Caribbean Regional Fisheries Mechanism (CRFM)

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REPORT OF THE FIRST ANNUAL CRFM SCIENTIFIC MEETING

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Foreword

The First Annual CRFM Scientific Meeting was a joint meeting of five CRFM Resource Working Groups: the CRFM Reef and Slope Fish Resource Working Group (RSWG), the CRFM Lobster and Conch Resource Working Group (CLWG), the CRFM Shrimp and Groundfish Working Group (SGWG), the CRFM Small Coastal Pelagic Fish Resource Working Group (SCPWG), and the CRFM Large Pelagic Fish Resource Working Group (LPWG). During the period 22-26 June 2004, these five Working Groups held sessions to review and conduct data analyses and assessments of selected resources, based on available data. In the limited time available, it was not possible to examine all datasets made available to the Working Groups, primarily because much time was spent in cleaning and preparing datasets. Representatives from all CRFM member countries participated in the plenary sessions of 28-30 June 2004, during which the Working Group outputs were reviewed, discussed and finalized.

The present report, which is a report of the First Annual Scientific Meeting, consists of four sections: Parts I, II, III and IV. Part I contains the proceedings of the plenary sessions, while Part II contains the detailed reports of the five CRFM Resource Working Groups. Those national reports, for which printed and electronic copies were submitted for consideration by the Meeting, are provided in Part III. The three verbal presentations noted under agenda items 9 and 10, were delivered by invited experts. Given that no written papers were submitted for these presentations, the corresponding Microsoft PowerPoint slides, comprising the presentations, are included in Part IV.

Fisheries scientists who participated in the First Annual Scientific Meeting, together with three assessment experts from non-CRFM countries, are responsible for the content of the present report. Their enthusiasm, persistence, and hard work in ensuring accuracy and quality of the material presented here, are gratefully acknowledged.

Research and Resource Assessment Programme

CRFM Secretariat

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List of Acronyms and Abbreviations

CARICOM	Caribbean Community
CARIFIS	Caribbean Fisheries Information System
CFRAMP	CARICOM Fisheries Resource Assessment and Management Programme
CFF	Caribbean Fisheries Forum
CITES	Convention on International Trade in Endangered Species
CPUE	Catch per Unit of Effort
CRFM	Caribbean Regional Fisheries Mechanism
DECR	Department of Environment and Coastal Resources (Turks & Caicos)
EEZ	Exclusive Economic Zone
FAD	Fish Aggregating Device
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GEF	Global Environment Facility
GLM	Generalized Linear Models
ICCAT	International Commission for the Conservation of Atlantic Tunas
IDRC	International Development Research Centre
IMA	Institute of Marine Affairs
IOCARIBE	Intergovernmental Oceanographic Commission
IUU	Illegal, Unreported and Unregulated
LFDA	Length Frequency Distribution Analysis
LME	Large Marine Ecosystem
LRS	Licensing and Registration System
MEY	Maximum Economic Yield
MSY	Maximum Sustainable Yield
NKFM	New Kingstown Fish Market
OECS	Organization of Eastern Caribbean States
SCCF	South Coast Conservation Foundation
SCRS	Standing Committee on Research and Statistics
TAC	Total Allowable Catch
TCI	Turks and Caiços Islands
TED	Turtle Excluder Device
TOR	Terms of Reference
TIP	Trip Interview Programme
TURF	Territorial Use Rights in Fisheries
UNDP	United Nations Development Programme
USA	United States of America
UWI	University of the West Indies
VPA	Virtual Population Analysis
WECAFC	Western Central Atlantic Fishery Commission
YPR	Yield Per Recruit

PART I – REPORT OF PLENARY SESSIONS

1. Opening of the meeting

The opening remarks were delivered by Mrs. Pamela Browne, Permanent Secretary in the Ministry of Agriculture and Fisheries. The welcome address was given by Mr. Raymond Ryan, Chairman of the Caribbean Fisheries Forum and Chief Fisheries Officer of the Fisheries Division, St Vincent and the Grenadines. Dr. Susan Singh-Renton, Programme Manager, Research and Resource Assessment, CRFM Secretariat, gave the vote of thanks.

2. Election of chairperson

Mr. Ryan was elected Chairperson of the meeting. However, since Mr. Ryan's responsibilities at the St Vincent and the Grenadines Fisheries Division would have likely resulted in his absence at some sessions he recommended the election of a Vice-Chair. Dr Singh-Renton was nominated to serve as the Vice Chair.

3. Adoption of meeting agenda and meeting arrangements

The agenda was presented (Appendix 1). Since the meeting was to follow an informal format it was noted that agenda items would not necessarily be addressed in the order listed. The meeting agenda was adopted without modifications.

4. Introduction of participants

A list of participants is provided in Appendix 2.

5. National (country) reports - Presentation of National Fisheries Information

National fisheries information was presented verbally for Anguilla, Antigua and Barbuda, Barbados, The Bahamas, Belize, the British Virgin Islands, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St Lucia, Suriname, Trinidad and Tobago, and Turks and Caicos. The following summarizes the major queries and areas of discussion, in respect of the verbal presentations. National reports, which were submitted in a reproducible format, are included in Part 3 of this report.

5.1. Anguilla

There was some discussion on the reasons for increased capture of spiny lobster in deeper (offshore) waters and the capture of spotted spiny lobster in inshore areas. This appears to be due, at least in part, to overexploitation of spiny lobster in the inshore areas. Currently there is no law requiring that fishermen submit data to the Fisheries Department. There have been serious incidents of conflict between Anguillan fishermen and French fishermen who fish in Anguillan waters. The question was asked whether this was still the situation. It was noted that Anguillan fishermen no longer approach these vessels at sea.

5.2 The Bahamas

There was some discussion on the export of sponges. It was indicated that next to lobster and conch, there is also a major fishery for sponges to support the export market to Greece and other countries. However, since the participant's primary responsibility is for the lobster and conch resources he was unable to give further details. The question was raised as to whether the increases in landings of lobsters in the 1990s were due to the use of condominiums. It was indicated that 'condominiums' make harvesting easier and may cause landings to increase over the years but there is no clear evidence that they are solely responsible for the observed increase in landings. The enforcement of management regulations for lobsters, especially closed seasons, was also questioned. Although regulations are enforced it was indicated that more work was required to ensure compliance.

5.3. Dominica

There was some discussion on whether the small sizes of *A. solandri* observed in catches from Dominica, compared to other countries, was due to the use of Fish Aggregating Devices (FADs). The FAD fishery intensified only over the last four years, but the extent of their use before 1997 is uncertain. Additionally, it was also noted that both Grenada and Dominica catch small (juvenile) and adult yellowfin tuna at certain times of the year. There is clearly a need for more thorough data collection to facilitate a more in-depth analysis.

5.4. Guyana

With respect to the use of TEDs (Turtle Excluder Devices), clarification was sought regarding catch exports to the USA and whether current modifications to TEDs were consistent with recent changes in USA legislation. It was indicated that the USA conducts monitoring to ensure compliance and certification. TED compliance certification was awarded following the most recent monitoring exercise.

5.5. Montserrat

Clarification was sought on which species are referred to as 'coastal pelagic'. These are species such as halfbeaks, needlefish and scads. The reason for disappearance of the bigeye scad in coastal areas was questioned. This was possibly attributed to the deposition of ash from volcanic activity in coastal areas.

5.6. St Lucia

Questions regarding the lobster fishery, enforcement of regulations and penalties for the capture of lobster out of season were raised. The land-based and marine-based police along with the Department of Fisheries are responsible for enforcement of regulations. Two staff members act as Surveillance Officers at the Department of Fisheries. Contravention of current regulations may result in charges up to EC$5,000. However, the Fisheries Department is proposing to revise its regulations so as to increase the penalty charge and to revoke licenses in instances of repeated penalty charges. The proposed revised legislation will allow a one-month grace period for hotels and restaurants following the closure of the lobster fishing season. Random inspections will be conducted at these institutions. In addition, these businesses will be required to declare their stocks at the beginning of the closed season. To avoid confusion in monitoring it is proposed that importation of lobster be discontinued during the closed season. Currently the importation of lobster species, other than the Spiny lobster, during the closed season is under consideration.

Concern was raised as to the management of lobsters. A regional approach was recommended given the biology of the species e.g., the 6-9 month larval phase, pelagic nature of the larvae and influence of environmental conditions on areas of settlement. It was noted however, that some level of collaboration has already been initiated through the harmonization of legislation among OECS countries.

5.7. Trinidad and Tobago

The question was raised as to whether there were foreign owned vessels registered under the flag of Trinidad and Tobago. At the time of reporting, no such vessels were registered in Trinidad and Tobago.

5.8. Turks and Caicos

The extent of regulation of the recreational fishery was questioned. At present, 30-day licences are issued to visiting tourists. New legislation is being considered for permitting line fishing only by recreational fishers. The question was raised as to whether any studies were conducted relating the amount of tourist based fishing and the associated contribution to the economy. Currently such a research programme is being implemented. Information was also sought on whether illegal fishing was a problem. Of the three main banks in the Turks and Caicos, the Moushwa bank is subject to illegal foreign fishing. It was pointed out that in view of the magnitude of illegal fishing, the catch quota for queen conch is set lower than the level of maximum sustainable yield (MSY).

Clarification was sought on the export of conch trimmings. About 15% of trimmings are exported. Conch is also exported to Haiti but the associated data are not available. A query was raised concerning the closed season for lobster and conch. It was clarified that the closed season for conch is July 15 to September 15 and the closed season for lobster is April 01 to August 01. In practice fishermen begin targeting conch from December and target lobster from August. The closed seasons are designated for socio-economic reasons rather than biology since there is need to spread the quota more evenly throughout the year. The question was raised as to whether conch quotas are achieved before the end of the fishing season. This was initially a problem but processing plants have tried to spread operations throughout the year. At the time of the Meeting, the quota for 2004 had not yet been reached even though the July 15 deadline was near.

6. Reports of the fish resource working groups

6.1 Reef and Slope Fish Resource Working Group (RSWG)

6.1.1. Red Hind (*Epinephelus guttatus*)

The length frequency data of small fish discarded from the analysis showed a wider range of sizes and if sample sizes were sufficient, this would have been useful for identification of cohorts. The data suggest the existence of three cohorts in 1996, but confirmation should be based on additional information. Sampling solely from handlines is biased as this gear targets the larger size ranges. However, it was pointed out that the discarded data also reflected unrealistically low size ranges in the catch. There is a need to sample less selective gear, but all commercial gears currently used appear to be highly selective.

It was noted that catch per unit effort data and estimates of total catches were available, but time constraints precluded analysis of these data. Ageing studies conducted at the Institute of Marine

Affairs (IMA) have not yet been completed. As a result, age and growth information was not available to the meeting.

Clarification was sought on whether the differences in the high ‘K’ values in the literature with current observations in the fishery were due to reductions in the population resulting in fewer large fish in the catch or under-sampling of large fish due to gear selectivity. It was indicated that there is insufficient understanding of the fishery to answer this question.

The difficulties in assessing stocks of hermaphroditic species and identifying biological reference points were noted. Sperm limitation may be a crucial factor as overfishing result in declines in the male population (larger fish) first. This poses a major challenge for management.

It was recommended that given the importance of *E. guttatus* to the Leeward Islands, the species should be the focus of assessment at the next Scientific Meeting. This will be addressed in the associated Terms of Reference. Attempts will be made to acquire aging data from the IMA and fishery related data from the respective countries for the assessment. The extent to which stocks are sharing should also be considered.

There were concerns regarding the usefulness of existing data for future assessments. The data provided for the meeting were difficult to interpret. Clarification is to be sought on the proportion of total catches of *E. guttatus* available at the New Kingstown Fish Market and the estimates of total catches derived by the Fisheries Division. The apparent seasonality of the species, from observation of catches at the New Kingstown Fish Market, is due mainly to a switch in target species around mid-year rather than any real changes in the population. There is need for a review of the data requirements for the next meeting.

No management recommendations were provided for *E. guttatus*. However, concern was expressed that the reasons for decline in landings between 2001 and 2003 be investigated and recommendations made to correct the situation.

6.2 Conch and Lobster Resource Working Group (CLWG)

6.2.1 Caribbean Spiny Lobster (*Panulirus argus*)

6.2.1.1 The spiny lobster fishery of Belize

Clarification was sought on the statement that ‘high mortality due to red tide occurrence was accompanied by increased production’. The high production was due to dying lobsters being displaced from habitats and easily collected by fishermen.

The stable catches observed and high estimated fishing mortality seemed contradictory and further clarification was sought. High fishing mortalities, which decline rapidly, are not uncommon to lobster fisheries. In the open season, fishermen drive the population down quickly, largely because they know where to fish the lobster. The depletion of the population is a catchability issue, which is to be addressed further. There is a need to look at declining cohorts by comparing the buildup during the closed season and loss in the open season. The true fishing mortality is uncertain since marine reserves make an unknown proportion of the stock unavailable to exploitation. Fishermen also catch conch on lobster trips, therefore effort is not totally directed at the lobster fishery.

The recruitment index as used in Cuba is suggested to predict catches as a management strategy.

6.2.1.2 The spiny lobster fishery of the Turks and Caicos Islands
The question was asked regarding the usefulness of predicting catches at the beginning of the fisheries as a management strategy since the quota will still be caught. It was noted that the stock recruitment relationship estimates a quota that optimizes long term stock size.
It was noted that the recruitment index was estimated for August and quota calculated for the season. However, this quota can be mostly filled very early in the season. An economic study on the lobster fishery in 2003 suggested that the fishery was already beyond the maximum economic yield (MEY).

The question was raised as to whether any attempts were made to separate new recruits coming into the fishery each year from those that entered in previous years. In theory, with a recruitment index, a cohort can be followed through a model. This has not been done in this assessment, though future work should focus on catchability since it is linked with catch rates and economics.

6.2.1.3.The spiny lobster fishery of The Bahamas
It is clear, after the difficulties in interpreting the data for the assessment, as well as the time constraints, that a participant from the Bahamas should attend the next meeting of the Working Group. It was also noted that lobster data were obtained from St Lucia and Jamaica. However, there was insufficient time and human resources to complete assessments of these stocks during this year's meeting.

The Working Group recommended that the CASA model be used to try to improve growth modelling used in the assessment. The software models growth transition to a particular size given a start size. This approach may be particularly suitable for crustaceans when tagging data is available. It was therefore suggested that age at length data be collected possibly from tagging programmes.

6.2.2. Queen Conch (*Strombus gigas*)
Given that countries' submissions of data on queen conch were limited and late, and that there were insufficient persons to analyse the available data, no assessments of queen conch were completed during this year's meeting. The Vice Chair indicated that in view of requests made by CITES, several countries were preparing to conduct visual abundance surveys of queen conch, and that the survey data would likely be analysed later this year, possibly during an inter-sessional meeting of the CLWG.

6.3. Shrimp and Groundfish Resource Working Group (SGWG)

6.3.1. Shrimp resources - *Farfantepenaeus notialis* (southern pink shrimp) and *Xiphopenaeus kroyeri* (Atlantic seabob)

The question was asked whether the size of shrimp caught is a function of the area in which the various fleets operate and whether closed seasons were considered for management purposes. It was clarified that the sizes of shrimp and species caught are related to the areas in which the different trawl fleets operate. Examining correlations between environmental parameters and recruitment may assist in determining closed seasons.

There was concern regarding the management of the shrimp stocks since they are shared by other countries such as Venezuela. The assessment performed by the Working Group focused on two species for which Venezuela lacks data, mainly because these species are not as commercially important to Venezuela. Joint assessments using data from both Trinidad and Tobago and Venezuela have been conducted in the past. Management recommendations were considered for application to all fleets.

