Regional Cooperation for the Responsible Use of the Caribbean Spiny Lobster Resource

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ABSTRACT

The Caribbean Spiny lobster, *Panulirus argus*, resource supports valuable fisheries in the western central Atlantic, which provide employment and high economic returns. Recent assessments under the auspices of FAO Western Central Atlantic Fishery Commission (WECAFC) have indicated that the resource is being fully or overexploited over much of its range. Primarily because of the lengthy pelagic phase of *P.argus* larvae, the resource is shared in the region so national research and management initiatives will be most effective biologically and economically if implemented in a coordinated and co-operative manner. There has been some regional co-operation in research and management through the FAO WECAFC, in co-operation with regional agencies, in particular UNEP, CFMC and CRFM. Under the auspices of WECAFC, workshops on the assessment and management of the Caribbean spiny lobster resource were held in Belize City, Belize, 1997; in Merida, Mexico, 1998 and 2000; Havana, Cuba 2002; and in Merida, Mexico 2006. This paper provides an overview of the results and management decisions of the 2006 workshop, which included the recommendation that countries should adopt a minimum size of 74 mm of carapace length, or above, for harvest and to manage fishing mortality in order to achieve sustainable use of the resource. Greater effectiveness in research and management can be achieved through regional cooperation.

KEY WORDS: Caribbean, Spiny lobster, *Panulirus argus*, Regional cooperation

Cooperación Regional para el Uso Responsable del Recurso de la Langosta Común del Caribe

La langosta común del Caribe, *Panulirus argus*, sostiene una pesca valiosa en el Atlántico Centro-Occidental, que proporciona empleo y altos ingresos económicos. Evaluaciones recientes llevadas a cabo bajo el patrocinio de la Comisión de Pesca para el Atlántico Centro-Occidental (COPACO) de la FAO señalan que este recurso está siendo plenamente explotado o sobreexplotado en numerosos lugares. Principalmente debido a la larga fase pelágica de las larvas de *P. argus*, este recurso es compartido en la región de modo que la investigación nacional y las iniciativas de ordenación serán más efectivas a nivel biológico y económico si son implementadas en forma coordinada y cooperativa. Ha habido cierto nivel de cooperación regional en los ámbitos de la investigación y de la ordenación a través de la COPACO, con la colaboración de organismos regionales en particular PNUMA, CFMC y CRFM. Bajo el patrocinio de la COPACO, se celebraron talleres sobre la evaluación y la ordenación del recurso de langosta común del Caribe en Ciudad de Belice, Belice, en 1997; en Mérida, México, en 1998 y en 2000; en La Habana, Cuba 2002; y en Mérida, México, en 2006. El presente documento presenta una resumen de los resultados y las decisiones del taller del 2006, que incluía la recomendación de que los países deben de adoptar un tamaño mínimo de 74 mm o superior de largo del caparazón para la captura ye el manejo de la mortalidad de pesca para lograr el uso sostenible del recurso. Es posible alcanzar una mayor eficacia en los ámbitos de la investigación y de la ordenación a través de la cooperación regional.

PALABRAS CLAVES: Langosta común del Caribe, *Panulirus argus*, Cooperación Regional.

INTRODUCTION

Awareness of the value of the Caribbean spiny lobster, *Panulirus argus,* resource has led to a steady increase in landings over the last 50 years which have given rise to concern for the sustainable utilisation of the species. In response to this concern, workshops were arranged by FAO, under the auspices of the Western Central Atlantic Fishery Commission (WECAFC) in co-operation with regional agencies, in particular UNEP, CFMC and CRFM . The workshops were held in 1997 (Belize City, Belize), 1998 and 2000 (Merida, Mexico), 2002 (Havana, Cuba) and 2006, (Merida, Mexico). The workshops were aimed at undertaking national and regional assessments of the fisheries and stocks, using the available data, with the intention of discussing greater cooperation between the lobster producing nations of WECAFC to ensure effective and responsible research into and management of the fisheries. Each workshop concentrated on improving the scientific information generated by the previous workshop. Sound scientific information is necessary for taking management decisions at both the national and regional levels. Fourteen countries attended at least one of the workshops and 12 attended all five.

This paper reviews some of the more important findings of the 2006 stock assessment workshop (FAO 2006). It considers the need for greater cooperation between states in their research and management of this fishery and considers the constraints to such cooperation and approaches which could be considered to facilitate it.

