination regarding boundary area uses, migratory species, pollution, conservation, enforcement, and management?

These new jurisdictions cover both living and mineral resources on the shelf and, in most cases, include portions of deep ocean basins that, especially around volcanic islands and archipelagos, offer the potential of commercial exploitation of manganese nodules.

The gain in ocean area means, however, that national economic planning and development must now include both land and oceanic resources within a new framework, and new planning strategies will be in order along with previously needed, but long delayed, coastal zone management and protection strategies. It is a formidable task for large states and will overwhelm the smaller unless external counsel and assistance is provided on an unprecedented level.

At the very least, a variety of new EEZ regulatory measures will be needed, and Roy Lee of UN/OETO has summarized them as follows:

1. Territorial sea and EEZ boundaries will have to be determined by some states.
2. A state may also need to make laws and regulations in respect of safety of navigation, marine traffic, protection of navigational aids, cables and pipelines, artificial islands, scientific research, hydrographic surveys, and control of customs and immigration. Where necessary, sea lanes and traffic separation schemes may also be needed for regulating other dangerous substances. While these laws and regulations may already exist, they must be re-examined in the light of the extended jurisdictions, particularly from the point of view of their enforcement.

3. Measures and requirements relating to resource management are probably needed most. With regard to living resources, the island state will have to determine, inter alia, the total allowable catch without depleting the stocks and its capacity to harvest. Other states may have access to the surplus only in pursuance of such terms and conditions as may be required by the island state concerned.

This active requirement of the island state with respect to fisheries is due partly to the consideration of world need for protein and partly to the demand of the distant-water fishing states which can no longer fish in those waters where they have previously depended. The need for management of living resources is therefore of paramount importance for most states. Some states will need to deal with such matters as licensing of fishermen, fishing vessels and equipment, species and quota which may be caught, seasons and areas of fishing, type, size and fishing gears that may be used, information required of fishing vessels, enforcement procedure and methods, and conservation of living resources.

4. Regulations may be needed regarding mineral and petroleum exploration and extraction.

But where do the priorities, strategies and plans come from and how will they be coordinated?

Furthermore, despite the greatly expanded powers over marine resources conferred on states by adoption of EEZ's, no one has defined corresponding responsibilities to safeguard and manage scientifically the living resources within each EEZ. Yet the resources of one EEZ are seldom independent of other EEZ's.

This has been recognized by CARICOM with reference to fisheries resource management in Caribbean EEZ's, and the 1978 statement provided as Annex B to this paper outlines an alternative strategy to letting each state confront the problems of inter-locking ecosystems separately and independently. Unfortunately, it was a nice idea ahead of its time, but I include reference to it here to illustrate that when you are dealing with a resource worth \$US 100 million annually, scientists and planners and conservationists with regional perspectives and objectives, however rational and compelling from an ecological standpoint, will be hard pressed to achieve their management objectives in the face of the national considerations of newly independent West Indian states, without a strategy of their own. The present search for regional strategies for critical marine habitats and natural area protection in the Caribbean, of which this workshop is a part, offers a preliminary model for a full

spectrum regional marine resource strategic planning effort on the part of CARICOM or whomever.

But there are problems (some old, some new), and I would like to turn now to briefly review some of them.

CURRENT PROBLEMS OF ISLAND MARINE RESOURCE MANAGEMENT

A. Perhaps the single biggest problem in dealing with the marine resources of islands is the paucity of solid historical and statistical information and the basic ecological data needed to develop a rational exploitation and management strategy for the coastal and marine resources of each specific island. The material needed is either so completely lacking in value or sufficiently incomplete that it is often risky to use in its present form. This problem results from:

- (1) The more or less acute shortage of academics who can carry out research on the physical, chemical, geological, economic, social and ecological aspects of a coastal area.
- (2) The lack of government measures aimed at stimulating coastal area and marine related research, data collection and monitoring.
- (3) The small number of effective marine and coastal research centers in the region that are directly concerned with local and regional environmental management, as well as the large number of centers in the region that tend to serve as scientific hotels or sponsors for researchers from external areas who have little interest in the resource management problems of the area and whose research efforts serve them, but not the host area or region, effectively.
- (4) The failure of most small island states to develop and maintain national museums, national archives, national libraries, or their equivalents (since these serve as repositories of data otherwise scattered and neglected).

B. Only two island areas in the region, both appendages of the United States, have established full fledged coastal area development programs and EEZ resource management programs to rationalize the development of adjacent marine and coastal areas. Until equivalent programs are developed by each major island in the Caribbean, it is very unlikely that any integrated or coordinated management strategy can be developed for the use of coastal and marine resources within the area.

Further, because of the topography of most Caribbean islands, traditional patterns of habitation and employment, and even informal recreational activities, there is (as in the case of continental areas) an enormous concentration effect within the coastal zone. For a variety of reasons this has resulted in a high population density in the coastal zone of small islands. Trinidad, for example, has coastal areas with 1,200 persons or more per square mile as opposed to the national average of 500. In those coastal areas, drainage is poor, solid waste problems are more concentrated, water supply is more difficult to obtain and maintain, and there are serious conflicts among users, both traditional and new.