The question was asked whether there was a means of distinguishing differences, based on selectivity, between male and female shrimp and how they recruit to the fishery. Data were available from the literature but it does appear that abundance differs between the sexes. In the next assessment, an attempt should be made to estimate growth parameters from the length frequency data. For the Yield Per Recruit analysis the species *F. notialis* and *X. kroyerii* were combined, assuming the fleet properties were the same and selectivity varies. In Trinidad and Tobago, the fleets cannot be examined separately, as in the case of Suriname and Guyana where these two shrimp species are caught at different depths.

Regarding the impact of environmental parameters on recruitment, different correlation patterns were observed between the two species in recruitment and rainfall variables. However, recruitment is probably seasonal rather than caused by local rainfall. For future work, correlations between recruitment and river outflow from South America will be performed.

It was reiterated that the assessment was preliminary and will be refined by using new software to fill data gaps in such a large data set for an 11 year period. In the current analysis, the gaps in the data set were filled using GLM, which ignores the time series effect with cohorts in populations. In the VPA model selectivity was estimated by gear and again, due to the large data set, area influences could not be examined. The model will also be refined to make the selectivity more reliable. The suggestion is therefore to be very cautious with management advice based on the results of the current assessment.

6.3.2. Groundfish fisheries

No assessments of groundfish fisheries were completed this year.

6.4 Small Coastal Pelagic Fish Resource Working Group (SCPWG)

6.4.1 *Selar crumenophthalmus* (bigeye scad), *Decapterus macarellus* (mackerel scad), and *D. punctatus* (round scad)

It was noted in the discussions that the low catches for 1999 for Grenada were due to a fish kill in that year. Although pelagic species were not affected, generally fishing and the consumption of fish were avoided. High catches of round scad during the dry season (January to July) are possibly due to environmental factors. Similarly, it was noted that in St. Kitts and Montserrat, destruction of sea-grass beds and subsequent declines in catches were thought to be due to hurricanes and volcanic activity respectively. Catches of bigeye scad are also highest during rainy season when the fish are spawning.

It was suggested that the data set used was good for GLM analysis since unbiased data were available from the NKFM. There is currently no sampling programme and there are large gaps in available data. A structured sampling approach needs to be considered. This can possibly be restricted to a frame survey. Data were only sufficient to observe general trends. Length frequency data should be collected and there is a need to determine the extent to which these resources are shared. Fish aging and genetic research should be considered for this purpose. Aging studies are relatively easy since these are small fish and easily purchased. Catch and effort data are difficult to collect, because of the complex distribution of the landing sites, and the opportunistic nature of fishing activities.

The scad fishery is difficult to manage since it is a multi-species fishery. The regulation of mesh sizes alone may not be a sufficient management measure. Co-management, involving the fishing industry, may be promoted through the existing TURF system. Since the various species spawn at different times of the year then some spawning grounds or beaches can remain open and others closed. There is also the potential to perform ecological studies that could be used to establish closed seasons and areas.

The scad fishery is very important, both socially and economically. It was noted that small coastal pelagics in general, are susceptible to overfishing since they are affected by a variety of factors: coastal developmental activities, environmental conditions, their importance as food fish, and their use as bait for other fisheries. Management approaches should also consider the contribution of these resources to the diet of the larger pelagic species, which are currently the focus of fisheries development activities in the region.

6.5 Large Pelagic Fish Resource Working Group (LPWG)

6.5.1 *Scomberomorus brasiliensis* (Serra Spanish mackerel)

6.5.1.1 Surplus Production Model

In terms of the lifespan of the species, the time series of catch data (1977 to 2003) used in the model was reasonably long. However, it was recommended that efforts focus on acquisition of data for the pre 1977 period since, with a shorter time series, the results tend to be more dependent on model assumptions. The model becomes less sensitive to the starting biomass the longer the time series e.g., if one goes back to the unexploited state. Currently the model is also very dependent on the Trinidad catch per unit effort (CPUE) data in the last few years. The estimate for the intrinsic growth rate of the population (r) is driven by these data points.

From the data used it is difficult to predict the current status of the stock. The assumption of a 1977 biomass consistent with that expected when fishing at the maximum sustainable yield (FMSY) is to be reconsidered. Venezuela had a substantial fishery for the species in the 1950s and this should be taken into account in the model.

It was suggested that catch data from the ICCAT and FAO databases be compared and clarification sought from Venezuela to explain any differences. It was also pointed out that discrepancies in recent catch data for Venezuela from these two databases was a major problem in the wahoo assessment. Both databases indicated a decline in recent catches but the magnitude of this decline differed. The Venezuela catches of *S. brasiliensis* used for the analysis were obtained from ICCAT and they also showed a decline in recent years. It was suggested that these catch figures be verified with Venezuela and it was recommended that the assessment be refined accordingly.

Regarding the practicality of the recommendations made in the assessment, it was indicated that catch data for Trinidad exist from as far back as the 1960s and possibly the 1950s. The Fisheries Division is currently computerizing historical catch data. Additionally, length frequency data exist for 1995 to 1998 and these are also to be computerized in the near future. Collection of length frequency data for the species recommenced in 2004. An arrangement for joint research between Venezuela and Trinidad and Tobago already exists (currently joint assessments of several shrimp species are conducted). Future assessments of *S. brasiliensis* can also be conducted under this arrangement. To incorporate the entire range of the stock in assessment it was recommended that Trinidad and Tobago should request that both Brazil and Venezuela submit data for analysis of the species at the 2004 ICCAT SCRS Meeting. Since the stock of *S. brasiliensis* is shared among several countries studies to discern the migration patterns are important. However, implementation of tagging studies is a huge undertaking which should not be the focus of attention in the short term.

To improve the assessment, expansion of the catch and catch per unit effort time series and standardization of CPUE were given high priority. Ageing studies should also be conducted to facilitate the application of analytical age structured models.

The responsibility for management was also raised since small tunas and tuna-like species are listed under ICCAT. For stocks of small tunas and tuna-like species of limited distribution, ICCAT's SCRS is of the view that the responsibility for management is better left to regional or sub-regional bodies. This is the case for the US Spanish and king mackerel stocks. It was therefore suggested that regional groups such as the CRFM, take the lead in providing management advice for shared stocks of mackerels and other small tunas within the region.
The assessment results suggest that there is not much room for an increase in current levels of exploitation. This concern should be presented to managers to guide the management strategy. It was noted however, that management objectives of various CRFM countries are broad and there is limited understanding, at the senior Government level, of management approaches to inform the selection of a suitable strategy. It is hoped that the results and report of this meeting will help to stimulate improved dialogue and reaction at the management planning and decision-making levels of government.

Attention then focused on presentation of technical and scientific information in a format that would be better understood by managers. It was agreed that the information should be summarized and simplified. It was also suggested that a glossary of scientific terms be included in the report. ICCAT documentation was identified as an information source.

The fact that managers are more receptive to scientific information of high certainty was also raised. It was noted that this is not reflective of the real world situation. Currently scientific information is presented to managers in a manner reflective of the uncertainty of knowledge of the species and stock structure. Each management option is associated with a corresponding quantified risk of an undesirable outcome, such as overfishing. Such an approach provides managers with a wider choice of management strategies and is more likely to promote support of measures to improve the certainty of assessment results.

6.5.2 *Acanthocybium solandri* (wahoo)

6.5.2.1 Surplus Production Model

Questions arose regarding the appropriate management advice given the uncertainty in the data and overall assessment. For example, the time series of usable data was relatively short, and it was necessary to constrain the input of intrinsic population growth rate for the estimation procedure to generate estimates of carrying capacity (k) and MSY since unrealistic predictions of 'r' and 'K' were generated with unconstrained models. Currently, the model is unable to predict how the stock will react in future. It was agreed that there is a need to continue monitoring the CPUE in this fishery. Results of the analysis show no clear decline in CPUE. However, given the high uncertainties in the results of the analyses, a precautionary approach to management was recommended. Furthermore, a quota system is not the preferred management strategy at this time, given the limited monitoring capabilities of the respective islands, and the present inability to quantify an overall quota.

There is also need to take assessment results to ICCAT to encourage broader participation in assessments of shared stocks impacted by fisheries of other nations. Currently, several countries are considering the need for an assessment of *A. solandri* in the wider Atlantic region. The need to involve other non-CRFM countries which harvest the resource in assessment of the stock was evident. The commitment of CRFM countries in the timely preparation and submission of data is a necessity for the collaborative approach to assessment and management proposed.

It was clarified that *A. solandri* is a target species in some countries e.g., Grenada, St Vincent, St Lucia. While the species is targeted by trolling fleets it is more likely a by-catch of the longlining fleets. This will have to be considered in future assessments. Acquisition of historical data is extremely important for future assessments. It is proposed that more detailed analyses of CPUE, which consider different units of fishing effort, be conducted in future. This will provide management advice in the event that stocks begin to decline. Since decision makers are also more likely to respond to the social and economic implications of stock decline it was recommended that data on associated indicators be collected.

7. Review of the Terms of Reference for the Working Groups

It was noted that the Terms of Reference (TORs) for the Working Groups were already adopted by the Caribbean Fisheries Forum (CFF). These TORs are broad in scope to facilitate flexibility of the Working Groups. However, it was recommended that specific TORs be developed to inform each Working Group session. The issues to be addressed should be guided by the Ministerial Council. However, since this is the first scientific meeting, it was agreed that the meeting take the initiative to present the relevant issues to the Ministerial Council. The Vice Chair explained that the TORs were developed at a time when the CRFM Working Groups were holding separate on-site meetings at different times and in different years. During that period of operation, it was therefore necessary to elect a Chairperson for each of the Working Groups. Considering that the Annual CRFM Scientific Meeting now allows a joint meeting of all CRFM Working Groups, the Vice-Chair suggested that it was no longer necessary to elect a separate Chairperson for each Working Group. However, participants noted that the election of a Chairperson for each of the Working Groups would help to ease the workload of the CRFM Secretariat in preparing for scientific meetings in future years. The issue was addressed under agenda item 12.

<u>Establishment of an Ad Hoc Methods Working Group</u>

It was agreed that an ad hoc Methods Working Group be established to explore and recommend methodologies suitable for assessment of species in the region (see discussion of Special Lecture: Using Fisheries Science – How to make the best use of Working Groups). The TOR for this Working Group will be drafted by the CRFM and submitted for review by the Working Groups. The TOR should outline the membership of the Working Group, sources of funding, hosting of meetings of the Working Groups and include a review of methods to monitor and control small-scale fisheries.

Offers to host the first meeting of the Ad Hoc Methods Working Group were received from Dr Gerry Scott of the National Marine Fisheries Service in Miami and Dr Robin Mahon of the University of the West Indies, Cave Hill Campus. It was also agreed that this meeting should be scheduled for the near future and should provide clear goals for the next scientific meeting.

8. Review of issues pertaining to statistics, data sharing and assessment approaches for guiding fisheries management within the CRFM region

This agenda item was merged with agenda item 9 (i): Using Fisheries Science – How to make the best use of Working Groups – Paul Medley.

8.1. Data submission and establishment of a regional database

The acquisition of data was a problem as there is currently no regional database. It is recommended that such a database be established. Considerable time was spent cleaning up the databases at the meeting. This limited the time available for conducting the assessments. It was suggested that the CRFM select the list of species to be assessed at each meeting and communicate this, along with a format for data submission, to the respective countries. It was recommended that Consultants should visit the respective countries and advise on data preparation prior to the technical session. However, since this may be a costly exercise it would have to be considered in relation to the data issues to be addressed. Countries should also take responsibility for cleaning their database before submission. It was also recommended that countries receive feedback on how their data were cleaned and adjusted for the analyses conducted at this meeting.

8.2. Format of scientific report

It was recommended that the Scientific Meeting be divided into two sessions: technical and plenary.

A format for the preparation of the technical section of the report was proposed and agreed upon (Appendix 3). The report will be presented to the next Meeting of the Caribbean Fisheries Forum and then to the Ministerial Council. It is therefore necessary that management objectives and issues are clearly identified and put forward. This proposed format ensures that management advice is provided up front and verified by the assessments.

Due to time constraints of the technical session, it was not possible to complete the reports covering this session. However, a report of the plenary session was available for adoption. In future, the technical section of the report should be prepared and circulated before the plenary session to facilitate a review of the science and validity of results before the issues are presented to managers. Such a process is already implemented in other technical fora and ensures broad involvement and transparency. It was agreed that detailed national reports would be attached in the appendix of the scientific report to preserve the integrity of the country information provided. In addition, the associated species assessments will give a summarized description of the fishery in the region.

8.3. Scientific assessments

Selection of the species assessed at this meeting was based on the availability of data. It was recommended that the associated assessments be updated regularly. Suggestions of species for assessment at the next meeting included dolphinfish and queen conch. There were insufficient time and human resources to complete all assessments planned for this year. It was therefore recommended that the method for prioritizing species assessments be determined in consultation with the Caribbean Fisheries Forum (CFF).

It was recommended that the budget for the hosting of scientific meetings be reviewed, taking into consideration additional sources of funding. The meeting should also benefit from increased country participation.

9. Special lectures

9.1. "Using fisheries science – How to make the best use of working groups", by Paul Medley

It was noted that many of the participants were not familiar with the stock assessment methodologies used at the scientific meeting. As a result, relevant training sessions were recommended. This presentation explained the use of fisheries indicators and the concept of risk and uncertainty in management. Biological reference points have been used thus far, and it was recommended that social and economic reference points be included in future work since these are more likely to get the attention of managers. The use of reference points is a proactive management strategy and is the basis for plans of action for different levels of stock. However, given the current uncertainty of the data and the multispecies nature of fisheries in the region, the broad applicability of approaches relying on more conventional and data-intensive assessment methods was questioned. It was suggested that new approaches for assessment be explored. One example suitable to data limiting situations is the use of decision analysis based on robust non-parametric assessment methods involving the use of information gathered from interviews with fishers. These interviews involve questions geared towards determining the catch rates for a fishery and are used to estimate the parameters for a logistic model using PFSA software (website address: www.fmsp.co.org) or other suitable software.

It was also noted that the University of the West Indies promotes alternative approaches to fisheries management and it was recommended that working group sessions be held to discuss these alternative approaches. The use of group process is one such methodology that is used to eliminate misleading responses gathered from interviews.

9.2. "Variability in recruitment of multiple life stages of the Caribbean lobster *Panulirus argus*, in the Gulf of Batabanao, Cuba" by Dr Raul Cruz

From the presentation, Cuba is one of the most advanced countries in the region in terms of understanding the lobster stocks. The question arose on whether spawner stock size has been plotted against recruitment indices. This has not been looked at since only eight years of settlement indices are available for cohort analysis.

Distribution patterns of the larvae have been documented in several scientific papers. The closed season for the lobster fishery is March-May in Cuba, however in Dominica it runs from April to September. There is substantial research in Cuba that indicates the highest peaks in spawning and in recruitment occur during the months of Cuba's closed season.

Given the need to cover the Cuba archipelago, this is a very expensive and labour intensive project, requiring regular field sampling. The objectives of the project are to predict catch and examine life cycle. After recruitment indices are established, there is the possibility to continue monitoring the stock using fisheries data for VIA. It was recommended that carapace length and not tail length measurements should be used. More data is however needed to determine high, medium and low recruitment indices.

Low recruitment levels and the expected low catches may perhaps be due to migration. It is assumed that there are density dependents factors otherwise the population will be unstable. Types of mortality should be examined to determine density dependence. It has been observed that recruitment decreases after environmental disasters such as hurricanes as in 1988.

10. Review and status update of proposed LME (large marine ecosystem) project

This presentation outlined the objectives of the project and the plan for implementation. It is a project developed by IOCARIBE and submitted to the GEF for funding. It focuses on the Caribbean region and North Brazil Shelf. The project focuses on analysis and advice with emphasis on the governance process. The technical focus is on transboundary resource management issues in the LME.

The GEF focal points varied in the respective countries and a list would be provided. It was noted that relevant documentation on the project was made available through the Caribbean Fisheries e-group which is accessible by the Heads of Fisheries Departments. However, it was evident that the information was not made available to technical staff in some countries.