Life History and Distribution

According to Cervigón *et al.* (1993), *P. argus* is found from North Carolina (United States of America) in the north to Rio de Janeiro (Brazil) in the south and from the Gulf of Mexico to the Antilles islands. They describe it as being a shallow water species, occurring in water up to 90 m deep and found in sheltered habitats, including coral reefs and rocky areas.

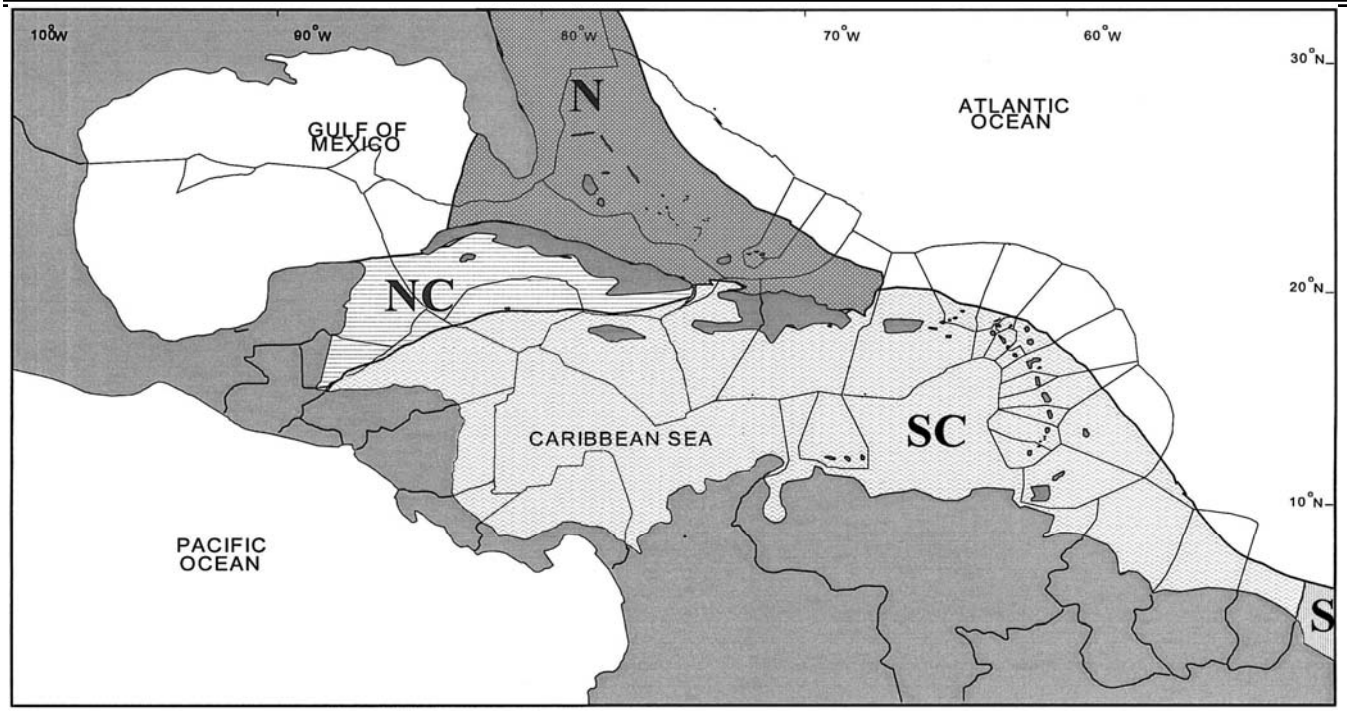

Figure 1. A Schematic representation of the assumed "stock" boundaries for P. argus in the western central Atlantic region, with four sub-regional "stocks" shown in different shading: N = Northern "stock"; NC = North Central; SC = South Central: and S= Southern. The approximate EEZs are for illustrative purposes only.

Cochrane and Chakalall (2001) reviewed available information on the life history of *P. argus* and its relationship with prevailing currents. The larvae are planktonic and spend an estimated 6 - 10 months in oceanic water (Sliberman *et al*. 1994, Arce and Leon 2001) providing extensive opportunity for wide distribution in the Caribbean and Wider Atlantic. During planktonic phase the larvae can become widely distributed within the region and the wider Atlantic

The potential for larval dispersal of *P. argus* is particularly important for effective management of its stock or stocks, as the larval dispersal will determine where recruitment for a given country or locality originates and will therefore play a major role in determining the boundaries of each stock. With a 6 to 10 month ocean pelagic stage, it seems likely that many localities will be highly dependent on recruitment from other areas, frequently other countries, which necessitates good cooperation between the linked nations if effective utilization of the resource is to be realized.