C. In most of the island territories in the region, there is no central body invested with either exclusive authority or competence for the planning of coastal and marine use, including the recently established EEZ. The management of coastal and offshore areas tends to fall within the various government agencies which have existed for extensive periods of time (for example, a physical planning office, a ministry of natural resources, a ministry of finance that handles economic planning, a ministry of external affairs, plus a ministry that deals with environment health) and are jealous of existing prerogatives and practices. Even when governments have some kind of integrated national planning authority, it is not uncommon for those authorities to consider the coastal and marine region to be an ecological entity totally external to their own mandate for comprehensive planning. Regretfully, the recent establishment of the EEZ has not yet been reflected in any significant structural adjustment of the entire planning and management process, especially with regard to the development of truly integrated, coordinated, multi-disciplinary planning regarding the marine environment.

D. Most of the island countries in the Caribbean region have various legal regulations that govern the use of certain specific resources in the coastal zone or in the marine areas, but these tend to be very sectoral and are, on occasion, incomplete, complicated, and lack linkages with other departments of government. In general, they totally disregard both ecological or environmental variables as well as any sensitivity to traditional uses. Furthermore, there is generally no provision in local regulatory procedures for the involvement of the public within the planning process. Caribbean governments generally rely entirely on the political process to reflect public goals and interests, but rarely reach out in any formal way to institutionalized segments of the public for counsel, advice, assistance or support between elections regarding resource allocation and management decisions.

E. Local knowledge on island coastal zone and marine areas has a very unfortunate tendency to be not only sectoral and limited but also highly user oriented. This consideration applies to public agencies as well as to private industry. For instance, data on currents and sea conditions is often collection by shipping interests but hardly suffices to meet the needs of an environmental planner concerned with coastal problems. Engineering investigations for the specific design of a shoreline structure in a particular bay or for dredging sand may not take into consideration the local fisheries

along the coast, and, in a parallel context, an economically important industry such as the petroleum processing activity, whether a tank farm or a refinery, normally pays little attention in its environmental investigations regarding oil spills and pollution problems to matters of wildlife and fisheries or how a rare species might be threatened by its activities. Furthermore, even research activities carried out on behalf of various international agencies also tend to be highly structured by the terms of reference imposed in the original working arrangement. Thus, it can be said that the characteristics of the coastal zones and the marine environments of island areas tend to be highly compartmentalized, highly single user oriented and, in general, the scope and depth of the available data are inadequate and rarely take into consideration the traditional uses. Furthermore, there is almost inevitably a prejudicial imbalance between the capacity of the traditional users of an island coastal environment and current or prospective new industrial users, in their respective capacity to mount sufficiently comprehensive and effective research and reporting activities regarding elements of the diverse parameters that actually need to be surveyed if a true interdisciplinary, holistic ecological assessment is to be carried out.

F. Oil spills and environmental protection. Locally speaking, the emergence of the Caribbean as a focal point in the American hemisphere regarding petroleum production, deepwater transshipment terminals, storage, processing and re-export activity is (with the exception of tourism) perhaps the most pervasive and possibly pernicious element in contemporary regional development activity.

- (1) As of 1973, one-sixth of the world's oil was produced in, refined in or transshipped through the Caribbean/Gulf area.
- (2) One of the world's largest automated refineries (800,000+ barrels/day) is located in the Caribbean. A new major refinery is proposed in St. Lucia by the same company where it is currently erecting a transshipment terminal. There are at least twenty other existing refineries.
- (3) The Caribbean region is an area where oil and tourism, as industries, confront each other, eyeball to eyeball, in at least ten locations.
- (4) The Caribbean region has no oil spill disaster contingency plan (except an industry sponsored effort which is not adequate), although the larger states and OAS have plans for one. Few islands have domestic contingency plans, and a small island regional oil spill contingency planning effort is needed also.
- (5) Six major deepwater (super-tanker) oil transshipment terminals exist or are under construction in the Caribbean, and others are being planned, partly as a reflection of environmental constraints on such facilities

in continental areas.

- (6) At least twelve major multinational oil companies have production/transshipment facilities in the Caribbean, and the big firms have a history of being difficult to regulate offshore and capable of presenting a united front when under pressure by governments.
- (7) The British Virgin Islands government has leased 600 square miles of seabed on its northern shelf area to Mobil Oil.
- (8) It is noteworthy that pollution originating from oil processing industries can be quite considerable in the areas of large oil refineries. In order to give an estimate of this pollution it can be assumed that about 1 cubic meter of water is used for each ton of crude oil processed in a refinery, and the resulting effluent contains amounts of oily substances in concentrations of about 100 ppm.