Clarifications were sought on the linkages between the Lesser Antilles Marine Ecosystem Project, co-ordinated by the FAO and funded by Japan, and the GEF LME Project. It was noted that the Lesser Antilles Marine Ecosystem Project was highly scientific in nature. The GEF prefers integration of regional activities however, it is expected that the leader of the Lesser Antilles Marine Ecosystem Project will sit on the Steering Committee of the LME Project.

11. Review and adoption of meeting report

A draft of the report of plenary session items 1 to 10 was made available for review and revision by participants on the afternoon of the last day of the Meeting. It was agreed that, in future, the detailed reports of the Working Groups, as well as the plenary session report, should be completed for review by the Meeting prior to formal adjournment.

12. Other matters

Under agenda item 7, some participants noted that it would be prudent to elect a chairperson for each Working Group, as well as species rapporteurs, as this would help to ensure easier handling of the increasing workload associated with data and meeting preparations for the future.

As noted under item 8, the list of species assessments to be addressed during the annual scientific meetings, is to be determined in consultation with the CFF. However, in view of the need to begin preparing for next year's assessments immediately after this year's Meeting, it was agreed to develop a preliminary list of species considered to be a priority for assessment in 2005. This list could be further modified by the CFF, if needed.

Flyingfish was among the species identified for assessment in 2005. Participants sought clarification regarding the ongoing work of the FAO Working Group on Flyingfish and the proposed assessment of this species by the CRFM SCPWG. In view of this, as well as the uncertainty of cooperation by the harvesting countries concerned, the Meeting recommended that the matter be presented to the CFF to obtain clear guidance on flyingfish work expected to be completed by the CRFM SCPWG in 2005.

During this year's data analysis sessions, several rapporteurs did not have their own laptop computers, and this restricted the amount of work that could be completed in the allotted time. In view of this, the increased number of assessments planned for 2005, and the desire to have completed all assessment reports for review prior to adjournment of the plenary sessions, the Meeting recommended that rapporteurs bring their own laptop computers in future.

Following identification of the species to be assessed in 2005, the chairpersons were elected to serve on each of the Working Groups and rapporteurs were also elected to deal with the specific proposed assessments. The allocation of rapporteurs' responsibilities took into account the need to involve scientists from the countries contributing data for the assessments.

A list of the elected Chairpersons, rapporteurs, and their responsibilities follow:

Working Group	**Chairperson (and Co-Chair, if elected)**	**Species assessments (proposed preliminary list for 2005)**	**Rapporteurs and allocated assessment responsibility for 2005**
RSWG	Sophia Punnett	(i) *Lutjanus purpureus* (Red snapper), (ii) *L. analis* (mutton snapper), (iii) *Epinephelus guttatus* (red hind)	(i) - (iii) Leslie Straker
CLWG	Lester Gittens	*Strombus gigas* (queen conch) Stocks of (i) The Bahamas, (ii) Jamaica, and (iii) The Turks and Caicos Islands)	(i) Lester Gittens (ii) Stephen Smikle (iii) Kathy Lockhart
		Panulirus argus (spiny lobster). Stocks of (iv) The Bahamas (v) St. Lucia	(iv) Lester Gittens (v) Laverne Walker

SGWG	Lara Ferreira (and Suzette Soomai)	(i) *Farfantepenaeus notialis* (southern pink shrimp), (ii) *Xiphopenaeus kroyeri* (Atlantic seabob), (iii) *F. subtilis* (southern brown shrimp), (iv) *F. brasiliensis* (redspotted shrimp)	(i) - (iv) Lara Ferreira (iii) & (iv) Yolanda Babb
		(v) *Lutjanus synagris* (lane snapper) (vi) *Macrodon ancylodon* (bangamary) (vii) *Cynoscion virescens* (sea trout)	(v) - (vii) Suzette Soomai
SCPWG	Crafton Isaac	(i) *Hirundichthys affinis* (fourwing flyingfish) (ii) Others to be determined, based on data quality and availability	(i) Elizabeth Mohammed (ii) Crafton Isaac
LPWG	Christopher Parker	(i) *Coryphaena hippurus* (dolphinfish)	(i) Christopher Parker
		(ii) *Scomberomorus cavalla* (king mackerel) (iii) *S. brasiliensis* (Spanish mackerel)	(ii) & (iii) Louanna Martin

13. Adjournment

The Meeting was adjourned at 6.25 p.m.

Appendix 1: Agenda

FIRST ANNUAL CRFM SCIENTIFIC MEETING

(*Sunset Shores Hotel, Villa, St. Vincent and the Grenadines, 28-30 June 2004*)

MEETING AGENDA

Informal sessions: 22-26 June 2004

Completion of selected fisheries analyses and assessments (fisheries to be analysed will be selected based on quality and availability of cleaned data in format suitable for analysis). {Consultants and Species Rapporteurs}

Formal plenary sessions: 28-30 June 2004

1. Opening of the Meeting
2. Election of Chairperson
3. Adoption of Meeting Agenda and Meeting Arrangements
4. Introduction of Participants
5. National (Country) Reports
6. Report of the Fisheries Working Groups
    (i) Reef and Slope Fish Resources
    (ii) Conch and Lobster Resources
    (iii) Shrimp and Groundfish Resources
    (iv) Small Coastal Pelagic Resources
    (v) Large Pelagic Resources
7. Review of the Terms of Reference for the Working Groups
8. Review of issues pertaining to statistics, data sharing, and assessment approaches for guiding fisheries management within the CRFM region
9. Special lectures:
    (i) "How should stock assessments be used?" {Presenter-Dr. Paul Medley}
    (ii) "Variability in recruitment of multiple life stages of the Caribbean spiny lobster, *Panulirus argus*, in the Gulf of Batabanó, Cuba." {Presenter-Dr. Raúl Cruz}
10. Review and Status Update of Proposed LME project.
11. Review and Adoption of Meeting Report.
12. Other matters.
13. Adjournment.

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Appendix 3: Proposed Format of Assessment Reports Prepared by Working Groups

1. The Fishery Being Assessed

1.1 Management Objectives

Very brief Statement of management objectives for this fishery for each country exploiting the stock if necessary.

1.2 Status of Stocks

Current status of stock in relation to management reference points. If the status cannot be determined this should be stated here with reference to the precautionary approach.

1.3 Management Advice

Management recommendations based on the stock state (reference points) and any other issues identified by the management and/or working group. These should be clearly related to management questions/objectives. This could review current management practices and how these may help or hinder the sustainability of the fishery in the light of current results.
Risk and uncertainty should be addressed here. Precautionary approach is recommended if status is indetermined (FAO Code of Conduct).

1.4 Statistics and Research Recommendations

1.4.1. Data Quality

Statement on the suitability and quality of data for providing advice necessary for meeting management objectives (consider long and short term needs).

1.4.2. Research

Recommendations pertaining to research for providing advice necessary for meeting management objectives (consider long and short term needs).
If research and/or data needs cannot be realistically met, this should be stated along with a recommendation that management objectives are reviewed with the aim of producing more realistic aims.

1.5. Stock Assessment Summary

In point form, short statements of the range of analyses performed, main results (including figures and tables)

1.6. Special Comments

Any other information pertinent to the assessment advice not included elsewhere. This will often include important assumptions and uncertainties, which the working group may wish to highlight.

1.7 Policy Summary

What we understand the policy to be and what has been addressed by the assessments. Policy should be in the form of overall goal down to specific objectives, which can be achieved on the ground. It may be necessary to ask management to reconfirm policies.

1.8 Scientific Assessments

1.8.1 Background or Description of the Fishery

1.8.2 Overall Assessment Objectives

1.8.3. Data Used

Name	Description

1.8.4. Assessment 1

1.8.4.1 Objective

Specific objective of the analysis.

1.8.4.2 Method/Models/Data

Description of the method, models and data used. Method can be a detailed technical description. If the same method is used in more than one assessment, a single description may be added as an annex. Commonly used methods can be referenced without description.

1.8.4.3 Results

Technical results obtained from the analysis.

1.8.4.4 Discussion

Discuss the results in relation to scientific meaning and management objectives.

1.8.5. Management

Detailed description of implications to management of the assessments. This should be summarized in the management advice section above. If the management advice section is adequate, this section can be omitted.

PART II – REPORT OF TECHNICAL SESSIONS

A. REPORT OF THE REEF AND SLOPE FISH RESOURCE WORKING GROUP (RSWG)

Rapporteurs: Yolanda Babb, Sophia Punnett, Paul Medley & Susan Singh-Renton

1. The Red hind (*Epinephelus guttatus*) fishery of St Vincent and the Grenadines

1.1 MANAGEMENT OBJECTIVES

No specific management objectives for this fishery are given in the fisheries management plan for St. Vincent and the Grenadines. General management objectives for the reef and slope fisheries have focused on limiting fishing effort to present levels. Regulations include gear restrictions and prohibition of destructive fishing practices. Additionally, the Fisheries Division is interested in the use of marine reserves as an effective management tool.

1.2 STATUS OF THE STOCK

Earlier fishery evaluation exercises have presented evidence that suggests that the red hind fishery of St. Vincent and the Grenadines may be fully or over-exploited (CFRAMP 2001; CRFM, 2003). A quantitative assessment of the fishery was not completed during the 2004 meeting, owing to time constraints as well as constraints in the available data.

1.3 MANAGEMENT ADVICE

Annual total landings of red hind increased to a peak in 1997 at around 40,000 kg, and then decreased by as much as 50% in the following year, 1998. After this, landings increased again to reach a new and higher peak in 2000 at a level close to 50,000 kg. However, landings have decreased steadily from that time to 2003 (Figure A). The periods of observed increases in landings may have been primarily due to improvement in the sampling programme (for the earlier increase), as well as increases in fishing efficiency and also introduction of new and more efficient fishing gears. The recent steady decline in landings since 2000 warrants further investigation. The Fisheries Division should strive to maintain accurate records of fishing licences issued for this fishery, as well as seek to improve statistical monitoring of the fishery as outlined in the subsequent sections of this report.

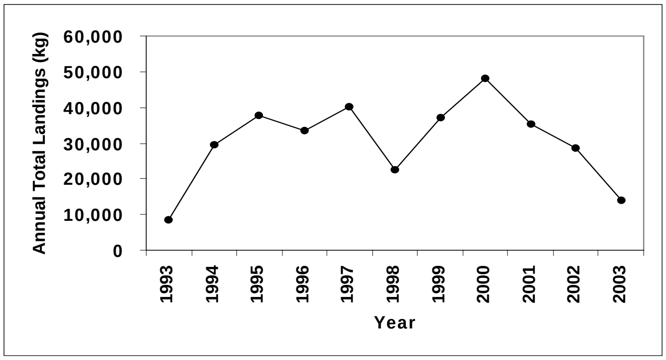


Figure A. Annual total landings (kg) of red hind during 1993-2003 in St. Vincent and the Grenadines.

1.4 STATISTICS AND RESEARCH RECOMMENDATIONS

1.4.1 Statistics

At present, data are collected on catches and primary gear used during a subset of the fishing trips in which red hind are caught. Detailed data on effort, such as number of lines and number of hours fished, and specific area fished, are not requested of the fishers at the time of data collection. Certain improvements in the current data collection programme are recommended.

(i) Units of weights recorded must be clearly specified, e.g lbs, kg.

(ii) Data on effective effort and area fished should be collected at the same time that fishing trips are sampled. The available catch and effective effort data would then allow at least the development of a reliable index of abundance that could be used to evaluate spatial (area) and temporal (annual) trends.

(iii) If resources are available, and management questions need to consider spawning biomass fluctuations, stock management units and stock mixing, or gear configuration restrictions, then development of a biological data collection programme is recommended. Units for length measurements must be recorded accurately and clearly, e.g. mm or cm.

1.4.2 Research

At present, there is uncertainty whether the red hind caught on various fishing grounds throughout St. Vincent and the Grenadines belong to a single stock. If it is not possible to conduct stock identification studies in the immediate future, then sampling programme should strive to gather more detailed data on areas fished, size composition of the catch, and maturity information. Additionally, sampling of hard parts for completion of age and growth research would help to enhance the interpretation of the observed size frequencies. The CRFM/IMA regional fish age and growth laboratory provides resources for conducting age and growth studies of red hind.

1.5 STOCK ASSESSMENT SUMMARY

Earlier fishery evaluation exercises have presented evidence that suggests that the red hind fishery of St. Vincent and the Grenadines may be fully or over-exploited (CFRAMP, 2001:

CRFM, 2003). Using a shorter time series of data, both statistical and analytical assessments conducted by Straker *et al.* (2001, in CFRAMP, 2001) showed evidence of stock decline. CRFM (2003) had noted that the mean size of red hind differed among the catches taken in different areas, and that the smallest fish were taken in the Central Grenadines where fishing pressure on this species was also apparently highest (Constantine *et al.*, 2003, in CRFM 2003). Additionally, CRFM (2003) observed a slight decrease over time in the mean size of red hind in the Central Grenadines, and cautioned that this was likely a signal that the resource was being negatively impacted by the level of fishing in this area at the time of reporting. A quantitative assessment of the fishery was not completed during the meeting, owing to time constraints as well as constraints in the available data.

1.6 POLICY SUMMARY

The fisheries management plan indicates a general commitment to the conservation and sustainable use of fisheries resources for the benefit of the people of St. Vincent and the Grenadines.

1.7 SCIENTIFIC ASSESSMENT

1.7.1 Description of the fishery

Red hind is a solitary and territorial species found mainly in shallow reefs and rocky bottoms. This species is distributed in the Western Atlantic: North Carolina, USA to Venezuela. It is the most common species of the genus *Epinephelus* in the West Indies, including The Bahamas, Antilles, Central and South American coasts. The sizes exploited range from 10 cm to 67 cm in total length (TL). This fish feeds on crabs (*Calapa and Mithrax*) and other crustaceans (alpheid shrimps and scyllarid lobsters), fishes (labrids and haemulids), and octopus. Sexual inversion can occur in some fish at 28 cm TL, with most fish larger than 40 cm being males {Source: http://www.fishbase.org/}.

The red hind fishery of St Vincent and the Grenadines is a multi gear fishery as fishermen use fish pots, trolling, spear guns, scuba, bottom long-line, palangue, hand-line (Straker *et al*., 2001, in CRFM, 2001). Based on the data collected, bottom long-line, palangue and hand line appear to be the most important gears (Constantine *et al*., 2003, in CRFM, 2003). The main fishing grounds for the fishery are the southeast shelf of St. Vincent and the east shelf of the Grenadines and extending outwards from the coast in waters up to 50 meters in depth. In this fishery, fishing trips are conducted on a daily basis, i.e. with fishing activities carried out during the daylight hours and fishing boats returning to port at the end of the day.

Vessels are 20 ft and longer, and are equipped with outboard engines (6-9 Hp) and sails. Pirogues use outboard engines up to 45 Hp. In the case of the line gears, circular galvanized hooks are used (size nos. 7-9), usually baited with small pelagic fish such as robin, jack, and ballahoo. The lines are left to soak only for some minutes at a time (Straker *et al*., 2001, in CRFM, 2001).

1.7.2 Data used

Name	Description
Biological data	Biological data (length measurements) were collected during the period 1994-2003. Sampling coverage appeared to vary from year to year, with the highest number of fishing trips sampled in 1999. The

	most sampled gear over the years was the hand line. Length measurements were collected in the Northern Grenadine Islands (Bequia and Petit Nevis) and Kingstown (Greathead, and Calliaqua). Data were imported into Excel for exploratory analyses.
Catch and effort	Catch data were collected at different landing sites throughout the archipelago. The fishing trip and primary gear used were the only measures of fishing effort recorded. These data were available for the period 1994 – 2003.

1.7.3 Assessment

Objective

It was not possible to complete a quantitative assessment with the available data, given constraints in both time and the available data. The Working Group decided to conduct exploratory analyses of the available data to: examine patterns in the size frequency distributions.