Roberts (1997) investigated the likely patterns of distribution of larvae in the Caribbean, based on an analysis of surface current patterns in the region. Assuming passive dispersal and dispersal periods of a maximum of two months, he estimated the mean transport distance of 18 sites in the Caribbean (both supply and delivery) to be slightly in excess of 200 km. This meant that each of these sites could receive recruitment from an average of 3.5 other countries (range one to seven countries). If the dispersal time is increased to six months or more, as with *P. argus*, the average transport distance and hence, number of countries on which any locality could be dependent for lobster recruitment, will be substantially increased.

The data provided by Roberts (1997) demonstrate predominantly northward and westward flows, suggesting that the southerly and easterly spawner aggregations will play important roles as donors of larvae and the more northerly and westerly countries will be more dependent on their "upstream" neighbours for ensuring spawner biomass remains at levels sufficient to sustain recruitment to their fishing areas. This should create a strong incentive for close cooperation in research and in management.

Genetic Studies

The implications of the combination of life history characteristics and current flows have been supported by genetic studies undertaken by Silberman and his colleagues. Using mitochondrial DNA, they investigated the genetic structure of *P. argus* and found no evidence of population subdivisions and little evidence for genetic heterogeneity within samples of lobster obtained from Panama and Venezuela in the south to Bermuda in the north. They concluded that this demonstrated a high level of gene flow between the different sites, consistent with the ecology of the species. Their results differed from earlier studies (Menzies and Kerrigan, 1979; Menzies, 1980; both reported in Silberman *et al*., 1994) using protein isozyme electrophoresis that suggested genetically distinct populations in Jamaica and in the US Virgin Islands, whereas samples from two sites in Florida and one in Trinidad

Table 1. Estimated status of Caribbean spiny lobster country-based on the best available information

Status of Stock	Countries
Under-exploited	Venezuela (some areas)
Fully-exploited or stable	Puerto Rico & Virgin Islands; Turks & Caicos; United States of America; Belize; Mexico; Costa Rica; Cuba; Antigua & Barbuda; Venezuela (some areas)
Over-exploited	Nicaragua; Jamaica; Dominican Republic; Brazil; Colombia; Honduras

The categories used in the table were based on the best available estimates of the population biomass as a proportion of unexploited biomass and/or fishing mortality rate. The category of greatest concern is that of "Unknown". The category of next highest concern is that of 'Over-exploited' in which case it is recommended that the country concerned urgently implements a recovery programme. It was noted by the 2006 Workshop that some countries in this category have already taken this step. The category "Fully-exploited" implies that caution is needed and countries in this category should have comprehensive and effective monitoring and management systems in place in order to ensure that over-exploitation is not occurring.

Table 2. Desirable Functions of a Regional Lobster Organization for the Western Central Atlantic, Excluding the Large Step of Delegation of National Responsibilities for Management. Those tasks marked with an * are considered essential.

Field	Task
General	Providing a forum for discussion on common problems and issues*
	Collection and dissemination of information relevant to research, monitoring, enforcement, processing and marketing
Research and data	Collection, collation, storage, dissemination and analysis of data on e.g. landings, effort, prices*
	Stock assessment and bio-economic evaluations at a regional scale*
	Promotion and coordination of regional scale research on e.g. stock structure, distribution of larvae, subregional differences in growth and reproduction*
	Provision of technical support to national research activities
Enforcement	To facilitate standardization in national laws and regulations, facilitating easier enforcement*
	To facilitate negotiations and development of reciprocal and cooperative surveillance and enforcement*
Management	To encourage and coordinate the establishment of regional standards in e.g. minimum size-at-capture, timing and duration of closed seasons (taking due account of subregional differences in life history)*
	To promote and encourage management cooperation amongst member countries*
	To provide information and advice to member countries on development of policies for fisheries on spiny lobster
	To coordinate and advise on fisheries access agreements with distant water fisheries
Marketing	To provide information on market trends and developments
	To coordinate marketing and sales activities to give greater opportunity and power to suppliers through increasing scale and stability of supply

could not be distinguished. These early results, however, were not supported by three later and separate allozyme studies that failed to find heterogeneity among the sites sampled in each case (Silberman *et al*. 1994). The bulk of the evidence therefore points strongly towards high levels of genetic flow throughout the area sampled.