G. The dimensional aspects of one vital user category in the marine environment -- namely, recreational charter boating (with its ancillary supporting components -- marinas, water sports such as diving, etc.) -- remain veiled in mystery, more or less unrecognized, unquantified, untaxed, and unregulated.

H. Cruise ships, tankers, roll on/roll off cargo vessels and barge traffic continue to compete with traditional pot fishermen for sea space, destroying thousands of pots annually by their arbitrary passage through seasonally shifting pot fishing areas, and encouraged, in part, by government failure to establish and maintain sea lanes.

I. Planners in the Caribbean are notoriously ignorant of and planning agencies are notoriously ill-equipped to deal with the marine environment in all its dimensions, not only because of its scientific complexity, but also because of countless unconventional uses, its international jurisdictional problems, and its need for different kinds of planning strategies (as opposed to traditional physical planning).

J. Governments are also notoriously ill-equipped to deal structurally with the administration and management aspects of both coastal and marine environments because the mechanism for or process of integrating adequate information flow and conflict resolution among competing users are inadequate. Furthermore, the marine eco-system and its living resources lack protagonists save for the scientists who have difficulty communicating with non-scientists.

SPECIAL CONSIDERATIONS FOR THE MARINE RESOURCE PLANNER

1. Apart from the overarching requirement for the process of strategic planning in the marine environment to incorporate the eco- "logic" of ecosystems (as per Ray, Johannes, and others), the identification and quantification of users, user activity and projected users is of prime importance, in part, because the process forces the planner to confront the competition/conflict/trade off question at the outset and provides a continuous feedback loop to both political reality and whatever planning/zoning/classification and mapping methodologies are selected.

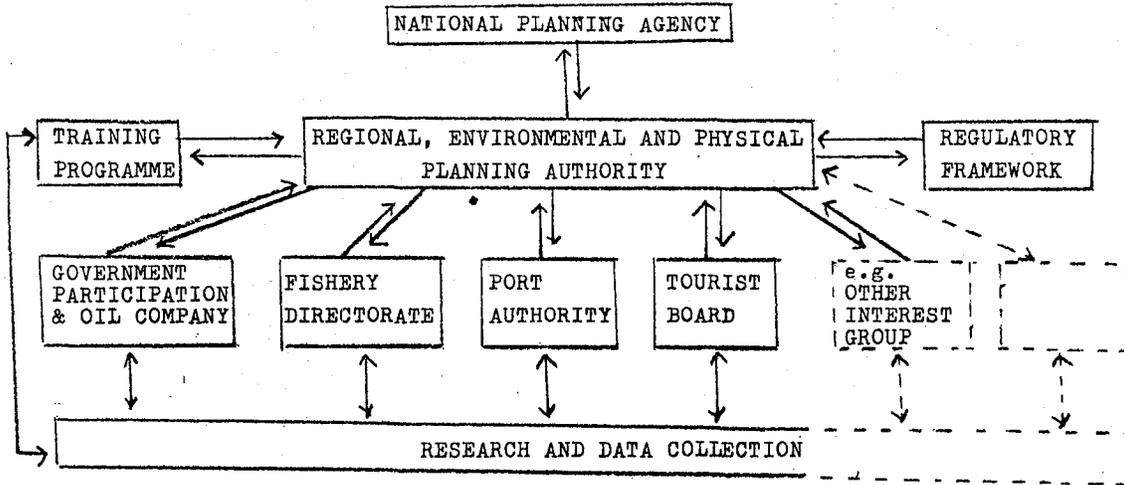
2. At the very least, a marine environment user assessment undertaking should document inter alia

- * Type and Categories
- * Frequency (cycling patterns)
- * Locus (point and scope)
- * Diversity
- * Slope
- * Significance (value, percentage GNP, percentage area affected, percentage extractive)
- * Jurisdiction(s)
- * Incompatibility Factors
- * Risk
- * Implicit Disbenefits

3. The planner must learn to deal with

- (a) Unconventional uses and projected uses, such as underwater laboratories, mariculture and upwelling, desalination, precious coral harvesting, underwater archaeology, ocean dumping, etc.
- (b) The open access problem.
- (c) Ephemeral/shifting juxtapositions of some uses.
- (d) Ephemeral intrusions (i.e., pollution) across boundaries.
- (e) The land person's naiveté and conceptual limitations via à vis "the sea", i.e., the lack of marine literacy within the community.

4. As the UN Ocean Economics and Technology Office has noted, there must occur a re-organization of the framework of planning if the needs of the coastal and marine zones are to be met and the eco-system carrying capacity not exceeded. Neuman, of that office, has offered a model that will be useful for discussion purposes.



Proposal for a regional planning authority

Needless to say, some adjustments will be needed in each island case, but the objective of comprehensive, integrated, multi-disciplinary, user/manager dialogue leading to a process of management is fairly obvious.