Using available size frequency data on the red hind fishery for the period 1995-1998, Straker *et al.* (2001) estimated K to be 0.51 and L_∞ to be 72 cm. These estimates are considerable higher than those obtained by other studies, and hence the Working Group decided: to explore the application of different growth parameter values in the estimation of total mortality using data from the different gear types.

Data and Method

General monthly and annual trends in landings of red hind were examined, as well as trends in gear usage.

The size frequency distributions for each year for the period 1996-2003 were plotted and examined. Additionally, using MRAG's LFDA software {Source: http://www.fmsp.org.uk/}, size frequency data were aggregated by calendar sampling quarter and plotted, to search for progression of modal size classes. The size compositions harvested by the various gears were also examined.

In view of the uncertainty about suitable growth parameters and restricted by remaining time available, The Working Group explored the estimation of Z using length-based catch curve analysis and applying various values of L_∞ within the range of 57-67 cm, and various values of K within the range of 0.12 - 0.50.

Results and Discussion

<u>Trends in landings and landings per trip</u>

Annual total landings of red hind increased to a peak in 1997 at around 40,000 kg, and then decreased by as much as 50% in the following year, 1998. After this, landings increased again to reach a new and higher peak in 2000 at a level close to 50,000 kg. However, landings have decreased steadily from that time to 2003 (Figure 1). The periods of observed increases in landings may have been primarily due to improvement in the sampling programme (for the earlier increase), as well as increases in fishing efficiency and also introduction of new and more efficient fishing gears. The recent steady decline in landings since 2000 may be a cause for concern, especially if effective fishing effort has not decreased. Detailed data on effort, such as number of lines and number of hours fished, and details of specific area(s) fished, are not requested of the fishers at the time of data collection. Data on effective effort and area fished should be collected at the same time that fishing trips are sampled. The available catch and effective effort data would then allow at least the development of a reliable index of abundance that could be used to evaluate spatial (area) and temporal (annual) trends.

In examining landings recorded per trip for the three major gears, bottom line, hand line and palangue, a gradual increase was observed for the hand line and bottom line gears throughout the period concerned. In contrast, the landings per trip for palangue gear fluctuated during the same period, with the highest rate observed in 1995 and the lowest rate observed in 2000 (Figure 2). As many as eight types of gears were used to harvest red hind during the mid-1990s, but the line gears have always predominated the fishery and have contributed to over 80% of the landings since 1997 (Figure 3).

Landings of red hind at the New Kingstown Fish Market (NKFM) for the period 1979-1994 showed distinct seasonality (Figure 4a), with the highest landings recorded during the later half of the year. When the data on landings for the whole archipelago for the period 1993-2003 were plotted, a similar but less marked seasonal pattern was observed, with higher landings being recorded from as early as May (Figure 4b). This seasonal pattern is probably partly influenced by the seasonality of the large pelagic fishery in which most of the harvest occurs during the period November-June (Mahon *et al*., 1990). That is to say, during the period when large pelagic resources are abundant and available to the fishery, many fishers in St. Vincent and the Grenadines target these species preferably. This may be related to an effort, on the part of fishers, to maximize profits from exploiting these resources, which would naturally be limited in any given year because of their highly migratory behaviour.

The monthly pattern in average landings of red hind per trip differed for the three main gears (Figure 5a). Apart from a sharp peak observed in February, bottom line gear showed higher averages during September to December. The average for hand line gear was the lowest among the three gears, remaining more or less constant during the first half of the year, and gradually increasing to the highest values observed during October to December. In the case of palangue gear, the landings per trip appeared to fluctuate about a constant level throughout the year, but with a distinctly higher peak recorded in December. The highest rates were generally recorded for the palangue gear. The handline gear is more often used by those fishers who switch from offshore pelagic species to reef species when the former become less abundant, and this may explain the gradual increase observed for this gear from July onwards. Although all gears showed higher rates during October-December, there were specific differences in the timing of the peaks, which may be related to differences among the fishing grounds used. Unfortunately, it was not possible to categorize the available data by area. The observed monthly trends in total landings of red hind also varied slightly among gears, and may also be due to differences in fishing grounds being used (Figure 5b). Interestingly, the total landings reported for the hand line gear were the highest of the three gears in all but 3 months, and may be due to the comparatively more widespread use of this gear.

Size frequency data analysis

During the earlier period of sampling when more gears were used, a broader size range of red hind was observed in the landings (Figures 3 and 6a-c). In the later part of the period studied, the size frequencies appeared uni-modal (Figure 6d-h), and were therefore not useful for estimating growth parameters. Interestingly, the distributions of size ranges recorded for the different gears appeared to have similar central points of tendency and with some distributions slightly skewed (Figure 7a & b). This, the low samples sizes in 1996, and the inability to separate landings from different fishing grounds and hence the real possibility of data on different stocks being combined, made it impossible to use the available size frequency data for estimated growth parameters using length-based methods.

Estimation of Z

The pattern of the changing Z-estimates was similar among gears (Figure 8). This was not an unexpected result as the size ranges concerned, and the representation of the various size classes in the landings were similar. It only served to emphasize the need to obtain reliable growth parameters if age-based methods are to be considered in the future.

1.8 REFERENCES

CFRAMP, 2001. Report of the 2000 Caribbean Pelagic and Reef Fisheries Assessment and Management Workshop. *CARICOM Fishery Report* No. 9. 139p.

CRFM, 2003. Report of the 2002 Joint Meeting of the CRFM Large Pelagic Fisheries Working Group (CRFM LPWG), the CRFM Reef and Slope Fisheries Working Group (CRFM RSWG), and the CRFM Small Coastal Pelagic Fisheries Working Group (CRFM SCPWG). CARICOM Fishery Report No. 10. 179p.

Constantine, S., S. Singh-Renton, and L. Straker, 2003. The Red Hind Fishery of St. Vincent and the Grenadines – An Interview Study. P145-157 In CRFM, 2003. Report of the 2002 Joint Meeting of the CRFM Large Pelagic Fisheries Working Group (CRFM LPWG), the CRFM Reef and Slope Fisheries Working Group (CRFM RSWG), and the CRFM Small Coastal Pelagic Fisheries Working Group (CRFM SCPWG). CARICOM Fishery Report No. 10. 179p.

Straker, L., S. Singh-Renton, and B. Lauckner, 2001. Assessment of red hind (*Epinephelus guttatus*) fishery using Eastern Caribbean Data. p 54 – 67 In CFRAMP, 2001. Report of the 2000 Caribbean Pelagic and Reef Fisheries Assessment and Management Workshop. *CARICOM Fishery Report* No. 9. 139p.

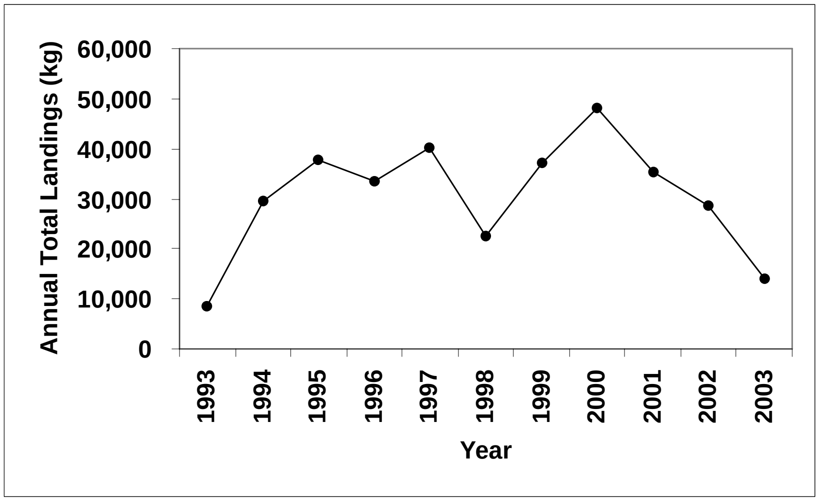


Figure 1. Annual total landings (kg) of red hind during 1993-2003 in St. Vincent and the Grenadines.

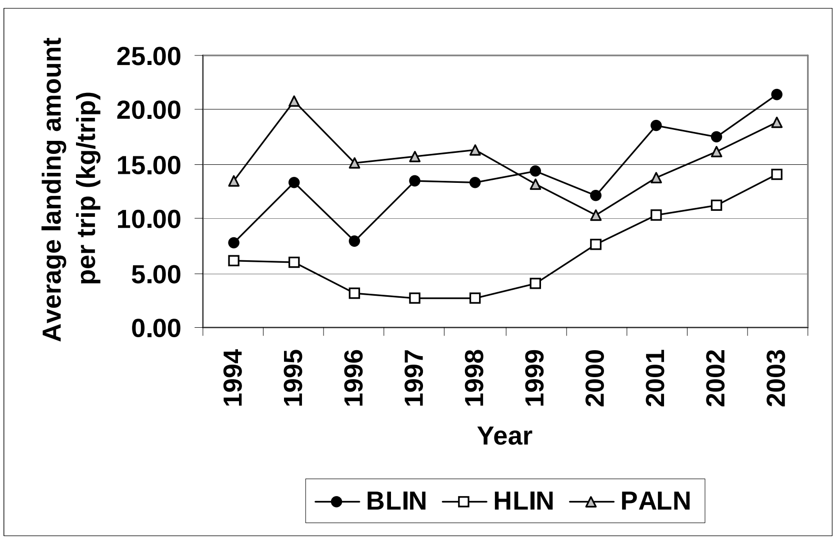


Figure 2. Annual average landing per trip (kg/trip) for the three major gears during 1994-2003 {Bottom line - BLIN; Hand line - HLIN ; Palangue - PALN}.

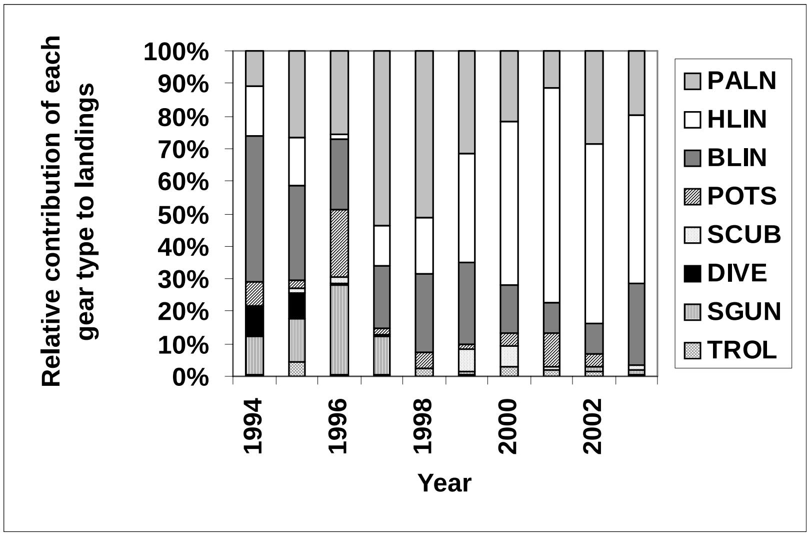


Figure 3. Relative percentages of the total landings harvested annually by the various gear types during the period 1994-2003 { TROL - trolling gear; SGUN – spear gun; SCUB – diving with scuba gear; POTS – fish traps; PALN – palangue gear; HLIN – hand line gear; DIVE – free diving; BLIN – bottom line gear}.

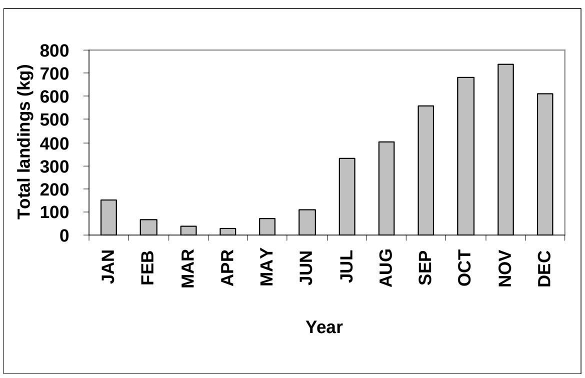
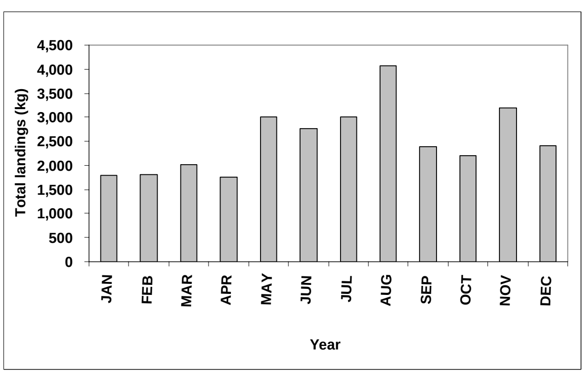


Figure 4. Average monthly landings (kg) of red hind at (a) New Kingstown Fish Market during the years 1979-1994, and (b) throughout the archipelago during the years 1993-2003.

(a)



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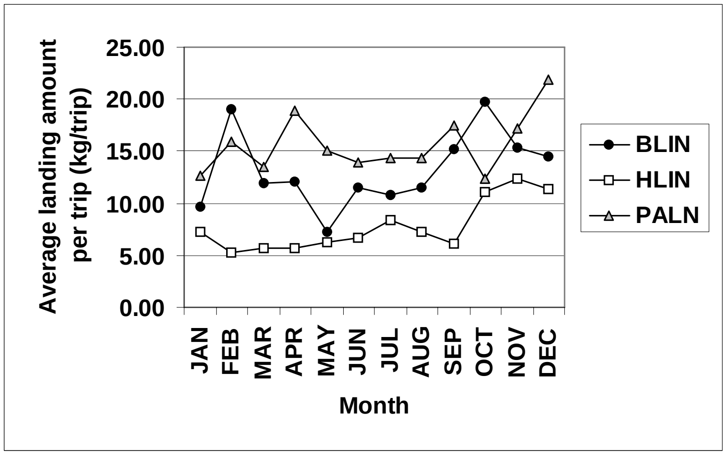

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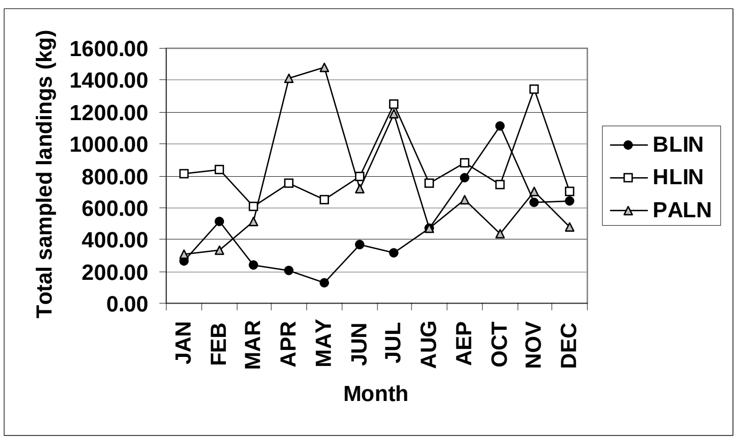


(b)

Figure 5. (a) Average landing per trip (kg/trip) and (b) total monthly landings recorded for the three major gears, bottom line (BLIN), handline (HLIN), and palangue (PALN).