A more recent study compared the mitochondrial DNA sequence variation between samples obtained from the western Atlantic and Caribbean with others obtained from Brazil (Sarver *et al*. 1998). Those authors described genetic diversity between the two areas that was equivalent to that expected between species or subspecies. They proposed the existence of a southern and northern form of *P. argus*, and suggested that the extensive soft-bottom coastal shelf between the Brazilian coral reefs and those of

the Caribbean formed a barrier between the two forms.

The information from these two studies cannot be considered conclusive and direct evidence; some quantification of a substantial export of larvae from southeast to northwest is still required before compelling arguments can be made. However, the information does raise the likelihood of two biologically distinct stocks: from Brazil and from a single wider Caribbean stock. The WECAFC pragmatic working definitions for *P. argus* stocks was revised accordingly.

Stock Structure Adopted by WECAFC

This characteristic of the Caribbean spiny lobster population clearly needs further study, which should include attempts to identify and then manage as entities, the discrete stocks within the population. This has not yet been done. If there is to be serious cooperation in management and research, it is important that reliable information on the true stock structure of the species is provided. Limited evidence is available at present.

For the purposes of the FAO workshops the following pragmatic definition of substocks was used which are hypothetical only.

Northern Stock — Bahamas, Bermuda, Cuba (North), Turks and Caicos Islands and United States of America (Florida).
North Central Stock — Belize, Cuba (Southwestern) and Mexico.
South Central Stock — Antigua and Barbuda, Colombia, Costa Rica, Dominican Republic, France (Guadeloupe and Martinique), Haiti, Honduras, Jamaica, Nicaragua, United States of America (United States Virgin Islands and Puerto Rico) and Venezuela.
Southern Stock — Brazil.

This "stock structure" was considered a plausible assumption, based on the nature of the coastal shelf and the prevailing currents in the region (FAO 2006). The “stock structure” adopted by WECAFC is for working purposes and for promoting regional cooperation and the sharing of data and information among the countries.

It should be noted that the "stocks" as defined here cover only those countries that are major lobster producers and participated in the WECAFC workshops. However, all other countries within each broad coastal area should be regarded as part of the same "stock" (Figure 1).

Status of the Caribbean Spiny Lobster Resource

The estimated status of the national populations of spiny lobster, as determined by the 2006 workshop, is presented in Table 1 (FAO, 2006). It was reported by Cuba, Mexico, and the United States of America that, despite good management and control, the populations in these important lobster areas are showing signs of declining. An additional factor that needs to be considered was that the landing statistics reported to FAO indicated that in the South and North Central subregions annual landings have declined, while in the South Central and North subregions annual landings appear to have reached an asymptote (FAO 2006), Figure 1.

State of Management

While substantial problems remained, a few Central American countries had made significant progress in improving the assessment and management of their lobster fisheries since the previous meeting of the WECAFC *ad hoc* Working Group on Caribbean spiny lobster, Havana, Cuba, 2002. Contributing to this progress in some cases was the fact that the countries had actively and successfully sought donor funding to assist in capacity building in fisheries assessment and management. In the case of Nicaragua, revenue obtained from lobster exports was also used to support management of the spiny lobster fishery. Notwithstanding some signs of progress in some cases, a substantial number of management problems need to be urgently addressed across the region (FAO 2006). These include:

Open Access — Open access, at least in the artisanal sector, continues to be a problem in the region as a whole and, as a result, fishing effort in the lobster fishery has continued to grow in an uncontrolled and unsustainable manner in a number of countries. In some cases an important contributory factor had been a failure in agricultural activities leading to displaced agriculturalists (farmers) looking to fishing as an alternative occupation, and to the better economic opportunities that may be offered by lobster fishing, at least until the resource has been depleted.

Fishing Mortality — The unacceptably high levels of capture of under-sized and juvenile lobsters that were reported in a number of countries is a serious problem. The true extent of this problem was likely to be even more serious than estimated from official sampling of landings because of the high incidence of illegal fishing. Capture of juveniles was a biologically inefficient use of the resource and, unless carefully controlled, can pose a serious risk to the sustained productive capacity of the spiny lobster population.

The 2006 workshop recommended that countries should adopt a minimum size of 74 mm of carapace length, or above, for harvest and to manage fishing mortality in order to achieve sustainable use of the resource.

