The Queen Conch Fishery In The Caribbean - An Approach To Responsible Fisheries Management

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ABSTRACT

The low abundance of queen conch (*Strombus gigas L.*) in many parts of the Caribbean is cause for concern and urgent steps are required to protect the resource and the livelihoods of those who depend on it. Queen conch represents one of the most valuable demersal resources in the region and is second only to spiny lobster in fisheries value to the Caribbean region. Although not threatened with extinction the queen conch has been placed on Appendix II of the Convention of International Trade in Endangered Species (CITES).

Generally there is considerable knowledge available on the biology, ecology and dynamics of the species that should be used as a basis for management action while additional knowledge is accumulated. However there are important uncertainties in the knowledge of the resource and these require actions based on conservative assumptions in keeping with the Precautionary Approach to Fisheries. This paper examines this principle and others related to the harvesting of living marine resources for long term sustainability, particularly as contained in the Code of Conduct for Responsible Fisheries. The Code urges states to apply the Precautionary Approach using the best scientific evidence available including stock specific target and limit reference points and what actions should be taken if these points are exceeded.

In view of the need to manage queen conch at the level of local aggregations much responsibility for management will rest will individual states. There is much to be gained from regional co-operation and it is recommended that a regional management arrangement be established to co-ordinate and facilitate exchange between management organisations. Sets of national objectives need to be developed with the participation of all recognised interest groups, including fishers. These objectives should encompass biological, social, economic, marketing and other key concerns. In order to develop a coherent set of regional objectives there may be the need for compromise.

KEY WORDS: Caribbean, fisheries management, queen conch, *Strombus gigas*

INTRODUCTION

The utilisation of the meat of queen conch (*Strombus gigas* L.) as food and its shell for artefacts and ornaments goes back to pre-Colombian times. From these origins until recently, the queen conch was harvested by artisanal fishermen mainly for local consumption and limited inter-island trade. However, within the past 20 years, a sizeable commercial fishery has developed as a result of an increasing human population, the migration of Caribbean people to North America and the growth of the tourist industry. Now, the queen conch represents one of the most valuable demersal resources in the region and is second only to spiny lobster in fisheries value to the Caribbean region. It was estimated, based on reported landings (Table 1) that approximately 6,000 mt of conch meat may be harvested from the region each year, and this figure does not take into consideration the unknown quantity used for local consumption and extracted by poachers. Applying an average wholesale value of US$ 10/kg to the known harvest results in an overall value of the Caribbean fishery of US$ 60 million. This estimated value of the fishery could, however, be multiplied several fold due to the jobs created in the processing and marketing of conch meat and ornaments particularly through the tourist and restaurant trade. In addition, the conch fishery provides valuable jobs and its high market value makes it an important source of foreign exchange through export or domestic sale to the tourist industry.

The largest single producer of conch is Jamaica, which exported 2,051 mt of conch meat in 1994, valued at US$ 8.33 million (Smickle, 1995). The conch fishery is one of the major foreign exchange earners for that country, earning more than the lobster fishery. Jamaica's 13 conch processing plants employ approximately 531 permanent workers and 749 temporary workers. In Cuba, a significant portion of the catch of 1,500 mt is used for bait, representing a substantial loss of potential income (Appeldoorn, 1994). The recorded landings of other countries fishing for conch are substantially lower than these two, with the next highest national landings being approximately 500 t per annum (Table 1).

DISTRIBUTION AND HABITAT

The queen conch (*Strombus gigas* L.) is generally distributed throughout the shallow waters of Bermuda and southern Florida, the Caribbean islands, Central America and north-easternSouthAmerica to Brazil, but is not found south of the Orinoco River in eastern Venezuela.They are found in clear waters associated with sandflats supporting seagrass beds and algal species where conch obtain both food (macroscopic and unicellular algae and detritus) and shelter. Older conch may be found in coral rubble and gravel substrates away from seagrass beds. Conch are found in depths ranging from shallow subtidal waters to 76 m.

However, densities decrease significantly below 30 m due to light limitations for plant growth (Randall, 1964).

STATUS OF STOCK

Although not threatened with extinction, the queen conch has been placed on the World Wildlife Fund Red Book as "commercially threatened," due to heavy fishing pressure which has resulted in drastic declines in natural populations in most fishing areas. Strombus gigas has been placed on Appendix II of the Convention of International Trade in Endangered Species (CITES), which lists species in danger of possible extinction. CITES requests importing countries to ensure that each shipment of conch is certified by the Scientific Authority of the exporting country so as not to endanger the conch population. CITES was concerned about the level of export of conch from Jamaica and requested a management plan for the species for that country. The plan was submitted to CITES which made it possible for exports to continue (Smickle, 1995). Accessibility, ease of harvest and high demand have resulted in generally fully-exploited or overfished conch stocks (Table 1).