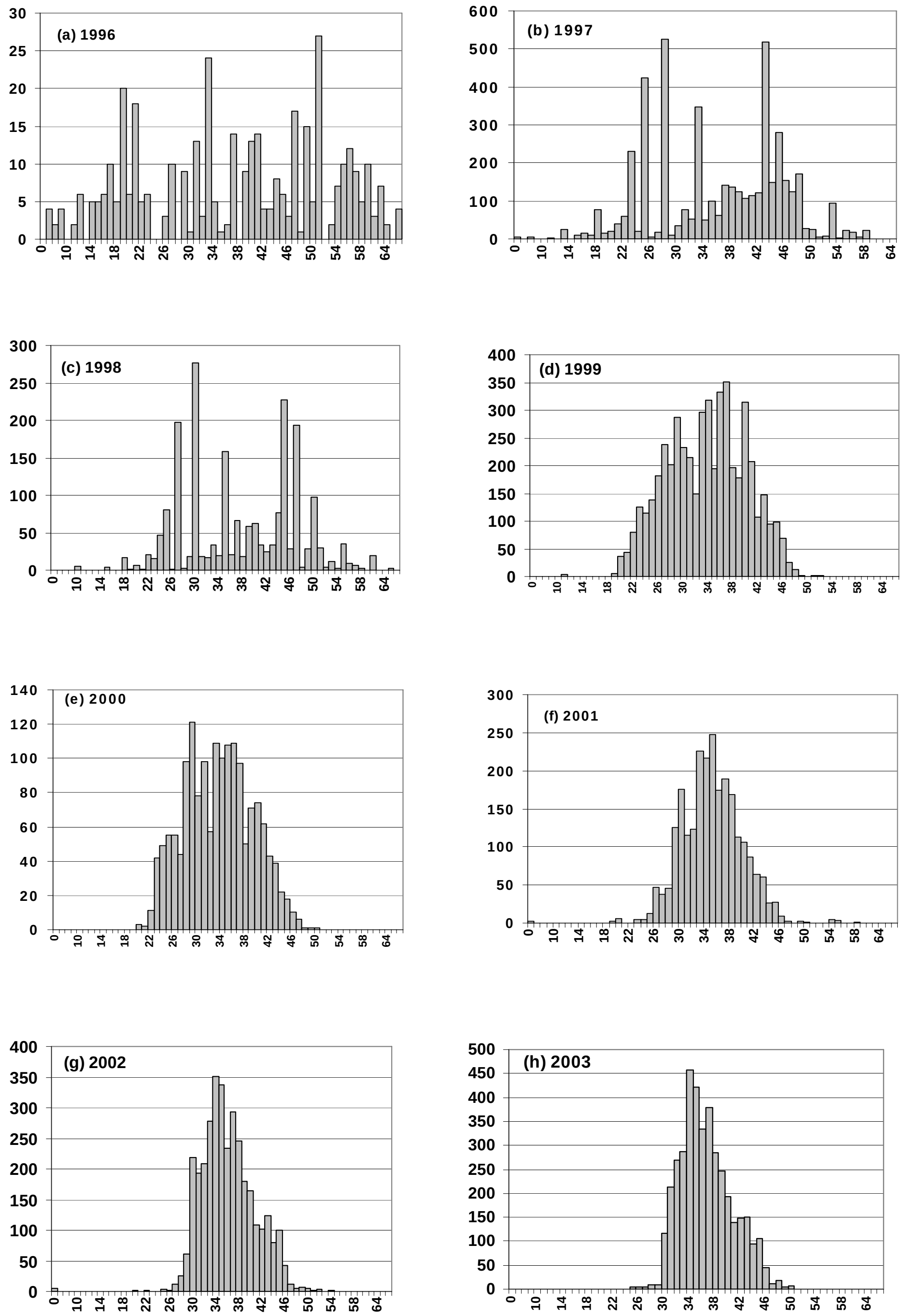
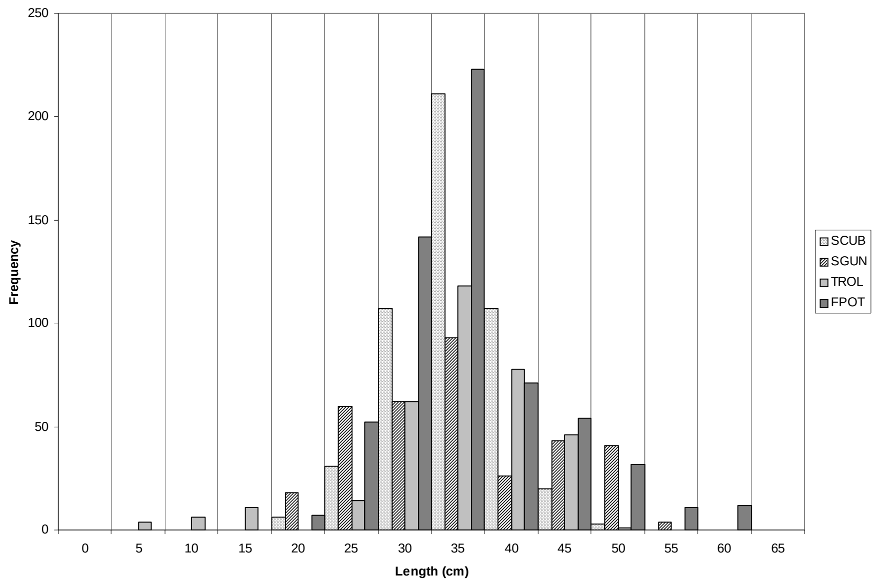


Figure 6. Annual observed size frequency distributions of the landings during the period 1996-2003.



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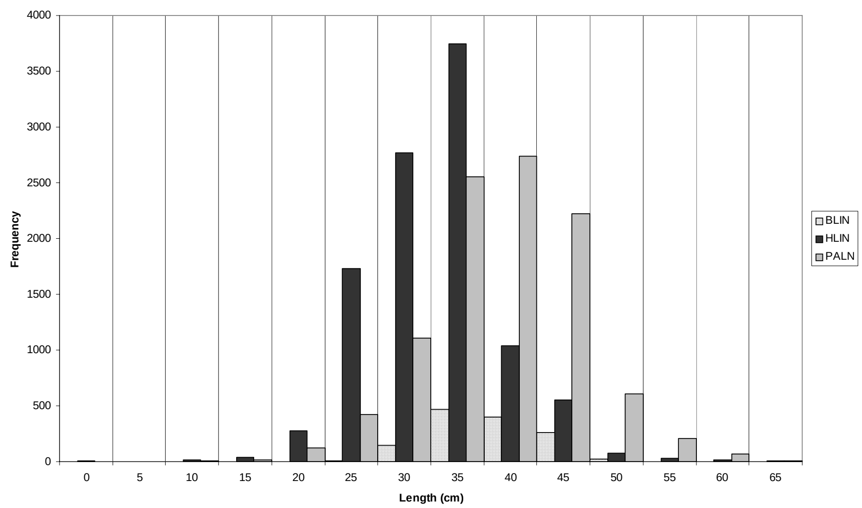


(b)

Figure 7. Size composition of the landings recorded for the various gear types; (a) trends observed with fish traps (FPOT), scuba gear (SCUB), spear gun SGUN, and trolling gear (TROL); and (b) trends observed with bottom line (BLIN), hand line gear (HLIN), and palangue gear (PALN).

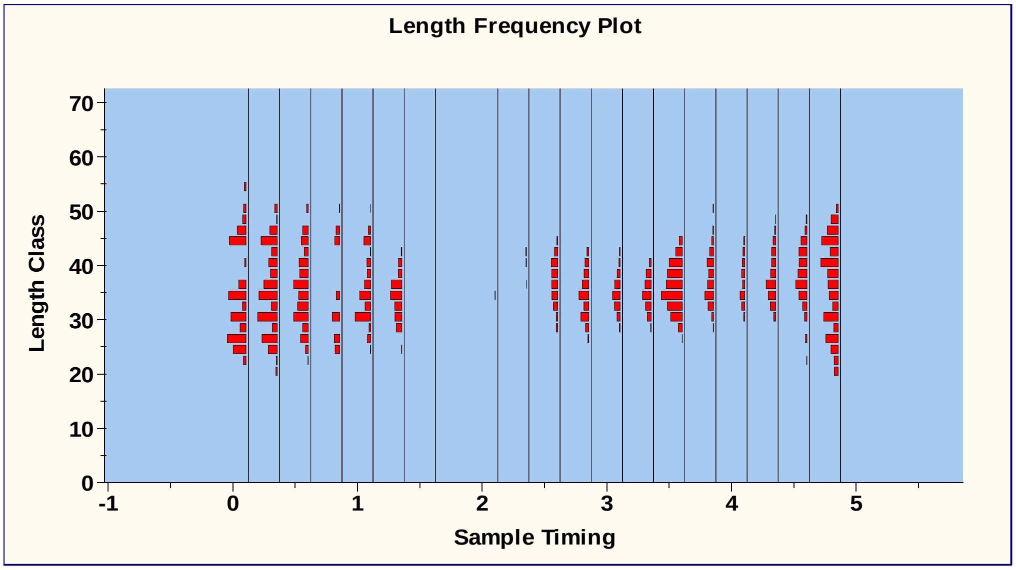
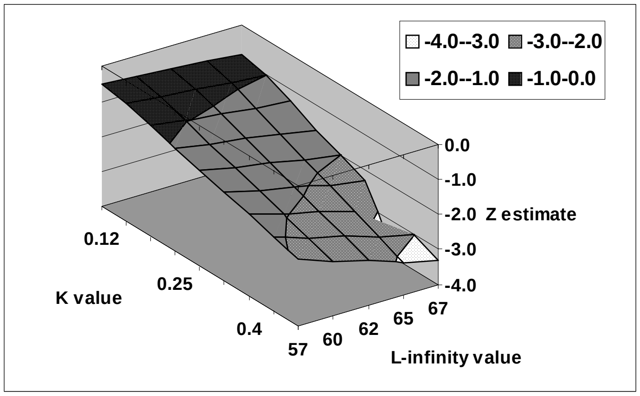


Figure 8. Size frequencies observed in samples taken in each calendar quarter for the period 1999-2003, commencing with the first quarter of 1999 at Sample timing =0.



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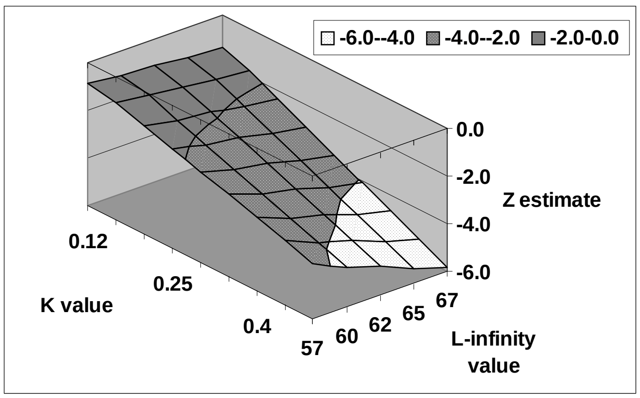

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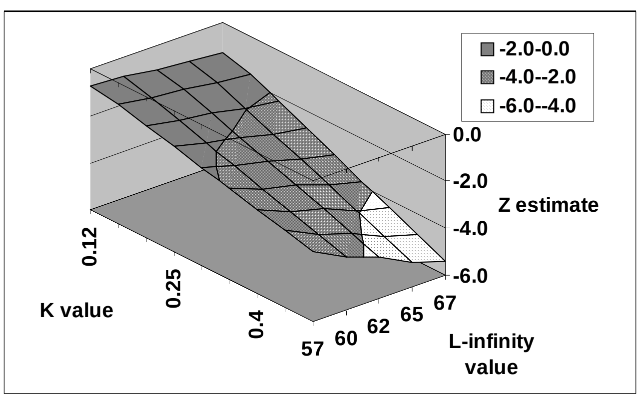


(c)

Figure 9. Range of Z-estimates obtained from length-based catch curve analyses of catches taken by (a) bottom line gear, (b) hand line gear, and (c) palangue gear, for different combinations of growth parameters, K and L-infinity, within ranges quoted in the literature.

B. REPORT OF THE CONCH AND LOBSTER RESOURCE WORKING GROUP (CLWG)

Rapporteurs: Ramon Carcamo, Sophia Punnett & Paul Medley

1. The Caribbean spiny lobster (*Panulirus argus*) fishery of Belize

1.1 MANAGEMENT OBJECTIVES

The management objectives of the lobster fishery are to stabilize landings for export markets of a sustainable fishery and also to maintain maximum economic sustainable yield to prevent undue loss of lobster habitat.

1.2 STATUS OF STOCKS

The spiny lobster (*Panulirus argus*) stock in Belize appears to be heavily exploited. This is suggested by the relatively high fishing mortality estimated for this fishery. However, it is suspected that this may only apply to a proportion of the stock and therefore the overall state of the stock remains uncertain.

1.3 MANAGEMENT ADVICE

There is no specific management advice at this time. Further development of policy and management questions, such as the value or potential harm of the use of shades or casitas could be answered using the current model.

1.4 STATISTICS AND RESEARCH RECOMMENDATIONS

1.4.1 Data Quality

The data that was used to conduct the assessment of the lobster population in Belize was catch and effort data gathered from two major fishermen cooperatives. The data was gathered from 2000 – 2003, where catch (lbs), area fished, gear type, and days fished were collected from purchase slips amassed from the fishermen cooperatives. However, in order to better assess the fishery in the future there are certain kinds of data that must be gathered that should complement the catch/effort data gathered. In particular, length and size compositions of the landings would allow development of better assessment models.

1.4.2 Research

It is important to collect tail length frequency data from the quantity that is exported by month, which should be useful to estimate growth parameters. Conducting a tagging study would also provide vital information on the estimate of the stock size, migration and growth parameters of the lobster in the different habitats.

Other important information that should be collected is economic data from the fishermen and cooperatives. Data variables would include prices paid to fishers and operation and investment costs. The economic viability of the commercial operation may be viewed from the possible effects of sustainable catch rates and product price on a vessel's net return. This information should provide better information when developing management plans.

1.5 STOCK ASSESSMENT SUMMARY

A preliminary assessment was carried out to develop a catch-effort based population model making use of the available catch and effort data. The assessment used the depletion that occurs after each season opens to estimate the fishing mortality. There appears to be recruitment during the closed season when the population rebuilds, and this allows us to apply this method. The results indicate that, on average, approximately 50% of the available stock is being caught each year. It is not possible at this stage to say whether this is too much without more management discussion. This assessment should, over a number of years, build a good picture of what is happening to the stock. It should also allow an accurate assessment of the benefits and costs of various management actions.

1.6 POLICY SUMMARY

The policy is directed at ensuring the sustainability supply of marine resource such as the spiny lobster, while continuing to contribute to food production, foreign exchange earnings and to improve nutritional status in the longer term. Actions to be taken to achieve the objective will be to improve fisheries management to reduce over-harvesting and maintain sustainable yields. Also, it is planned to strengthen the fisheries regulations and increase surveillance to improve compliance.

1.7 SCIENTIFIC ASSESSMENTS

1.7.1 Background or Description of the Fishery

Lobster is harvested by traps and shades inside the barrier reef in shallow water and by free diving with hook sticks on rocky bottom and also in deeper waters (60 ft–70 ft). The fishing fleet is comprised mostly of wooden or fiberglass skiffs with average lengths between 12-28 feet and usually propelled with outboard engines. In addition there are the wooden sails boats, which are equipped with sails and auxiliary engines. These boats would carry up to 8 small canoes and 10 divers. However, there is a lobster season in Belize that is open from 14th June to 15th February each year during which fishers are allowed to harvest lobster from the main fishing grounds. In addition there are other regulations that govern the sustainable existence of the lobster fishery. The fisheries regulation stipulates that it is illegal to be in possession of lobsters as follows:

- 1: Minimum carapace length is 3 inches.
- 2: Minimum tail weight is 4 ounces.
- 3: The Closed season is February 15th-June 14th
- 4: No person shall take berried females or moulting individuals.

The Belize marine fisheries sector has grown from approximately 790 registered fishermen and 566 boats in 1973 to approximately 2,600 registered fishermen and 790 registered boats in 2000.