A high proportion of sub-adults in the total catch can only be sustained at low fishing mortality rates. Therefore, when determining the maximum allowable fishing effort, countries will need to take into account the catch of juveniles. If countries are effective in reducing catch of juveniles, the sustainable yield will be higher than it would be if those catches cannot be controlled. The allowable

fishing effort should ensure that the spawning stock was not reduced to low levels at which future recruitment could be reduced. Good data and scientific advice will be required to determine these trade-offs and the maximum allowable effort in each case.

In all countries, fishing mortality had a major impact on stocks. Strict control of fishing effort to ensure that fishing mortality did not exceed sustainable levels, and did not compromise the productive capacity of the stock, was the primary concern. Nevertheless, a number of factors outside the fishing sector were also negatively impacting the stock in some countries. These include: an increased frequency of hurricanes and tropical storms over the last decade; lobster mortality as a result of red tides; and human-induced deterioration in lobster habitat. Coastal zone pollution and eutrophication leading to damage to coastal habitats, coastal zone development, and the construction of dams and roads in catchment areas were identified as having had negative impacts on lobster recruitment and production in some countries. The high demand for lobster, which provides an incentive for increasing fishing effort, and the increasing number of people entering the lobster fishery from other economic sectors were also considered factors of particular concern.

Artisanalisation of the Fishery — Coupled with the growth in fishing effort has been a trend towards increased artisanalisation of the fishery in several countries. This tends to lead to more vessels and more dispersed fishing and landing sites which were much harder to regulate. Higher dispersion also had the effect of increasing the costs for collecting the landed lobster by the processing sector. In addition, artisanalisation and the lack of alternative livelihoods was likely to lead to a reduction in the opportunity costs of fishing which, in these unregulated fisheries, depresses the bio-economic equilibrium in the fishery, increasing the likelihood of further reductions in the current status of the stocks. While governments may see artisanalisation as an opportunity to increase livelihood opportunities, they need to be aware of the biological and economic implications.

IUU fishing — Illegal, Unregulated and Unreported (IUU) fishing was common in the fishery in the region, especially in the southern parts. It was often linked to illegal and unreported intraregional trade. Governments also need to be aware of the fact that illegal fishing increases the total fishing mortality and the capture of undersized lobsters and that, while IUU fishing was occurring, legal fishing mortality will need to be reduced to compensate for this and to avoid over-exploitation.

Trap fishing and closed season — A particular problem reported from some Central American fisheries was the practice of leaving traps in the water, where they continue to fish, during the closed season. This practice results from the excessive number of traps being used in these fisheries, which would require a number of trips to and from the fishing grounds by the trappers simply to retrieve all the traps at the end of the fishing season. This practice was wasteful and tends to negate the potential benefits of the closed season. Some countries were currently seeking solutions to this problem.

Artificial habitats — There were concerns about the increasing use of artificial habitats (casitas) in fishing for lobster in some countries. Casitas lead to an increase in fishing efficiency, thereby effectively increasing fishing power, and also lead to a higher proportion of juvenile lobsters being caught. Artificial habitats can also have significant negative impacts on the natural habitat. Countries considering the introduction of or expanding the use of artificial habitats need to be aware of these problems.

Enforcement and compliance — Little or no progress was thought to have been made since the 2002 workshop in Havana, Cuba, in enforcement of and compliance with current management measures and the incidence of non-compliance and weak compliance across the region remains generally high.

Community-based management — It was noted that some progress had been made in the successful application of community-based management of artisanal fisheries, including spiny lobster, in Mexico and Saint Lucia. Effective community-based management should lead to higher levels of compliance and community participation in enforcement efforts. Nicaragua had recently adopted legislation that would delegate authority for managing effort in their lobster fisheries to the local government level. This is a positive development.

Research and management capacity — Weak research and management capacity was still prevalent in a number of countries, as were deficiencies in the quality and nature of data available to advise on lobster management. Technical assistance was required by most countries to address this problem.

Safety and health — The conditions under which divers operate in some lobster fishing countries in Central America and the serious health risks that these conditions pose, resulting in frequent fatalities and serious injuries was of serious concern. It was observed that in the dive industry in some countries, 33 percent of the crew was involved in accidents in a single fishing season. These conditions were considered alarming.

Towards Regional Cooperation

The steps referred to in the preceding section are essential prerequisites to sustainable utilization of a shared resource. A shallow water species such as *P. argus* is ultimately dependent on effective action within national EEZs for sustainable utilization. If each country in which the species occurred managed their populations at sustainable levels, the overall productivity of the coastal resource should be assured. However, improved, more robust and more cost-effective utilization can be provided by close regional cooperation.