The resource is harvested mainly by divers (free, SCUBA and Hooka) using small boats. In the Bahamas, hooka equipment and in Dominica, gillnets are also used. In some countries such as Belize, Colombia and Martinique, SCUBA is prohibited. In Jamaica, industrial size vessels (20-35 m) are used on the Pedro Banks. Twelve such vessels were licensed in 1995, most of which were leased from the Dominican Republic, Honduras, Nicaragua, and the USA. Some divers on these commercial vessels use SCUBA gear. The vessel crew usually consists of eight persons but this number could increase to 36 if divers and canoe operators ('dorimen') are included. Each trip, averaging 1-1.5 months, can land an average of 13,600 kg of meat (Smickle, 1995).

As can be observed from Table 1, the status of conch stocks is variable in that some areas like Saint Lucia have unfished populations while in other areas, such as Martinique, Cuba and Turks and Caicos, the resource is heavily exploited but not threatened. Overfishing is also apparent in many areas such as Colombia, Florida, Mexico, Puerto Rico, St. Thomas/St. John (US Virgin Islands) and Venezuela.

BIOLOGY AND MANAGEMENT

At the time of sexual maturity, conch cease to grow in length and produce a characteristic flared shell-lip. This begins to occur after three years of age. Tissue growth continues at this time, although at a reduced rate, and shell growth continues as progressive thickening of the lip. It requires five to ten months from the on-set of lip flaring for the conch to be sexually mature. In Belize, no ripe gonads were found until the lip thickness reached a minimum of

4 mm (Auil-Marshalleck, 1995).

Reproduction occurs by internal fertilisation throughout most of the year, February-November (Berg and Olsen, 1989) but is at the greatest intensity during the warmer months, April - September (Randall, 1964; Stoner *et al.*, 1992). The sex ratio is generally accepted as 1:1 in non-breeding aggregations. Sexual dimorphism exists where females are approximately five percent larger in shell length and 21 percent heavier at an age of three years. Males possess a verge (penis) and the females a genital groove.

Spawning occurs two to three weeks after copulation with the females producing an average of eight egg masses a season, each averaging 300,000 eggs, with as many as 750,000 being produced on occasion. Eggs hatch after approximately five days and two to five weeks later the larvae settle on suitable substrate and begin their benthic life. Juvenile conch spend much of their first year as substrate infauna, feeding epibenthically at night. Although conch have the potential for tremendous reproductive output, there is very little knowledge on larval transport and recruitment variability over the region. Until there is a better understanding of stock-recruitment relationships and the relative importance of larval drift versus larval retention, one should assume that conservation of local stocks will enhance local abundance. While regional action is desirable, management must start at the local level.

Conch management, as is the case for most fisheries in the region, has been constrained by a lack of reliable data and information about the status of the resource, the importance of larval drift and retention, and the inability to establish and adequately enforce regulations for its conservation. Although several countries have management regulations (Table 1), they are often not enforced. Several management strategies have been attempted but there is little or no evaluation of their success. Management regulations implemented within the region include closed seasons and areas, minimum shell length and meat weight, the landing of the whole animal, and the prohibition of harvest of juveniles and use of SCUBA gear.

SOME PRINCIPLES IN THE HARVESTING OF LIVING MARINE RESOURCES

The status of the queen conch fishery is not unique and world-wide many marine fisheries are in a very poor state, with over-exploited resources, declining returns for those dependent on the resources for a livelihood, and over-capitalisation. In 1991, in response to these problems, the FAO Committee on Fisheries (COFI) requested the establishment of a new set of principles or approaches which would result in the establishment of sustainable and responsible fisheries. This call was reinforced by the Canc•n Declaration arising from the International Conference on Responsible Fishing held in 1992

in Canc•n, Mexico and by the UNCED Summit in Rio de Janeiro in 1992 where the world community adopted Agenda 21, Chapter 17 of which deals with oceans, coastal areas and their living resources. This drive continued through three major initiatives. The first two were the adoption in November 1993 of the Agreement to Promote Compliance with International Conservation Measures by Fishing Vessels on the High Seas, as part of the process of elaboration of the Code of Conduct for Responsible Fisheries, and the adoption in August 1995 of the UN Agreement on the Implementation of the Provisions of the 1982 Convention of the Law of the Sea related to the provisions on Straddling Fish Stocks and Highly Migratory Fish Stocks. Finally, the FAO Conference in October 1995 adopted the global Code of Conduct for Responsible Fisheries. The Code is particularly pertinent to this meeting on queen conch fisheries, since it promotes the principles of sustainability of living marine resources and their environments and the precautionary approach to management, while taking into consideration biological, political, economic, social and cultural realities.