1.7.2 Data Used

Name	Description
Annual landings	Annual landings are reported by all the fishermen co-operatives to the fisheries department.
Co-operatives catch and effort data	The data that was collected were from daily slips that were issued to fishers at Northern and National Fishermen Cooperative.
Catch and effort data	Data collected was for 12months from 2000- 2003 and a few months of 2004

1.7.3 Assessment

Objective

The initial aim was to develop a catch-effort based population model making use of the available catch and effort data. A secondary aim was to estimate the fishing mortality in the seasons 2000-2003.

Method

The available 2000-2004 catch and effort data was arranged into months. There are four months without data, being the closed season. It was assumed all recruitment occurred during the closed season. This is a reasonable assumption as closed seasons are declared throughout the Caribbean partly because it is at this time many small lobster are caught. If there is no recruitment or immigration during the open season, the population can be described using a simple depletion model:

$$B_{t+1} = B_t e^{-M} - C_t e^{-M/2} \qquad 2.$$

where M is natural mortality per month and C_t is the total catch in each month t. The population size at the beginning of the season includes the new recruitment as well as adults which have survived the closed season:

$$B_t = R_t + \left(B_{t-4} e^{-M} - C_{t-4} e^{-M/2}\right) e^{-4M} \qquad 3.$$

where R_t are the new recruits and must be estimated. The initial population does not distinguish between recruitment and the adult population, so the initial population size, B_0, also must be estimated directly. M was assumed to be 0.03 month^{-1} a reasonable estimate for this species (FAO, 2000; Medley and Ninnes 1997).

The population model is linked to the observations, the catch and effort time series, through a log-linear model. This is a useful approach because catch and effort can be divided into different gear types and different areas. The effect of area and gear are assumed to be multiplicative factors and therefore the model takes the form:

$$\hat{C}_{ijt} = B_t f_{ijt} e^{-G_i + A_j} \qquad 4.$$

where G_i and A_j are the gear type and area factors respectively, B_t is the overall population size (combined over all areas) from the population model, f_{ijt} is the observed fishing effort and $\hat{C}_{ijt}$ is the expected catch, each split among gears, areas and months. The model was fitted by finding the parameters B_0, R_t, G_i and A_j which minimised the difference between the observed and expected catches:

$$\text{Minimise} \quad \left(\sqrt{C_{ijt}} - \sqrt{\hat{C}_{ijt}}\right)^2 \qquad 5.$$

The aim is to find the parameters that minimise the squared difference between the observed catch and the model's expected catch in each gear-area-month category. The square-root transformation was used to stabilise the variance.

The data used to fit the model is the sum of catches and effort in each gear-area-month category. The catch in each category can be estimated using the effort reported for each category and the log-linear model equation 4. In contrast, the total catch used in the population model (equations

2. and 3.) is only separated into month categories only and includes all removals, whether included in the catch-effort data or not. Although the catch and effort data are available for only part of the fleet, the population model can still be fitted as long as total catches in each month are recorded.

Results

The model fitted the data reasonably well, although there was evidence that alternative models, if investigated, may produce better results (Figure 1; Figure 2; Figure 3). Both gear and area affected the catchability significantly (Table 1; Figure 3; Figure 4). The population model was able to detect a clear decline in CPUE during the season after allowing for the catchability differences (Figure 6). Over the very short time series, the model indicates an increasing trend in recruitment (Table 2) and increasing trend in fishing mortality. These may only be part of background fluctuations and it is too early to place any firm interpretations on these estimates. However, the average fishing mortality is high and as much as 54% of the stock is removed in each season (Table 2).

Table 1. Analysis of variance table for the catchability model. The F statistic is significant for both catchability effects, although gear is clearly more important.

	Sum of Squares	Degrees of Freedom	Mean Square	F
Gear	23860	4	5965	52.02
Area	8681	5	1736	15.14
Error	41968	366	115	

Table 2. Recruitment and fishing mortality from the fitted population model. The fishing mortality is the sum of each month's mortality calculated as the catch divided by the stock biomass. This season's fishing mortality indicates 45-55% of the stock is taken each year.

Year	Recruitment	Fishing Mortality
2000	613534[a]	0.69
2001	451285	0.58
2002	599289	0.77
2003	630189	0.74

[a] B0 = First Recruitment and adult survivors combined. Other estimates are new recruits only.

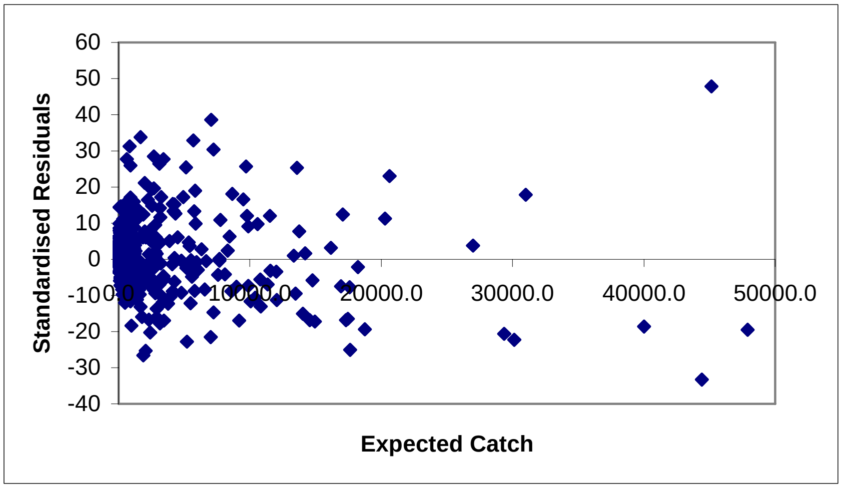


Figure 1. There is some evidence that the variance is increasing despite the square-root transform. A log-transform or alternative error model may produce better results.

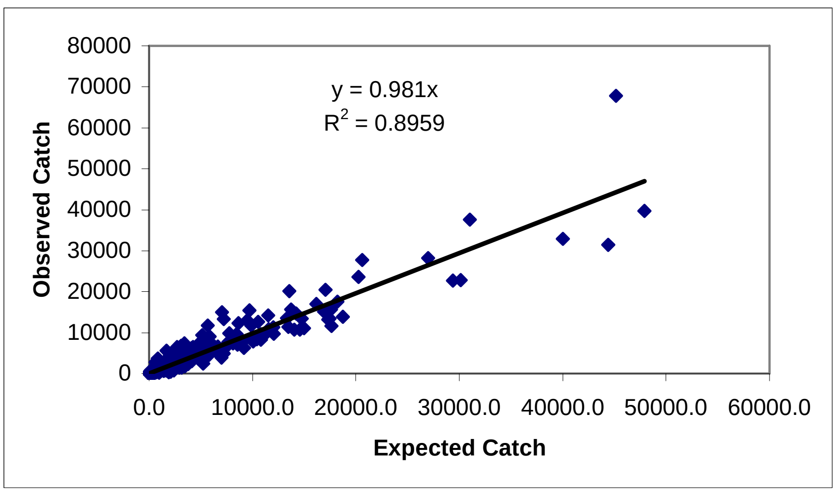


Figure 2. Observed and expected catch show the model explains approximately 89% of the variance. However, this includes the correlation between catch and effort as well as changes in abundance.

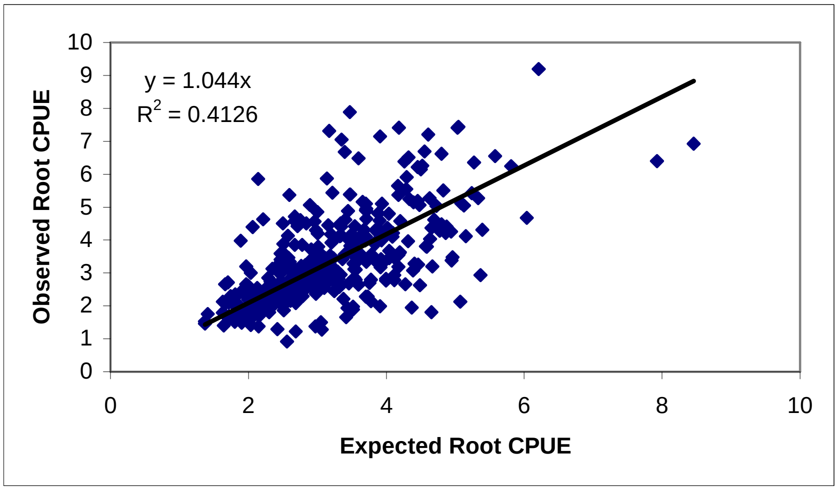


Figure 3. Observed and expected square root of the catch divided by effort ("root CPUE"). This relationship should be the result of differences in catchability and abundance rather than effort. The square root transform is necessary to linearize the relationship. It is possible better results might be obtained using an alternative link model, such as the catch equation.

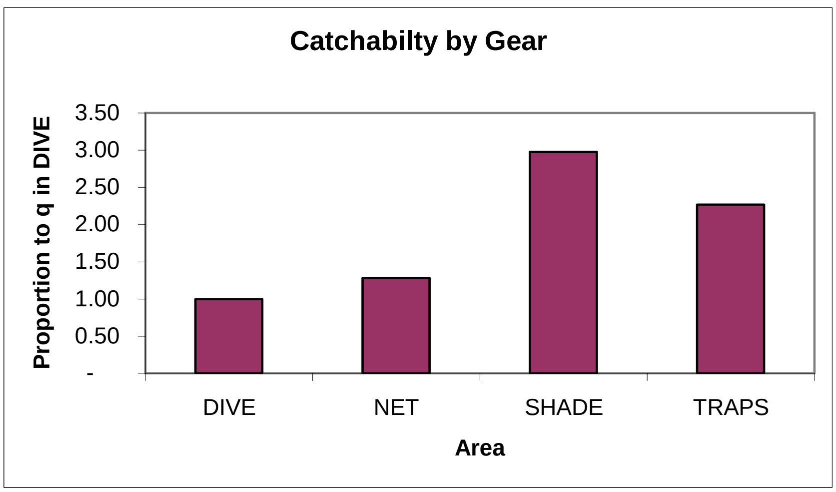


Figure 4. Relative differences between the catchability of each gear type. The most common gear, diving, had the lowest catchability. All other gears were relatively better, with shades (casitas) having the highest catchability. As shades become more widely used, the catch might initially increase. However, the fishery may not be able sustain higher fishing mortalities, and so higher catches may only be short-lived. Trawl only had three data points for a lobster bycatch and, although in the model, could not be reliably estimated.

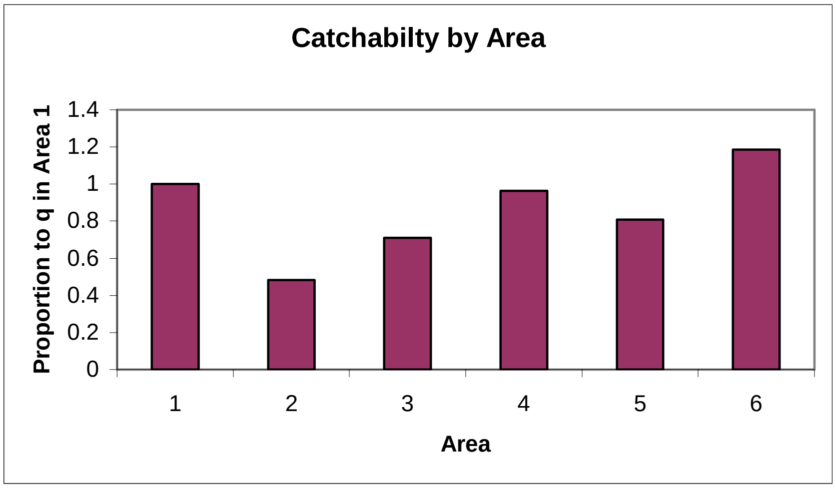


Figure 5. The areas show different catchabilities perhaps due to different densities of lobster or due to the relative difficulties for operating in different locations.

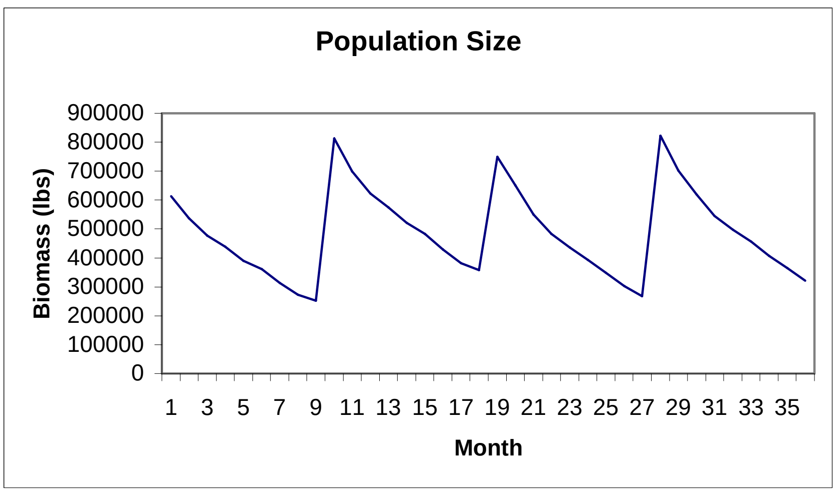


Figure 6. Estimated population changes over the months in the 2000 – 2003 seasons. The population model, supported by the catch and effort data, show a clear recruitment – depletion pattern.

Discussion

It is difficult to assess the conservation status of the stock. Fishing mortality is very high, but may only apply to a small proportion of the stock. An unknown proportion in the various Marine Protected Areas is not available to fishing. Other deeper waters may only be lightly fished. The largest lobsters are caught at the beginning of the season, suggesting at least some of the recruitment is due to adults migrating in during the closed season and not just young animals growing up to be large enough to be caught. It is also possible, of course, that lobsters are migrating out during the fishing season, contributing to the declining CPUE and biasing the estimates. These issues could only begin to be addressed by having size compositions of the catches.

It is clear that the apparent fishing mortality is very high and this should be of concern. It may be difficult to justify reductions in effort on this basis for conservation reasons, but there may be economic advantages to be gained from controlled gears and fishing areas used. The model can be used to address issues of gear and area controls in relation to economic effects on the fishery. Specific questions need to be proposed by management to be addressed by the model. Questions could include how the total catch or profit might change with: a switch from diving to shades, the reduction in effort of any gear, or particular areas being closed.

The assessment and data collection are clearly on the right track. However, there are various improvements to the model which could be made. The results suggest that an alternative error and/or link model may improve the fit to the observations. It may well also prove useful to see whether a model developed upon the same lines but working with numbers rather than biomass, and therefore adjusting for growth, would provide an improved fit. More importantly, a move towards a size based model that can follow cohorts would potentially separate out immigration of adults from new recruits and allow estimation of gear selectivity. However, data demands would be much higher and limit its potential. Once a model is developed which is acceptable to the working group, a “bootstrap” simulation or other similar approach should be used to estimate the uncertainty in the indicators such as fishing mortality and current biomass. This will give confidence intervals, which give an indication of the accuracy of the assessment and the likely range for the true value.

1.8 REFERENCES

FAO 2000. Report on the Caribbean Spiny Lobster Stock Assessment and Management Workshops. Section 2. Belize, 21 April - 2 May 1997 and Mérida, 1 June - 12 June 1998.

Medley PAH, Ninnes CH, 1997. A recruitment index and population model for spiny lobster *(Panulirus argus*) using catch and effort data. *Canadian Journal of Fisheries and Aquatic Sciences 54: 1414-1421.*

2. The Caribbean Spiny Lobster (*Panulirus argus*) fishery of The Bahamas

Rapporteurs: Ramon Carcamo, Sophia Punnett & Paul Medley

2.1 MANAGEMENT OBJECTIVES

The primary overall management objective for the spiny lobster fishery is to ensure that spiny lobsters are harvested for maximum economic benefit and that this is done in a sustainable manner (Gittens, 2004).

2.2 STATUS OF STOCKS

The current status of the stock has not been clearly identified. The current assessment suggests the stock is probably being fully exploited.