5. Lastly, the principles and methodology implicit in Miller's park planning strategy appear eminently adaptable to the larger context but need to be adjusted in light of recent experimentation with planning strategies for the coastal zone, as documented by UN/OETO and others. Zoning mechanisms for marine areas have yet to be proven workable. Matrix strategies have proven cumbersome and tedious, computer mapping and analysis of variables costly, and remote sensing both costly and insufficiently precise for most monitoring purposes. What it comes down to is getting on with the process of experimental design and strategic planning, on with the process of training new kinds of marine sector planners, and on with the process of politics, local and regional, which will ultimately determine the future of our marine ecosystems and resources in the Caribbean.

HYDROGRAPHIC FEATURES OF THE REGION

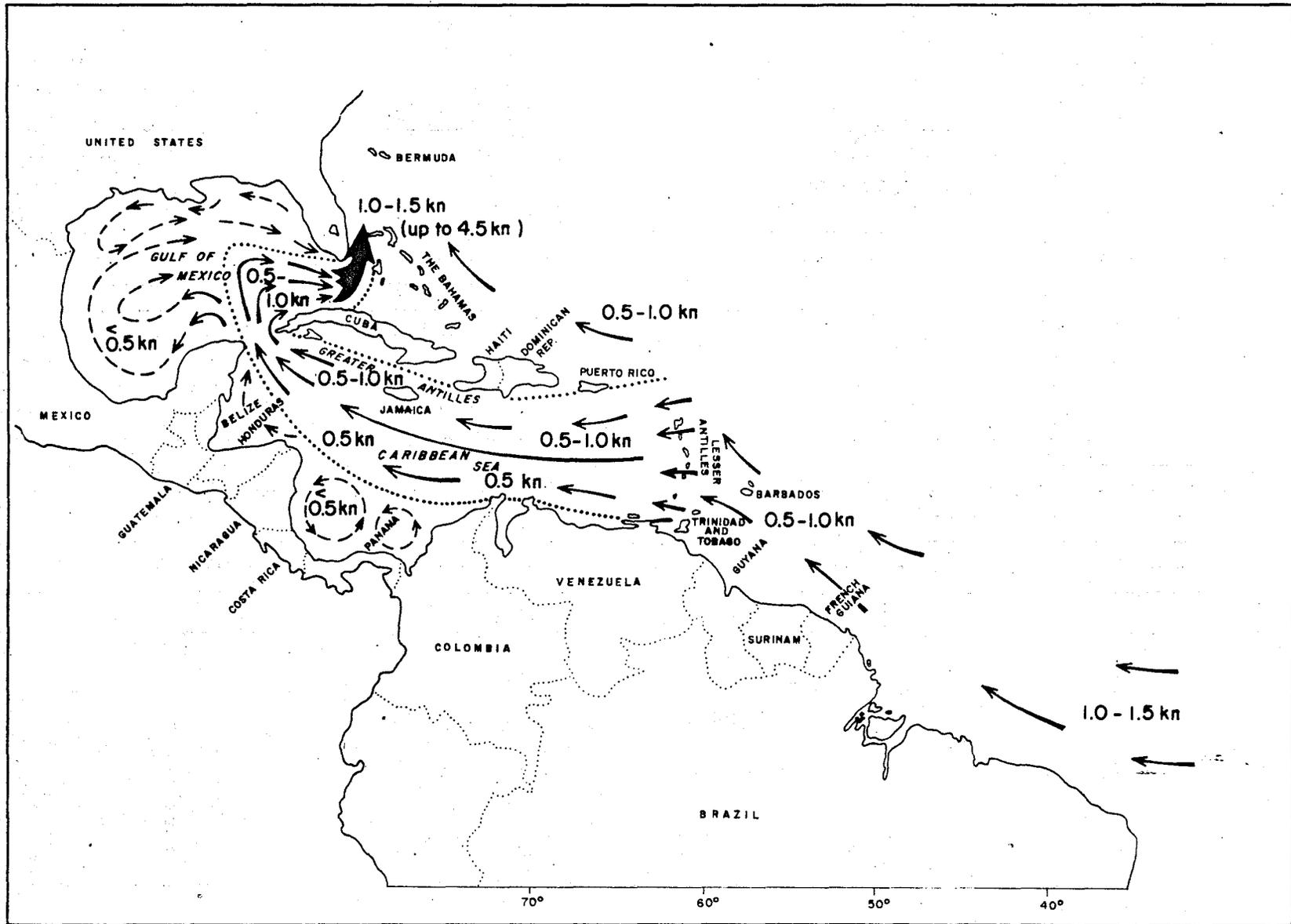
Oceanic circulation in the Caribbean region is highly dependent upon atmospheric patterns and the externalities of wind and density driven currents in the South Atlantic basin. The Caribbean region has extensive subaerial barriers extending along its northern and eastern boundaries, and the oceanic circulation in the basin is highly conditioned by the existence of numerous deep and even more numerous shallow passages between the islands linking the Caribbean region and the South Atlantic.