These moves both encourage and reflect an international awareness of the need to alter drastically the historical exploitative attitude to living marine resources and to replace it with practices that encourage sustainable and optimal approaches to these invaluable and irreplaceable resources. The declarations, agreements and Code all provide a framework for responsible fisheries which is generally accepted by the governments of the world and the many diverse groups with interests in fisheries and the stocks upon which they depend. If appropriately applied this framework should result in sustaining the stocks and the ecosystems in which they are embedded in healthy and productive states. It should be a very useful exercise, as this International Queen Conch Conference deliberates on the species and the fisheries which utilise it, to examine briefly some of these approaches, particularly as contained in the Code of Conduct, and their implications for managing the queen conch fisheries of the Caribbean area.

Long-term Sustainability

It is generally accepted that states and all users of living aquatic resources have an obligation to conserve these resources and the ecosystems in which they occur, in order to optimise returns for the present users and to provide all possible options for future generations. This obligation underlies the Code of Conduct for Responsible Fisheries and the many other international steps that have been taken in recent years. Clearly, this goal of sustainable utilisation is not easy to attain in highly variable stocks interacting with complex and usually poorly understood ecosystems and affected by fisheries which are, themselves, driven by complex forces of demography, local and global economics, societies and politics. In the case of the queen conch, sustainable

utilisation has to be practised in the face of considerable uncertainty about many biological features of the stock or stocks, including abundance in most areas, growth rates, natural and fishing mortality rates, recruitment processes and others. In addition, there are 20 different states fishing for what is probably a single stock and, within most if not all states, the fisheries are made up of a range of types from artisanal to highly industrial, with a host of intermediates.

Acceptance of the Precautionary Approach to Fisheries (FAO, 1995) is implicit in the Code of Conduct, and the steps necessary for responsible fishing when confronted by complexity and uncertainty are well described in the Guidelines to the Precautionary Approach to Fisheries. These Guidelines emphasise that sustainable utilisation requires the application of "prudent foresight" and suggest that this includes, amongst other attributes, the following.

i) The avoidance of changes that are not potentially reversible.
ii) The prior identification of undesirable outcomes and of measures that will avoid them.
iii) That any necessary corrective measures are implemented without delay and are rapidly effective.
iv) That where there is uncertainty, primary attention should be given to conserving the productive capacity of the resource.
v) That the fishing and processing capacity should be in harmony with the production potential of the resource, to avoid continual social and economic pressure to over-exploit the resources in order to utilise this capacity.
vi) That all fisheries should be conducted according to an explicit and appropriate management plan and that the administrative and legal framework exists to ensure implementation of the plan.

These themes, and others, are also picked-up in the Code of Conduct for Responsible Fisheries which urges States to apply the precautionary approach using the best scientific evidence available, including stock specific target and limit reference points, and what actions should be taken if the points are exceeded. Of these, (a), (b) and (d) refer more specifically to the resource and require good insight into the status and dynamics of the resource. The avoidance of irreversible changes and prior identification of undesirable outcomes, and identification of uncertainty, presuppose a certain level of knowledge of the resource. In addition, point (d) stresses that where there is uncertainty, the doubt should be used in favour of the resources.

In the case of queen conch, a considerable amount is known about its general biology and ecology, as presented in the brief summary at the start of this paper. There have been a number of good studies on the species in general and on its occurrence, dynamics and fisheries in specific regions. It's general

distribution is reasonably well known and its growth rates, reproductive biology and ecology, feeding biology and ecology, levels and causes of natural mortality, as well as the general level of exploitation throughout its range have all been studied with considerable success (Berg and Olsen, 1989; Table 1). However, despite this progress, and in keeping with many fish stocks around the world, there are still several key uncertainties in existing knowledge of the resource, which need to be considered in its management, and which require consideration of the principles of the Precautionary Approach. The most important uncertainties would appear to be the following.

i) The detailed stock structure of the resource.
ii) The actual fishing mortality and effort on the resource in many parts of the region.
iii) The mean age at first-capture and variability about that.
iv) The distribution of larvae and hence about the origins of recruits to local areas.
v) The inter-relationships and movements between conch in the deeper water and shallow water.
vi) The locality of "nursery" areas for the non-planktonic juvenile stages.