2.3 MANAGEMENT ADVICE

There was inadequate information provided to the working group to allow specific advice. All available data and previous research needs to be assembled for the working group. There needs to be significant improvements in catch and effort monitoring and in taking biological samples to allow reliable status determination. In particular, additional data should be obtained from sampling fishing trips.

2.4 STATISTICS AND RESEARCH RECOMMENDATIONS

2.4.1 Data Quality

Generally the available data appears to be poor, with the exception of the export size compositions and total catch. Although the export size compositions appear to be complete and of good quality, these data by themselves do not allow a full assessment. They could form the basis for developing a catch-at-length model. Other data, such as effort or sampled size compositions were not available. There is a general need to improve catch monitoring and sampling.

2.4.2 Research

It will be necessary to compile all available information so that gaps can be identified for the development of an acceptable assessment model. This requires not just monitoring data, but also information relative to socio-economic objectives. For this purpose, policy also needs to be developed along with methods to control fishing activity. That is, management needs to identify controls on catch or effort which can realistically be enforced, and try to identify target and limit reference points for these controls that meet the desired policy objectives.

The main specific recommendations relate to compiling the data necessary to complete a full assessment.

- Obtain monthly catch and effort data for developing an abundance index. Data should include, where possible, covariates and factors, such as gear type, necessary for standardizing the index.

- Break down the export compositions from annual into monthly data. As far as possible, exports should be allocated to the month in which they are caught, although it is recognised that this cannot be done accurately, with the data already collected.
- Separate catch, effort and size compositions for the different banks. Strictly speaking, separate assessments should be undertaken for each bank. While recruitment may be shared the adult stocks are separate and treating them as a single stock may result in a poorer assessment.
- Collect length frequency data in each month stratified by each of the tail size classes.

It should be noted that a full assessment is now at least possible if adequate quality data can be assembled. The minimum requirement would be the total catch composition and a catch and effort time series for each month Therefore data compilation should be the priority inter-session activity.

2.5 STOCK ASSESSMENT SUMMARY

It was only possible to conduct a preliminary assessment so no firm results are available. The best interpretation suggests that fishing mortality has been increasing in line with the catches (Figure A), but it is not possible to assess the state of the stock.

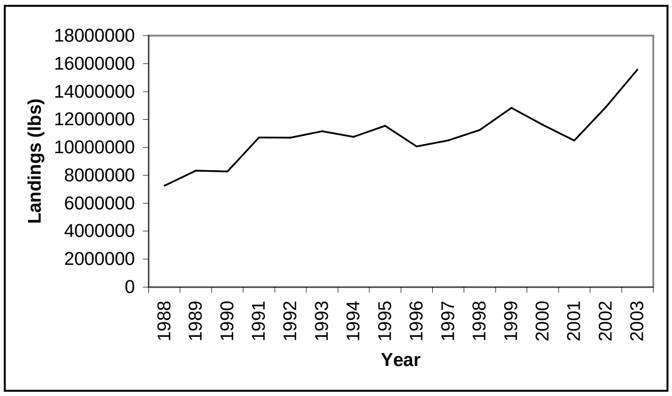


Figure A. Summary of total lobster landings in each year 1988-2003.

2.6 SCIENTIFIC ASSESSMENTS

2.6.1 Background or Description of the Fishery

The fishery is prosecuted mostly by mother boats tended by a number of small collecting vessels. Most catches are taken from casitas, known as condos, using hooks. Mother vessels go out for several weeks and process the lobster by removing the heads and landing frozen tails only.

2.6.2 Overall Assessment Objectives

The main aim is to assess the state of the stock. The longer-term aim will be to develop proper target and limit reference points based on a clear policy.

2.6.3 Data Used

Name	Description
Export tail size composition	Most lobsters are exported. Tail sizes are sorted into size classes for export. Amounts exported are submitted by the processing plants to the Customs and the Fisheries Departments. The data was only available as annual totals.

2.6.4 Assessment

Objective

The assessment aimed to update a previous model fitted to the export tail size composition data. Additional information was not available to improve the model.

Method/Models/Data

The model consists of converting the tail weight composition to age composition, then treating the data as catch data in a separable virtual population analysis (VPA). The conversion from tail weight to age used an age-length key estimated from the growth model. The method is the same as that used for the shrimp assessment.

Construction of the Age-Length Key

The age length key is a matrix of probabilities. Each cell in the matrix is the probability that a fish is within the age and size class defined. It is calculated from the joint log-normal distribution where the mean is given by the age at length from the deterministic von Bertalanffy growth model. The probability is then apportioned to discrete age and size classes by integration.

$$P(c) = \int_{a_c}^{a_{c+1}} \int_{s_c}^{s_{c+1}} N(a, s | \mu, \sigma)\, ds\, da \qquad (1)$$

where $P(c)$ = probability that a lobster is in class c with size and age lower and upper limits as s_c, s_{c+1}, a_c, a_{c+1} respectively. The mean log-weight at age is given by the log of the von Bertalanffy growth curve converted to weight using log-linear model:

$$\mu_a = \ln(a) + b \ln\left(L_\infty \left(1 - e^{-K(a-t_0)}\right)\right) \qquad (2)$$

where a is the age, and L_∞, K and t_0 are the standard von Bertalanffy growth parameters. Other probability distributions besides the log-normal could be used, but the log-normal is convenient and assumes the variance in length increases with age, which is likely.

The proportion of fish of a particular age in any length class was calculated as the difference between the cumulative normal distribution of the two log-length class boundaries. This function is available in MS Excel (*NormSDist((x-μa)/σ)*). This represents the inner integration in equation (1). A numerical approximation to the integral (Simpson's rule) over one year's aging was applied to approximate the outer integral in equation (1). So the proportion of cohort age a in length class i (p_{ai}) was calculated as:

$$\begin{aligned} p_{ai} = \tfrac{1}{2}\Big[&\big(\mathrm{N}(\ln(l_{i+1}); \mu_a, \sigma) - \mathrm{N}(\ln(l_i); \mu_a, \sigma)\big)/3 \\ &+ \big(\mathrm{N}(\ln(l_{i+1}); \mu_{a+0.5}, \sigma) - \mathrm{N}(\ln(l_i); \mu_{a+0.5}, \sigma)\big)\, 4/3 \qquad (3) \\ &+ \big(\mathrm{N}(\ln(l_{i+1}); \mu_{a+1}, \sigma) - \mathrm{N}(\ln(l_i); \mu_{a+1}, \sigma)\big)\, /3 \Big] \end{aligned}$$

where N( ) is the cumulative normal distribution, l_i is the lower limit for length class i. The probability that a lobster is in any particular age group, given its length class, is calculated as the probability (equation 3) normalized by the sum of probabilities over the age groups for this size. That is, we know the lobster is in this size group, but the age group remains unknown. The rows of probabilities for each length class can be combined into a matrix. A row of catches at length can then be converted to catches at age by matrix multiplication:

$C_{lt} P = C_{at}$ (4)

where C_{lt} = Catch-at-length row vector for a particular month, P= the age-length key matrix which has rows summing to 1.0, and C_{at} = the catch-at-age row vector resulting from the conversion.

The growth parameters used were obtained from the literature (Table 1). The growth variation parameter (sigma) was set at a level which appeared to be reasonable for the data. It could not be fitted formally however since it was too heavily correlated with other parameters.

Table 1. Growth parameters used for the age-size key. The parameters were from the FAO lobster working group meeting report (2000).

Growth Parameters				**Carapace length to weight conversion**	
K	**L_∞**	**t_0**	**Sigma**	**a**	**b**
0.23	190	0.44	0.3	0.000100603	2.63

Separable VPA

A standard separable VPA was fitted to the age composition assuming they were catch-at-age data (see Lassen and Medley 2001). Separable VPA model requires age-based selectivity and the exploitation rate in each year as parameters in the model and are fitted. A log-normal likelihood was assumed. Recruitment had to be fixed through the time series. As the model remains exploratory and imperfect, the statistical uncertainty, using a bootstrap simulation for example, was not assessed.

Results

The export size composition indicates an increasing proportion of smaller tail sizes (Figure 1). This suggests that fishing mortality is increasing, recruitment is increasing or selectivity is changing. Given also catches are increasing, the most likely explanations are fishing mortality and/or recruitment has been increasing. It is not possible to separate which of these is most likely to be the case without a population index.

The age to weight class conversion key created from the von Bertalanffy growth curve could not determine age accurately as weight classes are finely divided and annual catch data (Figure 2). Monthly data may allow better age determination for this model as August catches should be more closely related to the recruitment in each year.

Catches seem to take predominately younger lobsters between one and three years old (Figure 3). This is probably because condos select for smaller lobsters.

It was not possible to separate trends in exploitation rate from trends in recruitment without a population size index as provided, for example, by catch and effort data. Therefore the results remain incomplete. Assuming constant recruitment indicates an upward trend in the exploitation rate (Figure 4).

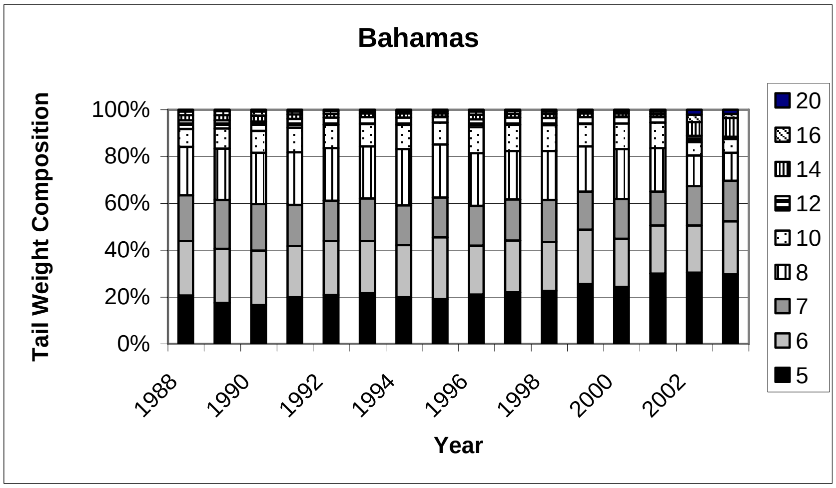


Figure 1. Summary of lobster tail weight composition in each year 1988-2003.

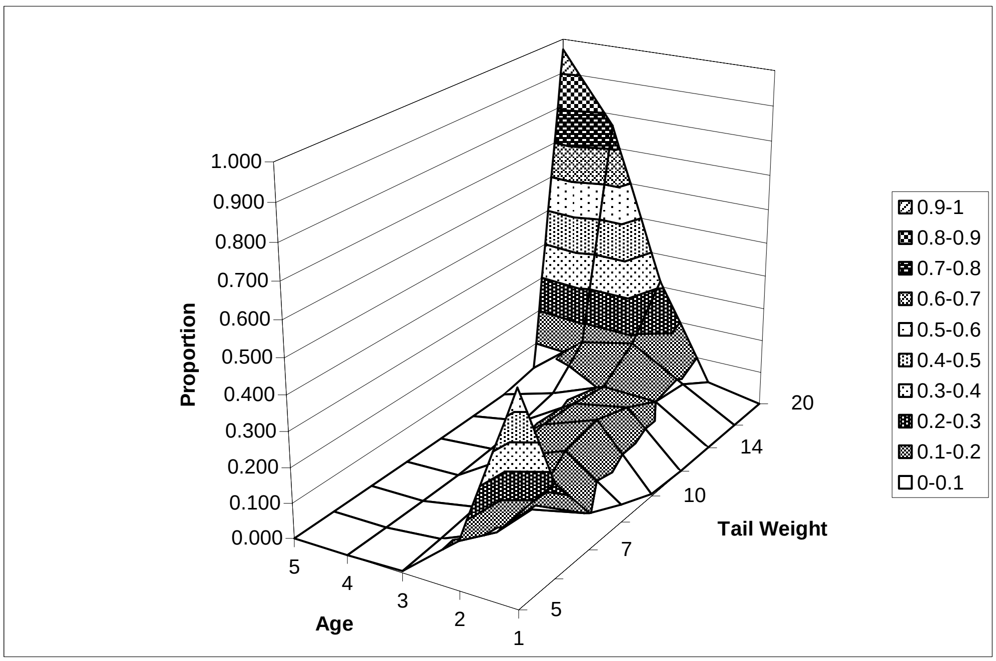


Figure 2. Age to weight class conversion key for the von Bertalanffy growth model and current parameters (Table 1). Note that the ridge is relatively flat, indicating that the weight classes are not very informative on age for the middle weights.

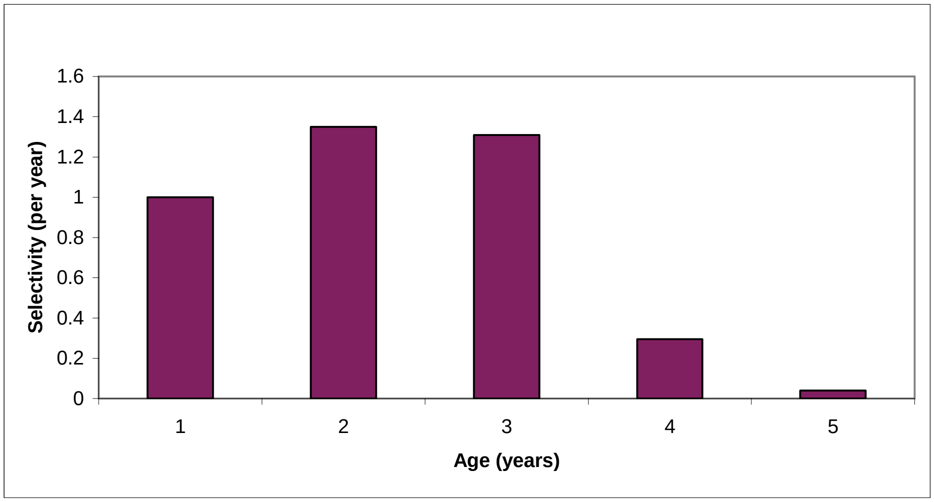


Figure 3. Selectivity estimates (relative to age 1 = 1.0) indicating older lobsters are under represented in the catches with peak selectivity at two years old.

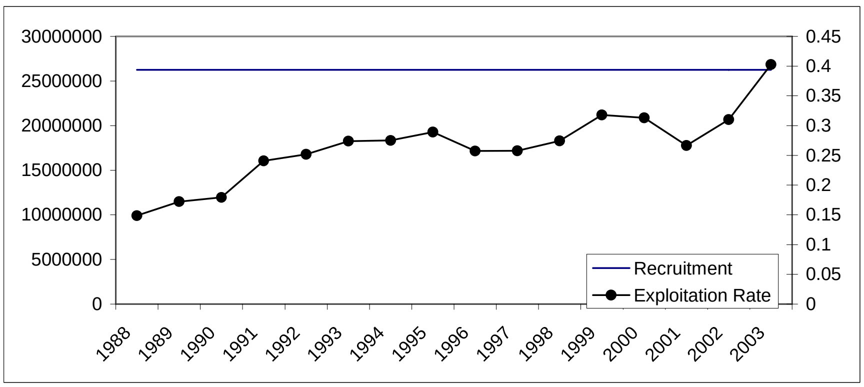


Figure 4. Model results indicating the results if recruitment is kept at fixed estimated average rate, the exploitation rate must be rising to explain the increase in catches. The alternative hypothesis, increasing recruitment with fixed exploitation rate is equally well supported by the model and data.

Discussion

The model provides a description of the data, but does not provide a full assessment. In particular it was not possible to separate changes in abundance from changes in fishing mortality, which is a requirement for a proper assessment. As a result it is not clear what the state of the stock is.

It seems reasonable and precautionary to assume recruitment has been constant through the time series. This results in the catches being explained by increasing fishing mortality rather than increasing recruitment. It should be borne in mind that an even more pessimistic position could equally well be true based only on the current data as evidence. That is, recruitment could actually be decreasing, making fishing mortality increase even more sharply. While there is no evidence for this position, there is no real evidence against it either.