The total area of this region is 4.31×10^6 km². As the mean water depth is 2,174 meters, the total volume of the water masses in the region is 9.37×10^6 km³. The greatest water depth is located in the Cayman Trench (6,895 meters) to the west of Jamaica.

The Caribbean Sea is internally subdivided into various basins which are bordered by submarine sills. For example, a sill of less than 200 meters between Jamaica and Honduras separates part of this sea; other sills with depths of less than 3,000 meters also divide this main body of the Caribbean Sea into three different basins: the Colombian basin in the west, the Venezuelan basin in the middle of the area and the small Grenada basin to the west of the Leeward and Windward Islands and east of the Aves swell which extends from Saba to Venezuela.

The most striking hydrographic feature in the region is the continuous flow of water through the area from east to west in the Caribbean Sea proper, followed by a movement from southeast to northwest in the Yucatan basin and finally, in the Gulf of Mexico, a strong flow to the east again through the Straits of Florida. Approximately 30×10^6 km³ per second pass through the various passages between the islands of the Lesser Antilles transported to them by the combined equatorial currents. The general movement of this water, which is reasonably stable throughout the year (although some seasonal changes can be found in velocities), is shown schematically in the attached Figure in which an area of continuous flow is indicated by a dotted line. Velocities given are mean velocities during the year. Outside the dotted line currents are weaker and also relatively unstable.

The sea surface temperature in the tropical parts of the region has an average value of 27° centigrade and does not vary considerably throughout the year. The seasonal fluctuations do not exceed 3° centigrade. There is very little reliable information on the sources and effects of pollution from most of the countries in the Eastern Caribbean Archipelago. There is, in fact, a very real need for the early implementation of national monitoring programs to establish the degree of coastal pollution from both industrial sources as well as from agricultural runoff and urban areas.



REGIONAL MANAGEMENT FOR PELAGIC
FISHERIES OF THE EXCLUSIVE ECONOMIC ZONES
OF CARICOM COUNTRIES IN THE CARIBBEAN SEA

INTRODUCTION

Exclusive Economic Zones (EEZs) up to 200 miles (360 km) from the coast will have come under the jurisdiction of most coastal states of the world by the end of 1978. In the Caribbean CARICOM countries the total area of EEZs will approximate 750,000 km² (exclusive of Guyana) and for most of the island states will represent oceanic areas with a resource potential of appreciable amounts of pelagic fishes including tunas, billfishes (marlins, etc), kingfish, flying fish, dolphin fish, etc. An estimate of the total annual potential yield of pelagic fishes from this large area is about 100,000 tonnes based on various reported catches of tunas, flying fish, kingfish, etc., and surveys made by FAO. This estimate is exclusive of near-coastal small pelagics and reef fishes presently exploited by national fisheries. Such a large quantity of fish can be valued in the order of \$US 100 million annually but is at present only lightly or not at all exploited by coastal states and only beginning to be exploited by distant water fleets in the course of their high seas operations in the Atlantic. Proposed regional fisheries joint-ventures are also being planned to exploit some of this fisheries potential. However, as development of these fisheries gets under way a regional policy with respect to management of these resources should be formulated through data analyses from fisheries research and statistics. Fisheries policy should also include the possibility of being able to bargain on a regional basis with fishing interests for maximum utilization of the resources and a reasonable share or return to the coastal states in whose EEZs the fishes are caught.

While the division of oceanic areas into economic zones is extremely complex in some areas among the islands, and may take some time to negotiate between adjoining states, it would be useful for policy guidelines with respect to fisheries to be formulated at an early stage. Since a large part of high seas operations of fisheries for pelagic species such as tunas takes place within

100 miles of land, a common regional approach to negotiations with countries for use of EEZ pelagic resources would be valuable. Incidentally, with respect to the non-CARICOM states in the island chain such as Martinique, Guadeloupe, St. Maarten etc., a preferential allocation of pelagic fishery resources of nearby states or free access to adjoining economic zones would be reasonable since the highly migratory pelagic species are constantly moving and may need to be followed for some distance to be fished effectively on some occasions. Also management of the pelagic resources would need to be on a regional scale because a migratory fish population will cover vast areas of ocean and may be fished only occasionally in areas of concentration for relatively short periods. Added to this is the fact that origins of such populations (where they spawn) may be far away from where they are eventually fished.