Of these, probably the most important from the point of view of sustainable utilisation are those referring to the stock structure and sources of recruitment. If there is a single stock throughout the region, then local depletions are less serious, in that recruitment from distant areas can replenish these areas if fishing mortality is reduced, and there is little or no loss of genetic diversity. In other words, as long as the biomass of the total stock is at a level where future recruitment is not endangered, the changes are unlikely to be irreversible. However, if recruitment is derived largely from the immediate vicinity or, even more extreme, if there are genetically isolated local stocks, local depletions may not recover and may involve loss of genetic diversity. Under such circumstances, changes would not be reversible. In the case of such doubts, clearly the precautionary approach requires that management must be based on the assumption that there may be a number of localised stocks and that local depletions must be avoided. In other words, conch populations in each of the major fishing areas and grounds must be treated as if they are a stock in themselves and each unit managed on a sustainable basis.

The other uncertainties should be treated with similar caution. Where there is uncertainty about the actual fishing mortality and its relationship to the level which can be sustained by the local stock, the fishing effort should be constrained at its existing level, and not allowed to increase unless there is clear evidence that the resource can sustain it. Conversely, if there is evidence of over-exploitation, appropriate steps to correct this must be taken as soon as

possible. Similarly, there have been suggestions that deep-water refuges, where SCUBA fishing is not practised, provide a reservoir of spawning stock that can sustain recruitment when the shallow water densities have been reduced to low levels. In view of the uncertainty about the inter-relationships between deep and shallow water components, this should not be used as an argument for allowing excessive reductions of density in shallow water, until the movements have been quantified and until there is proof that these deep water refuges will serve this function.

The locality of nursery areas is an important consideration for the conservation of the queen conch. Identification of the areas would enable the establishment of reserves to ensure sufficient survival of juveniles to maintain the desired level of adult biomass. The use of reserves, for both adults and juveniles, would seem to have the potential for an important role in queen conch conservation. The sedentary nature of adults and non-planktonic juveniles would enable the protection of reserves of biomass which could supply surrounding areas with larvae. However, the positioning and size of such reserves would have to be designed to take cognisance of the actual dispersal patterns of the species. If recruitment is, in fact, localised, then reserves would have to be closely spaced in order to replenish large areas. Enforcement of a large number of small reserves could be problematic unless the local fishers and interest groups were firmly behind the approach.

Balancing Potential Effort with Productivity of the Resource

A number of countries appear to have taken steps to ensure that fishing effort on queen conch is restricted to appropriate levels. Berg and Olsen (1989) reported that Venezuela, Belize and Bonair had systems of limited entry and licensing. Jamaica has also introduced a limited entry system into its queen conch fishery and no new licenses are currently being issued (Smickle, 1995). Some other countries such as Colombia and Cuba have limited effort through the use of closed seasons, many other countries have included an option for closed seasons in their management plans, while others have opted for systems incorporating closed areas, such as the Bahamas and Venezuela. Mexico has opted for annual quotas by areas and closed seasons.

A decision on how best to manage fishing effort needs to consider the biological, social, economic and political realities of each specific case and is likely to differ by country. However, there does appear to be widespread and growing awareness of the fact that open access systems, even if the resource is protected by other means such as closed seasons or areas, are highly likely to lead to economic problems, including waste of labour and capital and depressed incomes (Pearse, 1994). In order to avoid these problems, an appropriate system of limited access is required, in which a number of fishers or fishing

units are licensed to fish for queen conch in the EEZs of each state. This number should be such that each participant can expect a reasonable return on their investment and labour without endangering the stocks. By extension, the total effort within the region should similarly be balanced for the species production throughout the region. In those states that already have excess effort, this will require some very hard decisions on who should be excluded and who granted access. However, failure to take such decisions will ultimately lead to all or most ultimately loosing the benefits they currently enjoy, as the resource is depleted to non-productive levels. Again, such decisions will have to be made by each state with due consideration to its unique circumstances. However, the Code of Conduct for Responsible Fisheries does stress that due recognition should be given to the needs of indigenous traditional fishers and to local fishing communities which are highly dependent on fish resources for their livelihood. An operational interpretation of these requirements is that a previous history of fishing should normally be a major consideration in claiming a right of access.

The sedentary nature of queen conch could lend itself to the adoption of approaches incorporating community-based management or even territorial use rights to fish, or TURFs (Pearse, 1994). The advantages of giving long-term rights of access to the resource, with an associated greater sense of responsibility for its optimal use, to specific communities or co-operatives could well lead to improved sustainable use of the stock. A key question here, however, is again the detailed stock structure of the resource. If recruitment to localised aggregations is dependent on a regionally distributed stock, then there will be less scope for localised management, and regional cooperation and management strategies will be essential. If, however, there are local, self-sustaining stocks, such localised management and the development of community-based management approaches could be feasible.