The question of stocks shared by two or more states is addressed in the United Nations Law of the Sea of 10 December 1982 (LOS). Article 63 concerns "Stocks occurring within the exclusive economic zones of two or more coastal States or both within the exclusive economic zone and in an area beyond and adjacent to it" This article requires that, where this condition applies (United Nations 1998):

> *"… these States shall seek, either directly or through appropriate sub-regional or regional organizations, to agree upon the measures necessary to coordinate and ensure the conservation and development of such stocks…"*

This requirement is based on the need to manage stocks as units if management is to be effective, which fundamental concept is well addressed in paragraph 7.3.1 of the FAO Code of Conduct for Responsible Fisheries (FAO 1995).

The LOS in Article 61, dealing with "Conservation of the living resources", in paragraph 2 also requires that (United Nations 1998):

> *"The coastal state, taking into account the best scientific evidence available to it, shall ensure through proper conservation and management measures that the maintenance of the living resources in the exclusive economic zone is not endangered by over-exploitation. As appropriate, the coastal State and competent international organizations, whether subregional, regional or global, shall cooperate to this end".*

These two Articles provide the legal impetus and fundamental principles upon which regional management of *P. argus* should be based. The nature and extent of the sharing of the resource is uncertain, as a result of the unknown extent and direction of distribution of the larvae. However, there can be no doubt that it is substantial and it is likely that some countries are important donors of larvae to the region, others are important recipients and all certainly function as both to some extent. The linkage is further strengthened by the fisheries, which use similar methods, the existence of common markets for export, and the similar problems faced by the national fisheries management agencies from research and monitoring to enforcement. In almost all countries there is an urgent need for improved management and fishing practices, and this could be done most effectively with regional cooperation.

Functions of a Regional Organization

Given the large number of countries sharing these problems and opportunities, direct cooperation between individual countries, an option in LOS Article 63, would be impractical and the establishment of a regional body to deal with cooperation in research and management of the lobster resource and fisheries would seem to be essential. This would obviously result in some costs to the participating States but the amounts involved need to be taken in the context of the very high value of the fishery.

While there has been a very high degree of cooperation and willingness to share information at the WECAFC workshops, there is likely to be political reluctance to move directly from totally informal and infrequent cooperation into a position where national management authority and responsibility is delegated to any regional lobster organization (RLO). While this may be a desirable goal in the long-term, it is one that will need to be approached slowly and with due sensitivity to sovereign rights. However, there is much that can be done at a regional level without any sacrifice of these sovereign rights. The support given to the establishment of an "ad hoc Working Group on Spiny Lobster" by member countries at the Ninth Session of the Western Central Atlantic Fishery Commission (WECAFC) held at Saint Lucia from 27 to 30 September 1999, represents an important starting point for an effective RLO.

Some desirable, and some considered essential, tasks of a RLO are shown in Table 2. These tasks are self-explanatory and need not be discussed in depth here. The essential roles of an effective RLO can be summarised as increasing efficiency and effectiveness of national efforts by reducing unnecessary duplication, rapidly disseminating information of common interest, acting as a forum for issues of common concern and the provision of mutual support, especially in activities such as monitoring and enforcement.

The structure and mode of operation of an RLO could be adapted to local needs, capacity and means. At one extreme, an independent staff of administrators, technicians and field staff could be established with the dedicated task of serving the Organization and its members. At the other extreme, the Organization could be served by staff employed by the national agencies but allocated responsibility for serving appropriate functions on the RLO. In the latter case, communication between the different people serving the Organization could be predominantly through the media such as telephone, fax and electronic communication, although annual or at least biennial physical meetings would be highly desirable. The most effective

and efficient mechanism would seem to be some intermediate between these two extremes.

Clearly, there will be a cost involved in setting up such an RLO, and this cost is likely to be the greatest deterrent to further real progress. However, this factor needs to be considered in the light of the enormous economic, and very real social, value of the fishery. A mere 0.5% of the US$ 500 million estimated value of annual landings would result in an annual budget of US$ 2.5 million, an amount greater than the budgets of such respected regional fisheries agencies as the International Pacific Halibut Commission and the International Convention for the Conservation of Atlantic Tunas (ICCAT), and a very respectable proportion of the budget of ICES: the International Council for the Exploration of the Sea (WECAFC 1997).