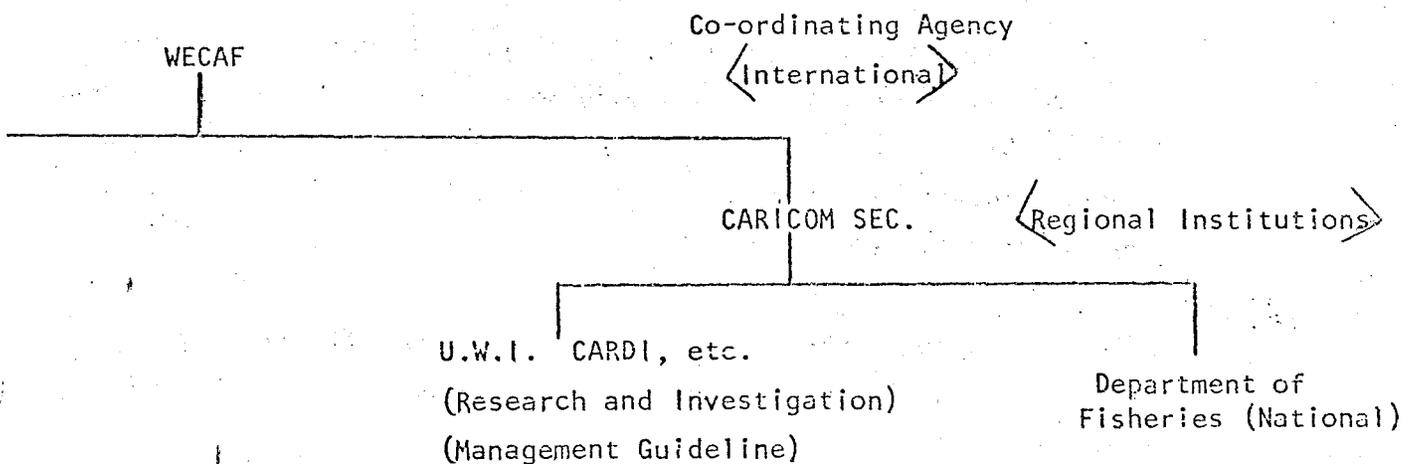
SUGGESTED POLICY GUIDELINES

The following guidelines with respect to management of pelagic fishery resources in the CARICOM area are suggested:

- (a) States should give and update information on landings of pelagic fish and on capacity to harvest these species in terms of fishermen and boats and gear. Many species come near shore and are harvested regularly. Fishing records from St. Vincent in 1976 showed that about 30% of the catches were of pelagic species.
- (b) States should promote optimum use of pelagic fish resources giving access to other countries to fish surpluses, recognizing in this way the scarcity of world fish supplies and their obligation in claiming an exclusive economic zone of large area.
- (c) Allocation of pelagic fish resources may be on a preferential basis to neighbouring states, may be bid for competitively or divided arbitrarily or according to management quotas for various species on a first come first served basis.
- (d) Licensing fees and conditions as applicable should be uniform throughout the region to make sense for fisheries management.
- (e) One of the important conditions of allocation of quotas and/or licensing should be that data on catches by species, number of days fishing and boats and areas where catches are made should be supplied to a regional body and/or coastal state which is undertaking management of the resources.
- (f) Conditions of licensing or allocation of quotas may specify that part or all of the catches of selected species (except tunas?) may be landed and processed in the coastal state.

- (g) Surveillance to denote infringement of regulations with respect to economic zones including area, gear and species, etc., may not be necessary in early stages since distant water fleets report positions to world data systems (for tunas), but coordinating surveillance efforts or the processing of such data and reporting to coastal states could be done most effectively by a regional body (partly because of the large area of the EEZs involved and the capabilities of individual states).
- (h) Research and analyses of the data collected could be done most effectively by a regional body (a Fisheries Section in CARDI or a regional fisheries research unit in CARICOM).
- (i) Management of the pelagic fish resources would be based on research information, and would be coordinated by a regional body (CARICOM) which would be able to undertake implementation of agreed policy such as allocations of quotas, negotiations of conditions, etc., on behalf of member states.

ORGANISATIONAL RELATIONSHIP OF VARIOUS AGENCIES



ADVANTAGES OF REGIONAL MANAGEMENT OF EEZ PELAGIC FISH RESOURCES

The advantages of a regional approach to management of the pelagic fish resources in the exclusive economic zones of member countries are:

- (a) The pelagic fish populations are mainly common to the surrounding seas of these countries and intermigrate between the proposed economic zones, so that common management procedures are required to maintain the stocks from over-exploitation and to promote their optimum utilization.
- (b) Some highly migratory fish species such as tunas in these zones are sought after by distant water fleets and negotiation of appropriate rates of exploitation could be done by a regional body from a position of strength when the larger area is considered than would be in question if negotiated by a single state.
- (c) Negotiation with regional non-CARICOM states for preferential allocations of pelagic fish resources or preferential conditions would be for mutual advantage if based on common policy implemented by a regional body.
- (d) Information on research results, advice on management procedures, etc., could be made more readily available to coastal states by a regional body (CARDI Fisheries Section could handle the data from their own research results and from other research entities in the region and provide the advice through CARICOM).
- (e) CARICOM as already constituted would have a special advantage in its contact with member states and its international recognition as a negotiating body.