Transparency, Consultation and Joint Decision-making

Arising from the above considerations, it is clear that any decisions made on the future management of queen conch will have potentially far-reaching implications for the resource itself, for all those who depend on the resource for their livelihoods and for those who have other serious interests in the resource. It is important to recognise that a failure to take decisive action will have equally profound consequences. As such, it is critical that any decisions are made with the full knowledge of all the interest groups and are made following consultation and input from them. The ideal would be to arrive at a management policy that has the full support of all the interest groups. Such an ideal may well be unattainable, but this should not prevent efforts to arrive at consensus or as close to it as possible.

This meeting may be seen as a step in that process. It will need to be followed up by consultation at the national level with the fishers, the fishing industry, the processors and marketers, tourist groups, conservation groups and others as required. The purpose of these consultations will be to reach agreement on the objectives for the fishery and on the best means to achieve these management objectives, facilitating the development of national and regional management plans. These consultations will probably need to be accompanied by educational and awareness building campaigns to make people aware of the issues and possible strategies for optimising the fisheries.

It is clear that there is also an urgent need for regional co-operation and consultation on the management of this regional fishery, if real progress is to be made in sustainable utilisation of the species. Therefore these national consultations and the establishment of national objectives and management plans should be followed by a regional forum of responsible authorities to establish international approaches as necessary. While it was stated above that the resource should be managed in the form of localised stocks, these local stocks may still transcend national boundaries in many cases. For example, Mahon (1990) suggested that states sharing the same island-shelf should manage their queen conch resources jointly. In addition to this, there should be a regional management strategy for the resource, including the sharing of information and, wherever possible, the adoption of uniform management measures. For example, if it is biologically feasible to have the same minimum size, or the same closed season for the whole region, it should make enforcement much easier.

This regional co-operation and joint management will require on-going meetings and co-operation between the states with interests in the queen conch resource. This is strongly urged within the Code of Conduct for Responsible Fisheries. Such co-operation and joint management will probably necessitate the establishment of a regional conch management organisation or arrangement. The exact nature of the organisation or arrangement, hereafter referred to as an arrangement, will have to be settled by the states themselves, but all states with interests should have representation within the arrangement and, where interested states are not members, they should be encouraged to become members. Members of relevant governmental and non-governmental organisations should also be allowed to attend meetings related to the arrangement and should have access to the records and documents relating to it.

MANAGEMENT OBJECTIVES

Effective management is only possible when clear objectives are established and a critical end-product of the national and international consultations and meetings should be a set of generally agreed upon objectives. One such

objective is the long-term sustainability of the resource. The round of consultations described above should enable identification of the desired national objectives, and the next step will be to determine appropriate management plans to achieve these objectives, or come as close as possible to realising them without exceeding sustainable exploitation rates. UNCLOS and all relevant instruments stress the need to base management measures on the best available knowledge of the state of the resource and its potential productivity or the effort that it can sustain. Based on this principle, the most appropriate approaches to regulate and manage the fishery should be determined. Again, this international queen conch meeting should play an important role in the initial collation of the best available knowledge.

The objectives, national and regional, need to consider, amongst others, the following points.

i) Whether the stock, local or regional, is under- fully- or over-exploited and hence whether there is a need to reduce or an opportunity to increase the yield from the stock. Where there is sufficient knowledge, a target reference point suitable for conserving the stock (such as F0.1 or f0.1), and an appropriate harvesting strategy such as a constant catch or constant escapement should be identified. The strategy selected should also take cognisance of the social and economic objectives listed below and should reflect both the status and dynamics of the resource and the desired nature of the fishery.

ii) Open access or limited access and, if the latter, how it is to be implemented and how much effort will be permitted in the fishery? In the absence of better knowledge, it may prove desirable, for example, to freeze effort at its current level until better stock assessment information is available. While this could be a national decision, if any one or more states decide to retain an open access approach, this could lead to a spill-over of surplus effort, possibly through poaching, into adjacent states. This would clearly be undesirable.

iii) How the access should be allocated and, for example, the relative importance given to artisanal, commercial, recreational or other fisheries.

iv) Whether the fishery should target a high quality product designed for export, such as was suggested as one objective for the Lesser Antilles states by Mahon (1990), whether to prohibit exports as in the Bahamas (Table 1) or whether to focus on the bait market, as occurs in Cuba (Table 1). In principle, each state should be free to make these decisions for itself, provided that they do not jeopardise the regional management by, for example, allowing animals smaller than the regional size limit to enter the regional market, thereby making enforcement more difficult.

v) The need for measures to protect critical habitats, such as seagrass beds for juvenile conch. Here it will be necessary to ensure adequate measures at the national level but also to ensure that, collectively, the regional protection is adequate for the species as a whole.
vi) If either a fishing practice or the status of the resource or local stock is considered to be detrimental to the ecosystem as a whole or to be threatening biodiversity in any way, then overcoming these problems needs to be identified as an objective and the steps to correct these impacts should be identified and implemented.
vii) Whether there are exceptional circumstances that require emergency action to alleviate the problem, such as a dangerously low abundance of animals in an area, which may require the prohibition of fishing for conch. These decisions could be made at a national and bi- or multi-national level.