Of greater relevance, however, is that most of the lobster producing countries will need to increase their investments in monitoring and managing their national fisheries for spiny lobster if they wish to continue to reap the benefits from this goose and its golden eggs. A continuation of current relaxed and often inappropriate controls will lead to reductions in productivity and yield in most countries and, given the strong biological linkages, it is hard to see that this will not effect the whole region. These increases could be directed totally into national mechanisms, but it should be clear from Table 2 that better returns on the investment could be realized if some of this investment was channeled into greater cooperation, including the establishment of an RLO with at least those functions shown in Table 2 as being essential. The economic value of the fishery is such that a substantial portion, if not all, of the funds required for effective management of this resource should come from those making a profit from it, be they fishers, processors, wholesalers or retailers. The required funds need not come from national budgets already hard-pressed to meet basic needs such as health, education and housing.

CONCLUSIONS

Taken together, the results of the 2006 workshop indicate that there was cause for substantial concern that the sustainability of one of the most socially and economically valuable fisheries in the western central Atlantic region was currently at serious risk. It has also highlighted the fact that, on a regional level, urgent and far-reaching steps need to be taken if the national fisheries are to be transformed into sustainable operations that will continue to provide social and economic benefits indefinitely.

The spiny lobster resource and fisheries of the region are closely linked by the shared nature of the resource, mobile fishing fleets and the international nature of trade in Caribbean spiny lobster. All of these require that utilisation of the resource and management of lobster fisheries is undertaken in a cooperative and coordinated manner at the regional level. The cooperation being promoted by FAO through the WECAFC ad hoc Working Group on Caribbean Spiny Lobster must be incrementally improved until the long term goal of greater cooperation through an RLO is achieved. The existing cooperation taking place at the scientific level through WECAFC and other intergovernmental organizations as well as bilateral and multilateral cooperation between countries, has assisted all countries in their task of provision of scientific advice for management. Nevertheless there was still room for considerable improvement.

The starting point for improved management and sustainable use lies at the national level and it is imperative that all countries with significant biomasses of *P. argus* take steps to reduce effort as needed and adopt suitable technical measures such as biologically effective minimum sizes-at-capture and closed seasons. However, primarily as a result of the lengthy pelagic phase of *P. argus* larvae, the resource is shared by the region and therefore national initiatives will be most biologically and cost effective if implemented in a coordinated and cooperative manner throughout the region. In addition, much can be gained by greater cooperation in all aspects of monitoring, managing and marketing the fisheries for lobster and its product. Many of the problems and issues are shared and uncoordinated national attempts to address them will inevitably lead to duplication and wasted time and resources.

Regional cooperation will best be undertaken in a formal manner. While this has been initiated with the establishment of an “ad hoc Working Group on Caribbean Spiny Lobster" by the Ninth Session of WECAFC, this is only a first step. For regional cooperation to achieve the objectives of improved and cost-effective coordination in management, it will be necessary for the participating countries, which should include all those producing significant quantities of spiny lobster, to take ownership of the Working Group and to invest resources and confidence in it, developing it into an effective component of and adjunct to their own research and management efforts. The funds necessary for implementing improved management at the national and regional level can and should come at least in part from those deriving benefits from the resource.

In order to improve enforcement and effectiveness of management regulations, in particular the timing and length of closed seasons and minimum size regulations, countries, especially close neighbors, should consider standardization of such regulations where possible and biologically realistic. This process could be initiated by groups of neighboring countries using the hypothetical stock structure adopted by the WECAFC, which are Northern, North Central, South Central and South as a starting point. Other requirements for sustainable utilization, such as the reduction of capture of juveniles, illegal trade and combating IUU fishing, of the resource could also be initiated through these “stock groups”.

LITERATURE CITED

Andrade, G., J.A. Negreiros Aragão, R. Nonato de Lima Conceição, R.C. de Almeida Carvalho, N.M. Ehrhardt (Group Leader), and C.A. Sobreira Rocha. 2000. Region 1: Brazil and Venezuela. In 'Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (*Panulirus argus)'* (Eds. P. Medley and S. Venema). *FAO Fisheries Report* **620.**

Arce, M., and M.E. de León. 2000. Biology. In 'Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (*Panulirus argus)'* (Eds. P. Medley and S. Venema). *FAO Fisheries Report* **620.**

Arce, M., A. Clemetson, M.E. de Leon, J. Gonzalez-Cano, S. Marshalleck, S. O'Brian, R. Puga, V. Restrepo, V(Group Leader), G. Richards, V. Rios-Lara, E. Sosa-Cordero, and C. Zetina. 2000. Region 2: Belize, Southwest Cuba and Mexico. In 'Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (*Panulirus argus)'* (Eds. P. Medley and S. Venema). *FAO Fisheries Report* **620.**