NEED FOR SUPPORTING FISHERIES RESEARCH AND DEVELOPMENT

Fisheries research in the CARICOM area is essential to give information on the extent of the pelagic fish resources; the possibilities of increasing or enhancing these resources and the technology to exploit them effectively. Continuing and regular fisheries research is still relatively unknown in the area but this could be remedied through creation of a regional Fisheries Research Institute (e.g. a Fisheries Section in CARDI) with a long-term programme for various areas and species, including pelagic species. Before fisheries for pelagic species are expanded research should begin through collection of data using fishing boat charters and present fishing technology modified by masterfishermen and fisheries biologists who will study biology including behaviour of the main species to determine their catchability and abundance. A Project is planned by FAO (WECAFC) to improve and develop small boat fisheries but with insufficient direct input by fisheries biologists in the preliminary plan. Comprehensive and continuing statistics of the present national fisheries is also planned by WECAFC and these will indicate the present rates of exploitation of reef fishes and to some extent pelagic fishes, but this must be supplemented by active direct programs of study on pelagic species that will lead to development of fisheries for these species by the various states or the presently planned regional projects of CDB. Research results and recommendations are needed, in effect, before such development takes place, and regular research programmes should be carried on to monitor development effects whenever new or expanded fisheries take place. This could be done through staff activities of a Fisheries Section in CARDI able to make direct input in the field and also to coordinate other research efforts throughout the CARICOM area. Contact would be also maintained with other international bodies working on fisheries in the area such as WECAFC, ICCAT, etc.

CONCLUSION

It is suggested that Governments consider the possibility of delegating authority to CARICOM to coordinate management of the pelagic fish resources of their Exclusive Economic Zones. Regional research effort (for which there is a need) will indicate distribution and size of the resources by species, and best use of these resources should be considered in the regional as well as the national interest especially where capability to fish or arrange for allocation of quotas to other countries is in question. Regional policy guidelines should be written and agreed upon and could form a negotiating text from which a common stand could be taken to solve problems of quota allocation or licensing distant water fleets. The matter of data collection and analysis from records of catch and effort per area could be coordinated more easily if handled by a central agency such as CARICOM. Although the matter of surveillance within the large oceanic EEZs might not be easy to arrange because of the expenses involved it would be useful for the regional body to monitor reports of fishing fleet activities available at World Data Centres in Washington or Tokyo (for tuna). Multiplicity of contacts between individual countries and data centres, etc and monitoring information, especially where Governments do not have fisheries personnel, can be cumbersome and inefficient compared with the capability of a regional body such as CARICOM for the island states of the eastern Caribbean.

MARINE ECOSYSTEM CONSIDERATIONS

Carleton Ray's (1972 and 1976) extensively developed ecosystem approach to marine resource management is a valid and valuable concept. The underwater ecosystem is a complex organization of biotic and abiotic factors in an equilibrium network that is constantly shifting with a changing environment. As long as the environmental change is within the realm of the adaptability of the organisms comprising the community, there will be equilibrium shifts, but the ecosystem will remain viable. Perturbations (i.e., natural climatic changes or man-made impacts) that destroy this equilibrium could have catastrophic effects on the stability of the entire ecosystem.

Tropical systems are more complex, with many more species that are highly specialized. What is important from a management point of view is that any one organism is more easily destroyed by less catastrophic perturbations than in temperate regions, and is more likely to be replaced by a transient species. For example, the crown-of-thorns starfish found in the Pacific reef areas is rapidly eating away reefs that are being replaced by algae communities (Goreau, et.al., 1972). Thus exotic reefs are being replaced by less esthetic algal mats. This would have a catastrophic effect on an area designated to be preserved in its natural state. We are not suggesting that we should or could control the starfish outbreak, but it is an example of a perturbation in the tropics. The main point of my argument is that in the tropics a return to an equilibrium is a long successional process. The extensive literature on artificial reefs illustrates the long successional process required to establish a stable reef community. Tropical communities are very sensitive to perturbations. Even though an equilibrium may be easily established, the species composition is likely to be very different.

Inshore underwater areas of islands have the same problems of geographic isolation and "small size effect" as do terrestrial oceanic islands. Evolutionary factors operating on organisms on islands and continents are surely the same, although they are of different patterns (Dobshansky, 1965), creating populations that are different from the mainland. Colonizers of islands only have a subset of the gene pool of their original population. Natural selection, therefore, is different in these now isolated populations. Speciation is more rapid, and, as a result, islands have many more endemic species.

Inhabitants of islands differ from island to island due to priority effects (Levins, et. al., 1974), which gives an ecological advantage to the inhabitants which arrive first. Probability of colonizer species arriving in the same order to any two islands is low. Thus, the array of island inhabitants for each island is unique.

Island size is the limiting factor on the number of species that can occupy the space. Fewer species, fewer interactions, a decrease in competition, and a broadening of the niche are all characteristics of island populations.

There is no point in discussing the differences between marine and terrestrial ecosystems as this has been adequately outlined by Ray (1972 and 1976). One can, however, emphasize the point made in Ray's discussion that drawing parallels between terrestrial and marine conservation is hazardous. A comparative evaluation between the operation of the two systems is not available. Marine ecosystems have their own properties, and since scientific data on marine ecosystems is minimal compared with terrestrial ecosystems, there is much work to be done before effective management guidelines can be firmly formulated.