Additional objectives may also be identified at national and regional level. Again, there should be national objectives, which need to be drawn up within the context of the regional objectives, and regional objectives which incorporate, as far as possible, the sets of national objectives. Clearly this requires an iterative process. In this process, individual states must accept that some compromise may be necessary where sets of national objectives are in conflict and consequently threaten the attainment of regional objectives. In addition, the set of objectives needs to be reviewed and revised as necessary through the same processes, typically every three to five years.

Formulation of a Management Plan

The selected objectives and the means to achieve those objectives form the core of a management plan. The objectives will only be attained if the steps necessary to achieve them are adequately implemented and enforced. The issues of implementation and enforcement should be considered at the time of identifying the objectives and any objectives which are clearly impractical to implement or enforce should be discarded. For example, if the necessary capacity to monitor the resource, monitor catches of individual quota holders and enforce quotas does not exist within a state, then total allowable catch (TAC) should not be used as the mechanism to control fishing mortality. Similarly, as an example, the establishment of large numbers of small closed areas in isolated areas which cannot be patrolled, would not be appropriate.

Consultation and joint decision making should also be the means by which the objectives are translated into a management plan. The biological, ecological, social and economic implications of different options should be evaluated, and the costs and benefits of the different options, in these same terms, should be considered.

The management plans, both at the national and regional level should include the following aspects.

i) Clear identification of the geographical range of the management plan.
ii) Details of the states and/or the interested parties who are part of the management plan.
iii) The duration of the plan in its existing form and when it will be reviewed.
iv) The agreed objectives for the resource and fishery.
v) Details on critical stages in the life cycle of the queen conch and the general status of the stock (regional or local).
vi) Details on the access rights granted, including the number of parties with access, the conditions associated with access and the duration of the access right.
vii) List of the fishery regulations. These could include:
    - allowed fishing gear;
    - vessel specifications;
    - minimum size;
    - details on closed seasons;
    - complete specification of closed areas;any restrictions on sale or export; etc.

viii) Details on any steps being taken to protect or restore habitats important to the conservation of the species.

ix) Details on the data that will be collected to monitor the fishery and the status of the resource, how those data will be analysed and how the management plan will be altered according to the results. For example, if the length of the closed season will be dependent on the status of the resource, details should be provided on exactly what indicators of its status will be used, how these will be estimated and how they will be used to determine the length of the season.

x) The methods for control and surveillance of fishing, processing and selling operations, including details on responsible authorities and the assets that will be utilised. Details of the legal framework supporting the management plan and the penalties for infringement.

xi) Specification of the participants, arrangements, structures and responsibilities for ensuring on-going consultation between the management organisation, or arrangement at the regional level, and the various interest groups.

The management plan as listed above may appear to be an arduous and bureaucratic statement, of limited value. However, it has several important functions. The first of these is that it forms an effective contract between the interested parties and the states responsible for management of the resource and fishery. The agreed terms and approaches are explicitly listed so that all parties are fully informed on their rights and responsibilities. Secondly, it serves as a vital means of communication. It is highly unlikely that all members of the interest groups will be present at all steps in the consultation and decision-making process. The management plan serves as a means of informing them of the agreement of which they are a part. Where the literacy level of members of interest groups will prevent their being able to read and comprehend the plan, the national management plans, and the regional management arrangement, should incorporate steps to disseminate the information in a more appropriate manner. As with the objectives, the management plan needs to be evaluated, reviewed and revised as necessary every three to five years.

Data Collection and Research

The likely success of a management plan for queen conch will be directly related to how much is known about the resource and its dynamics. In accordance with the precautionary approach, the less certainty there is about these factors, the more conservative should be the approach, in order to provide a buffer to protect the resource and fishery in the event of incorrect knowledge or unexpected events.

It is therefore in the interests of all the interest groups that rigorous monitoring of the abundance of the resource, including changes in distribution and size or age structure, and the dynamics of the resource such as trends in its growth rates, reproductive characteristics and mortality rates, are adequately monitored. This will require the timely collection and analysis of appropriate data at the level of the local stock. Similarly the characteristics and behaviour of the fishery and the market should be closely monitored to evaluate whether the management plan is proceeding as intended and to monitor the status of the fishery and its impact on the resource. All these will require the existence of well-trained, experienced and equipped staff both in the field to collect the data and in the laboratory to analyse and interpret the data.