Barnutti Gallo, R., González-Cano, J., (Group Leader), Grant, S., Gutiérrez, R., Irias, A., Pérez, M., Rodríguez, J., Suazo M. 2000. Region 3: nicaragua, honduras, colombia and jamaica. In 'Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (*Panulirus argus)'* (Eds. P. Medley and S. Venema). *FAO Fisheries Report* **620.**

Bethel, G., R. Cruz, V. Deleveaux, D. Harper, B. Luckhurst, W. Joseph, P. Medley (Group Leader), and R.Muller. 2000. Region 4: Bahamas, Bermuda, North Cuba, St. Lucia, Turks and Caicos Islands and the United States of America. In 'Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (*Panulirus argus)'* (Eds. P. Medley and S. Venema). *FAO Fisheries Report* **620.**

Cochrane, C. and B. Chakalall. 2001. The spiny lobster fishery of the WECAFC region – an approach to responsible fishery management. *Marine and Freshwater Research* **52**:1623-31.

de León, M., R. Puga, and J. Baisre. 2000. Lobster fisheries in Cuba. In 'Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (*Panulirus argus)'* (Eds. P. Medley and S. Venema). *FAO Fisheries Report* **620.**

Deleveaux, V.K.W. and G. Bethel. 2000. National report on the spiny lobster fishery in the Bahamas. In 'Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (*Panulirus argus)'* (Eds. P. Medley and S. Venema). *FAO Fisheries Report* **620.**

de Pasquier, G. Andrade. 2000. 14b Reporte adicional de Venezuela. In 'Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (*Panulirus argus)'* (Eds. P. Medley and S. Venema). *FAO Fisheries Report* **620.**

Ehrhardt, N. 2000. Regional Review. In 'Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (*Panulirus argus)'* (Eds. P. Medley and S. Venema). *FAO Fisheries Report* **620.**

FAO. 2000. Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (*Panulirus argus)* (Eds. P. Medley and S. Venema). *FAO Fisheries Report* **620.**

FAO. 2006. Report of the FAO/WECAFC Fifth Workshop on Assessment of and Management of Caribbean spiny lobster. FAO Fisheries Report **826**. 2007

FAO. 1995. Code of Conduct for Responsible Fisheries. FAO, Rome, Italy. 41 pp.

Gallo, J., M. Rojas, y F. Correa. (1998). Aspectos sobre la biología y pesquerías de la langosta espinosa (*Panulirus argus*) en la República de Colombia. Workshop on the Spiny Lobster *Panulirus argus* in the WECAFC area. Reporte Nacional de Colombia. 18 pp.

Mace, P.M. and M.P. Sissenwine. 1993. How much spawning per recruit is enough? Pages 101-118 in: S.J. Smith, J.J. Hunt, and D. Rivard (eds.) *Risk evaluation and biological reference points for fisheries management.* Canadian Special Publication in Fisheries and Aquatic Sciences, 120.

Mahon, R. 1996. Fisheries and research for tunas and tuna-like species in the Western Central Atlantic. *FAO Fisheries Technical Paper* **357**. 61 pp.

Muller, R.G. 2000. 13b Additional report of the United States of America. In 'Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (*Panulirus argus)'* (Eds. P. Medley and S. Venema). *FAO Fisheries Report* **620.**

Navarro, R.B. and M.P. Moreno. 2000. 11b Informe nacional de Nicaragua. In 'Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (*Panulirus argus)'* (Eds. P. Medley and S. Venema). *FAO Fisheries Report* **620.**

Richards, G. 2000. National report of Belize. In 'Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (*Panulirus argus)'* (Eds. P. Medley and S. Venema). *FAO Fisheries report* **620.**

Roberts, C.M. 1997. Connectivity and management of Caribbean coral reefs. *Science* **278**:1454-1457.

Seijo, J.C. and E. Perez. 2000. Bio-economics. In 'Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster (*Panulirus argus)'* (Eds. P. Medley and S. Venema). *FAO Fisheries Report* **620.**

United Nations. 1998. International fisheries. Instruments with index. FAO and the Division for Ocean Affairs and the Law of the Sea, New York, New York. 110 pp.

WECAFC. 1997. International attitudes and approaches to co-operation in fisheries research and management. Paper presented to the Working Party on Assessment of Marine Fishery Resources, Belize, December 1997. WECAFC/RE/97/6. 17 pp.