Research programs need to be planned for obtaining baseline data on marine communities that offer feedback for formulating and modifying management regulations. Four ecological research approaches are proposed that go beyond the customary descriptive first effort and can provide data for management interpretation:

A. Species Diversity Analysis. Species diversity can be defined as the number of species, or in more quantitative terms, they are measures that represent both the number of species and their relative abundance. Using species diversity measures, different areas can be compared and the same area can be monitored over time for significant and informative changes.

It has been found, for example, that pollution usually results in a decrease in species diversity. However, if the pollution is nutrient rich (some sewage) there is a decrease in species diversity along with an increase in productivity. Nutrients are being converted into biomass.

Monitoring diversity, density, and size/class structure of various species in the community can serve as a sensing device to indicate troubled or changing areas. All marine reserve areas should have such a monitoring system.

B. Ecological Niche Analysis. A marine resource planner should know how organisms of the community utilize space, their position in the food web, and both their interspecific and intraspecific interactions. This information is critical for evaluation of the effects of removal or manipulation of any of the organisms on the rest of the community.

C. Succession, Cycling, and Recovery Rate Data. The studies of Simberloff (1969), Simberloff and Wilson (1969), and Heatwole and Levins (1972) on mangrove islands have shown rates of recolonization and establishment of species equilibrium on completely defaunated islands. Such studies are recommended for underwater areas as they predict recovery rates for areas subjected to disturbances.

Successional phenomena were discussed by Mueller-Dombois (1973), emphasizing succession occurring on islands, the ecosystem approach to the analysis of fauna and flora of areas, and stresses on island biota. The succession data presented on the Hawaiian biota allowed the investigator to examine impacts on the indigenous ecosystem. Such experiments are valid for marine ecosystem analysis.

D. Indicator Species. The plants and animals themselves are good indicators of environmental conditions. The appearance, disappearance, and dominance of certain species indicate environmental changes to which the organisms are responding.

Organisms that are signs of deteriorating environmental conditions should be known and recognized as such. Continuous monitoring of the species compositions should be done for each marine park or reserve area along with studies to add new species to the indicator list.

FISHING FOLKLORE AND SURVIVING LUNAR RELATED STRATEGIES

Within most artisanal fisheries communities in the Caribbean, there exists a great lore of traditional fishing strategies. Frequently this lore is based on misinterpretation or incomplete understanding of fish behaviour and oceanographic phenomena, but it is all derived from experience and subjected to the rigors of historical responses and natural selection. A fisherman who utilizes a body of lore that negatively affects his catch rate will not be as successful as one who utilizes a more successful body of lore. Consequently, although science may undertake to ascribe causal origins to successful lore, its functional role in the fishery is not dependent on an accurate understanding of the causative factors. It may be instructive, however, in the design of research efforts.

As traditional artisanal fisheries are being absorbed into contemporary cultures and economic formats and subsumed under local, regionally funded "assistance" programs, and while actual causal relationships between catch rates and environmental phenomena are being esoterically described by scientists, much of the traditional fishing lore in the Caribbean is falling into disuse. However, in many parts of the region, the introduction of modern fishing strategies and imported technologies has resulted in increased catch rates, despite increased capital investment levels. This failure points out the danger of wholesale disregard of traditional fishing strategies.

One of the most intriguing subsets of the larger body of Caribbean fishing lore is the role of lunar cycles and lunar-related fishing strategies which are utilized by most of the surviving artisanal fisheries in the region.

Trap Fisheries. Catch rate is alleged to be dependent on lunar phase. Even sticks for bracing traps (or fish pots) are still cut by many fishermen during the "dark of the moon" (during a three day period) when "the sap is high" (perhaps because they better resist infestation by marine borers).

Line Fishing. Fishing for yellowtails (Ocyurus chrysurus) is done during the full moon when the tidal current will spread the chum and attract the fish. Kingfish travel to the east as the moon proceeds from new to full and to the west from full to new. They, like most line fish, bite as the moon is rising and setting. Nassau groupers breed for two months near the winter solstice. During these two months 85 percent of the catch is taken from the first quarter until the last quarter. The catch almost always drops off during the day of the full moon.

Net Fishing. Feeding and schooling activity is believed to be related to lunar phase. Fishing activity definitely is, and many fishermen consult the Farmer's Almanac concerning whether or not a day will be a good day for fishing.

The preservation of such lore is not only of cultural import but also may lead to more efficient management of local fishery resources among island communities of the Caribbean. At the very least, information on lunar strategies and related kinds of local lore and practices should not be overlooked as a source by marine resource and coastal zone planners seeking to determine user practices, schedules, patterns and needs, as an element of the planning process. Such data minimizes user conflicts and aids in developing effective regulatory, protective marine resource management guidelines.

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