Much of this will happen at the national level and the states with an active queen conch fishery are responsible for its responsible execution. However, these data should also be examined and analysed at a regional level and the proposed regional arrangement will need to be responsible for that. It is important that there is agreement within the region on the data to be collected and the format in which it is to be collected. The indices measured and the methods of measurement should be standardised within the region to facilitate

comparison and joint analysis of data collected. The various states should share their data and information on the queen conch fishery freely, in order to facilitate and encourage regional perspectives on the fishery.

Implementation

Finally, of course, the management plan needs to be effectively implemented. In the case of queen conch, where there is considerable concern about its status in much of the region, the plan also needs to be formulated and implemented as quickly as possible. It should not be unreasonable to suggest a regional meeting of the states involved in queen conch fishing to meet in 12 months time to review and discuss the proposed national management plans, developed in the interim, and to agree formally on regional plans and strategies.

The pre-requisites for the successful implementation of the national and regional management plans have already been discussed. The states must ensure that they have the necessary research and administrative capacity to undertake the formulation of management objectives and the plans required to achieve those objectives. The states need to ensure that the legislation necessary for implementation is in place, or can quickly be enacted. They also need to ensure that they have the capacity for effective monitoring of the stock or stocks and the fishery, and for control of the fishery, including enforcement of regulations.

The above will all require commitment of personnel and facilities, which will cost reasonable amounts of money. It is highly likely that shortage of funds will be seen as a reason why the necessary steps cannot be taken. However, it needs to be recognised and accepted that, in a fishery reportedly worth approximately US$ 60 million and the second most important fishery in the Caribbean, urgent steps should be taken to ensure that a small but adequate percentage of that $60 million is utilised to ensure the resource upon which this income depends is adequately conserved and that the fishery is managed and executed in manner which yields the greatest benefits to the participating states and to the region as a whole.

Table 1. Summary of queen conch (*Strombus gigas*) fishery in the Caribbean region

Country	Landings mt (year)	Density (Conch/ha)	Stock Status	Regulations */Comments
Antigua and Barbuda	69 (1994)	n/a	Overexploited	225 g meat; 180 mm shell. Option for closed season.
Bahamas	41 (1991)	20-79-28.5 (1) 53.6-96.0 (2) (protected area)	Overfished only in localised areas	No exports of meat. No juveniles. Closed areas.
Belize	14 (1994)	n/a	Overfished. Peak production of 562 mt in 1988	180 mm shell; 86 g clean meat (removal of gonads, operculum and mantle). Closed season - 1 July-30 September. SCUBA prohibited.
Bermuda	Fishery closed in 1978	0.52-2.94 (3)	-	Fishery closed in 1978 as a result of low populations.

Table1.

Country	Landings mt (year)	Density (Conch/ha)	Stock Status	Regulations */Comments
Cuba	1500(1990) bait 55 (1994) food	n/a	Fully exploited. Peak harvest 2000 mt in 1977	Closed season. No juveniles. Quotas; annual quota of 55 mt for non-bait fishery. Prohibited recreational fishing. Regulations only apply to non-bait fishery. Catch not well utilised, mainly for bait.
Dominica	5 (1991)	n/a	Severely overfished	In draft; 225 g meat; 180 mm shell. Prohibited to harvest conch without flared (mature) lip.
Grenada	26 (1993)	n/a	Growth overfished	225 g meat; 180 mm shell. Prohibited to harvest conch without flared (mature) lip. Option for closed seasons.
Jamaica	2 3 0 0 (1993-94) (800 from Pedro Bank)	89.1-277.0 [4]	Current harvest rate probably not sustainable. SCUBA and HOOKA used	Interim commercial quota 2000 mt for 1994-95 season; quota to be reduced by 100 mt over next five years. Management strategy including limited entry closed season, protected areas and gear restrictions. No new licenses.

Table1. Country	Landings mt (year)	Density (Conch/ha)	Stock Status	Regulations */Comments
Martinique	20-30 (1990)	n/a	Inshore overfished. Deep water stocks available	Shell with flared lip, no juveniles; 250 g meat - only applies no marine reserve. SCUBA prohibited.
Mexico	25 (1989)	n/a	Overfished. Peak production of 454 mt in 1979	Closed seasons. Annual quotas by areas.
Montserrat	0.5 (1994)	n/a	-	In draft, 225 g meat; 180 mm shell.
Puerto Rico	73 (1989)	8.11 (5)	Recruitment overfished. 1983 production was 340 mt	Regulations being considered.
St.Kitts Nevis	16 (1994)	n/a	Overfished in nearshore areas. SCUBA gear used to exploit deeper waters	225 g meat; 180 mm shell. Prohibited to harvest conch without flared (mature) lip. Option for closed seasons.

Table1. Country	Landings mt (year)	Density (Conch/ha)	Stock Status	Regulations */Comments
St. Vincent and the Grenadines	37 (1994)	n/a	Stable. Possibly overfished in nearshores	225 g meat; 180 mm shell. Prohibited to harvest conch without flared (mature) lip. Option for closed seasons.
Turks and Caicos	510 (1994)	n/a	Stable. Probably fully exploited. Harvest peak of 904 mt in 1995.	227 g meat; 178 mm shell. SCUBA prohibited.
USA, Florida	Fishery closed in 1985	1.5-2.4 [6]	-	Fishery closed in 1985. Good enforcement and com-pliance with closure. No significant recovery over last 10 years.
US Virgin Islands	15 (1990-91) from St. Croix	7.6-12.25 [7,8]	Generally overfished. Stable in St. Croix	230 mm shell. Closed season - 1 July-30 September. Recreational limit of 6/person/day. Ban on fishing in St. Thomas and St. John.

Table1. Country	Landings mt (year)	Density (Conch/ha)	Stock Status	Regulations */Comments
Venezuela	400 (1988)	300-600 (9) protected area	Overfished. Growth over-fishing. Estimated that 90% of harvested illegally from protected areas of Los Roques National Park	Closed season (March to September) and areas. Three-year closure placed in 1991 but limited enforcement. No fishing allowed in Los Roques National Park.

Adapted from Tewfik, A., 1995

* Numbers refer to minimum weight and length.

(1) Smith and Neirop, 1984
(2) Stoner and Ray, in review
(3) Berg et al, 1992
(4) Appeldoorn, 1995. Smickle, 1995
(5) Torres Rosado, 1987
(6) Berg and Glazer, 1995
(7) Wood and Olsen, 1983
(8) Friedlander et al, 1994
(9) Weil and Laughlin, 1984.

CONCLUSIONS

i) The low abundance of the queen conch in many parts of the Caribbean is cause for considerable concern and urgent steps are required to protect the resource and the livelihoods of those who are highly dependent on it.

ii) Generally there is considerable knowledge available on the biology, ecology and dynamics of the queen conch, and this should be used as a basis for management action while additional knowledge is gained and accumulated.

iii) Despite (b) above, there are also important uncertainties in our knowledge of the resource and these require actions based on conservative assumptions, in keeping with the Precautionary Approach.

iv) In particular, it must be assumed that local aggregations of queen conch, on scales no larger than the island-shelf and, in some cases, at a smaller scale than that, are self-sustaining populations and possibly isolated stocks. Therefore management efforts must be aimed at maintaining densities of animals in all these local aggregations at densities adequate to ensure their sustained productivity.

v) Deep-water aggregations cannot be assumed to be reserves of spawning biomass to replenish shallow water areas, at the current level of knowledge.

vi) The use of marine reserves, distributed with frequencies appropriate to the dispersal distances of planktonic larvae, for both adults and settled juveniles, have an important role to play in queen conch management. These reserves must enjoy the support of local fishers and other interest groups.

vii) While socially and politically a difficult option, systems of limited access to the resource are inevitable if the queen conch resource is to be conserved and continue to support a socially and economically valuable fishery. The traditional and historic rights of fishers need to be considered in developing an access rights system for each state. The sedentary nature of the resource means, if recruitment is predominantly local, that community or cooperative based management approaches could be applicable where appropriate.

viii) Management of any fishery has serious implications for all interested parties. It is essential that management of the queen conch proceeds with full participation from all recognised interest groups, including the fishers.

ix) In view of the need to manage queen conch at the level of local aggregations, much of the responsibility for management will rest with individual states. However, there is much to be gained from close

regional co-operation, and it is recommended that a regional management organisation or arrangement is established to co-ordinate and facilitate exchange between the national management organisations

x) Sets of national objectives need to be developed as soon as possible with the participation referred to in (h) above. These objectives should encompass biological, social, economic, marketing, environmental and other key concerns.

xi) In addition to national objectives, regional objectives should also be developed. These will encompass the national objectives although, in some cases, there may be a need for compromise at the level of the national objective in order to develop a coherent and effective regional set of objectives.

xii) Similarly, at both the national and regional levels, management plans need to be developed to identify and describe the methods used to achieve the objectives. These management plans should include details on the stock (at the required scale), the duration of the plan and how it will be reviewed, the access rights and fisheries regulations, approaches to monitoring and control and all other actions and requirements for successful attainment of the objectives.

xiii) It is recommended that draft national objectives and management plans are developed over the next 12 months, using the best available information, and then tabled at a formal regional management meeting for the development of a regional strategy for optimal management of queen conch.

ACKNOWLEDGEMENTS

J. Caddy is thanked for helpful suggestions, particularly pertaining to long-term sustainability and M. Lizarraga for assistance.

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