The change in size composition is consistent with the increasing catch. Clearly the size composition data provides useful information and could form the basis for a reasonable assessment for this fishery. The most useful additional information would be a population index, which would allow estimates for changes in abundance to be separated from fishing mortality. Although imperfect, the catch and effort data series could provide the necessary information.

As a result, the most important recommendation is to assemble information with the specific aim of generating a biomass or exploitation index that can be used to fit the catch-at-age model. However, additional benefit might be obtained from using monthly rather than annual data. The largest catches and the smallest lobster are landed in August at the beginning of the season. Using months may not only allow improved selectivity estimates, but allow improved fit of the growth model which would be able to make better use of fluctuations in recruitment.

It would also make more sense to split the assessments among the different banks. Adult lobster will not migrate between banks, so they form separate closed populations after recruitment. Separating catches may, however, be problematic as lobster are all landed at the same processing facilities and it is not necessarily clear on which bank they are caught. Although this may lead only to a small improvement, it would nevertheless be worth attempting for scientific and modelling reasons.

It would be valuable to collect length frequency data in each month stratified by each of the tail size classes. Collecting such data each month would allow the length compositions to be estimated more accurately than the current weight composition. This would lead to more accurate estimates of age and therefore a much more accurate assessment. The conversion of size to age is often a weak point in this type of analysis and any method which might improve this estimate is advisable.

It will be necessary to review the management strategy for this fishery. While a stock assessment following the general form of that used here can provide an indication of the current state of the stock, it may not answer all questions related to the fishery. It will be necessary to identify other data that will be needed to meet objectives. Objectives would probably include maintaining sustainable economic benefits from the fishery and minimising environmental damage from condos. In order to meet such objectives, it will be necessary to monitor vessel catch rates and the number and placement of condos on the banks. If goals are set for the fishery, but there are no indicators monitoring how well these objectives are being met, the goals will probably not be met and management will remain ineffective.

2.8 REFERENCES

Lassen, H, Medley, PAH. 2001 Virtual Population Analysis: A practical manual for stock assessment. FAO Fisheries Technical Paper 400. 129pp.

Gittens, L. 2005. Bahamas National Report, In Part III of the present report.

FAO (2000). Report on the Caribbean Spiny Lobster Stock Assessment and management Workshops. Section 2. Belize, 21 April - 2 May 1997 and Mérida, 1 June - 12 June 1998.

3. The Caribbean spiny lobster (*Panulirus argus*) fishery of the Turks and Caicos Islands

Rapporteurs: Ramon Carcamo, Sophia Punnett & Paul Medley

3.1 MANAGEMENT OBJECTIVES

There are no specific management objectives for this stock.

3.2 STATUS OF STOCKS

The stock does not appear to be overfished and indications are current catches are sustainable. However, it is likely that the fishery is not maintained at a level to maximise profitability.

3.3 MANAGEMENT ADVICE

Without clear management objectives, it is not possible to provide specific advice. There is no evidence of a long-term decline in recruitment, and therefore the stock does not appear immediately threatened. No specific conservation action is recommended. It is important for management to identify target and limit reference points on which scientific advice can be based. This would allow development of more specific and useful advice on what management needs to do to achieve objectives.

3.4 STATISTICS AND RESEARCH RECOMMENDATIONS

3.4.1 Data Quality

Catch and effort data are obtained from processing plants. Data appear of good quality. Reported landings are probably close to complete. Local consumption is not included but probably negligible. Additional information could be obtained from local purchasers as well as the exports. Export data also should be assembled and used as part of the future assessments.

3.4.2 Research

Improved models need to be developed to make use of all the available data and allow estimation of appropriate controls, either effort or catch quota. There is adequate data to monitor the stock, but no accepted method to supply advice to management. The most urgent research is socio-economic in nature and particularly should focus on the management strategy to develop and protect the fishery.

Recommendations from the assessment consisted of:

- (i) Refitting the model with original recruitment index;
- (ii) Getting better estimates of spawning stock size using export size composition data;
- (iii) Develop reference points to protect the spawning stock; and
- (iv) Develop a co-management strategy, addressing the economics of fishery.

3.5 STOCK ASSESSMENT SUMMARY

The assessment used the available catch and effort data to estimate the new recruitment and adult stock size over the 1974-2002 period. Based on this fitted model, a stock-recruitment relationship was identified. This can be used to define the spawning stock required to produce the long-term maximum sustainable yield, a useful reference point for management. If the spawning stock is pushed below this value, the stock can be determined to be overfished. A bootstrap simulation was used to estimate uncertainty in the assessment, which was found to be considerable (Figure A). Nevertheless, it indicated that the spawning stock is unlikely to be low enough to be having a detrimental effect on recruitment. There was inadequate information on policy and socio-economics to develop further models or advice.

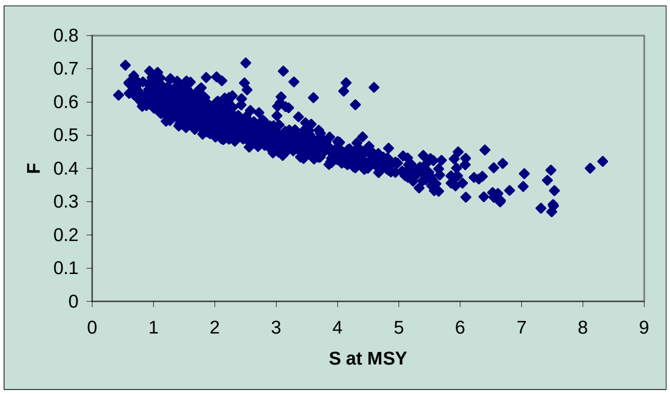


Figure A. The estimated current state of the fishery based on fishing mortality and the spawning stock as a proportion of the spawning biomass needed for maximum sustainable yield. The individual points are derived from bootstrap simulations. The spread of points represent the significant uncertainty in the assessment. However, the relatively few points below S at 1.0 indicate the stock is not likely to be currently overfished. No appropriate reference point for F could be determined.

3.6 SPECIAL COMMENTS

As all information was not available, the assessment conducted here was exploratory. The assessment needs to be done again after discussion with management and development of a clear policy, which can be translated into quantitative reference points.

3.7 POLICY SUMMARY

There was no specific policy available. It was presumed that the fishery should be limited to sustainable exploitation and advice was given on this basis.

3.8 SCIENTIFIC ASSESSMENTS

3.8.1 Background or Description of the Fishery

Catches for both lobster and conch are recorded as pounds landed at the end of each day's fishing at one of the five main processing facilities. Lobster are landed whole, although only their tails are exported. Fishers generally leave between 0700-0800 and return to land their catch by 1600. The length of a fishing day is variable and will depend, among other things, on weather conditions. Each boat carries a boat driver (keep-up) and 1-2 divers. Most boats are now made of fibreglass and have 55-70 hp outboard engines. Lobsters are collected free diving from up to 20 metres depth depending on the capability of the fisher. There is also a small trap fishery for lobster of 1-2 boats generally operating at depths unavailable to divers.

The lobster and conch are connected, with divers opportunistically switching between the fisheries as both use the same gear. The lobster fishery only began in earnest with the arrival of appropriate freezing technology in 1966. Both conch and lobster fisheries expanded, with some fluctuations, to 1979. However the fishery subsequently went into decline and by 1985 lobster catches had fallen to less than 400,000 pounds. As fishers switched to conch, the conch catch also began to decline as did income from the fishery. By 1989 the fishery was in the worse state it had ever been. However, there was a recovery between 1990 and 1994, with 1992 having the highest lobster catch on record. Similarly, there has also been an increase in the conch stock and stabilised catch rates the result of the quota imposed.

3.8.2 Overall Assessment Objectives

The objectives are to develop an acceptable model which can be used for decision making. Reference points consistent with some stated policy are yet to be determined, so it will not be possible to offer specific advice.

3.8.3 Data Used

Name	Description
Catch and effort data	The catch landed by each boat is recorded and submitted by the processing plants. Almost all catch is landed this way. Boats only go out for single days, so effort in boat days can also be obtained from this source. The catch-effort data series extends 1974-2002.

3.8.4 Assessment 5

Objective

The main objective was to develop a model suitable for estimating a catch quota. Although a model exists, a stock recruitment relationship is required to allow appropriate spawning stock to be estimated.

The model to be used will be based on the recruitment index model of Medley and Ninnes (1997). In this case, however, total August data will be used for the index rather than the daily data, because daily data was not available. It was also thought useful to test whether this slightly simpler method would be adequate for the assessment.

Method

The adult population size at the beginning of the season (S_t) depends upon the previous year's new recruits (R_{t-1}), the previous year's adult population size (S_{t-1}), natural mortality (M) and the catch (C_{t-1}):

$$S_t = R_{t-1} + S_{t-1}e^{-M} - C_{t-1}$$

Recruitment in each year is treated as an independent parameter and estimated by the model. The august catch is estimated as a function of recruits using the August catch and effort ($f_{aug,t}$):

$$\hat{C}_{aug,t} = R_t\left(1 - e^{-q_a f_{aug,t}}\right)$$

The remaining non-August effort is used to estimate the non-August catch:

$$\hat{C}_t = \left(S_t + R_t\right)\left(1 - e^{-q_t f}\right)$$

The model was fitted by minimising the squared difference between the observed and expected catches:

$$\text{Minimise} \quad \sum_t \left(\sqrt{C_{aug,t}} - \sqrt{\hat{C}_{aug,t}}\right)^2 + \left(\sqrt{C_t} - \sqrt{\hat{C}_t}\right)^2$$

Equal weight was given to the August and non-August catch series as they exhibited similar variance. The square root transformation stabilised the variance. The parameters were the initial adult population, each year's recruitment and the catchability parameters (q_a and q_t for the August and non-August catchability respectively). The model was fitted in MS Excel using the add-in Solver.

The main aim of the analysis was to see whether a stock-recruitment relationship could be found. A suitable delay between adult stock size (S_t) and later recruitment (R_t) should be 2-4 years based on what is known of the life history. The cross-correlations between estimated stock and recruitment were inspected to choose an optimal lag. The Beverton and Holt and Ricker curves were then fitted to the estimates using the log-normal likelihood.

Results

The model fitted the observed CPUE data well (Figure 1) explaining approximately 74% of the variance. Although the adult model fits well, the August CPUE residuals show some patterning indicating improvements in the model are desirable (Figure 2). Nevertheless, assessment does provide an adequate description of the population changes.

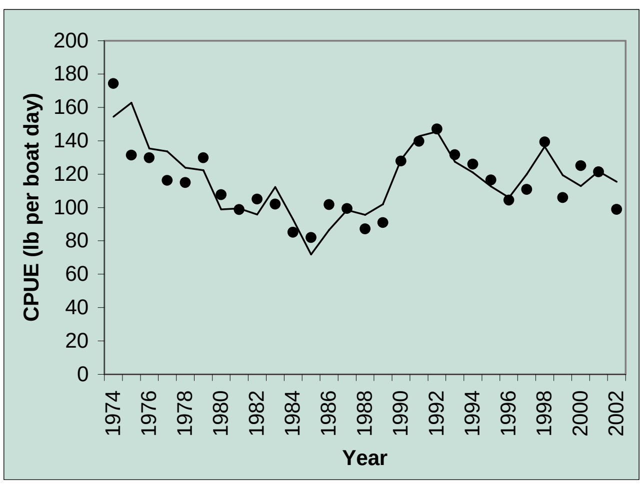


Figure 1. Observed and expected catch-per-day for spiny lobster (CPUE R^2 = 0.74).

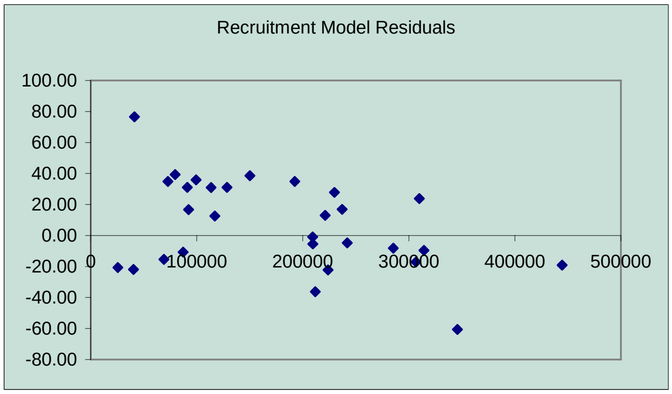


Figure 2. August CPUE residuals show some patterning not found in the model using daily data. This indicates August CPUE is a poorer index of recruitment.

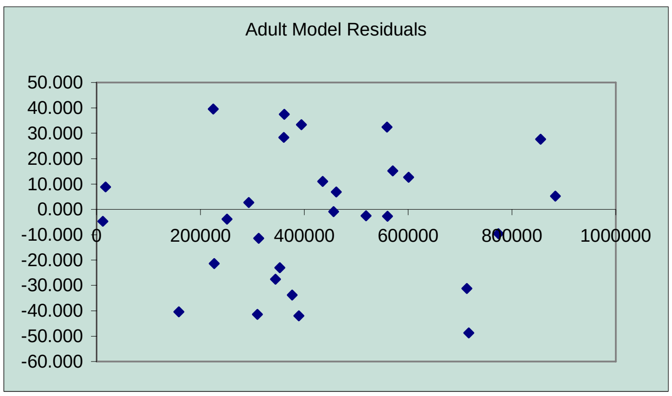


Figure 3. Residuals for adult CPUE show no pattern and the model appears reasonable.

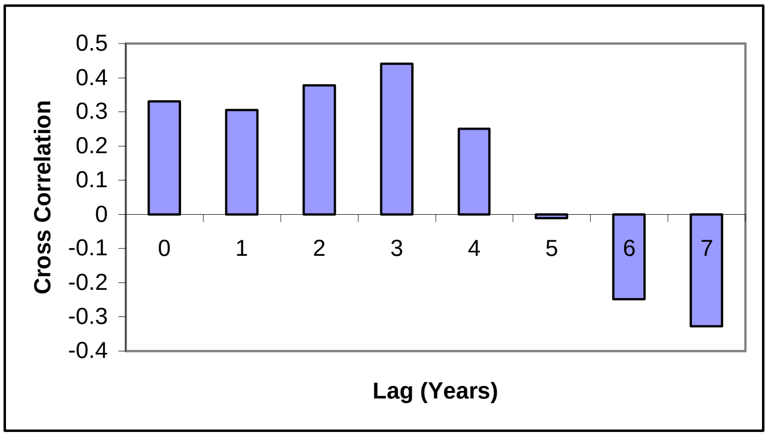


Figure 4. Cross correlation between spawning (adult) stock and recruits after lags of between 0 and 7 years. The correlation shows a peak at around 3 years, which is consistent with what is known about the life history.

The main problem with this approach to assessment is it only estimates the recruitment once it has occurred. It is therefore only able to predict the current year's catch. Without estimating the relationship between spawning stock size, it is difficult to set an appropriate limit reference point. The relationship between the adult stock size and recruitment was found to have a maximum correlation around 3 years lag (Figure 4). There was a functional relationship between the two, but it was not possible to discriminate between the Beverton and Holt and Ricker models (Figure 5). Nevertheless, the relationship was sufficient to propose a reference point for the spawning stock. That is, the spawning stock size which produces the maximum sustainable yield in the long term, based on the Beverton and Holt model.

To assess the uncertainty in the assessment, an empirical bootstrap simulation was applied. This consisted in randomising all residuals in the stock assessment model to simulate a data set and refit both the assessment model and stock recruitment relationship. The bootstrap simulation was repeated 1000 times and showed there was significant uncertainty in the estimate of the state of the stock (Figure 6). However, the assessment also suggested there is little evidence that the spawning stock is below MSY.

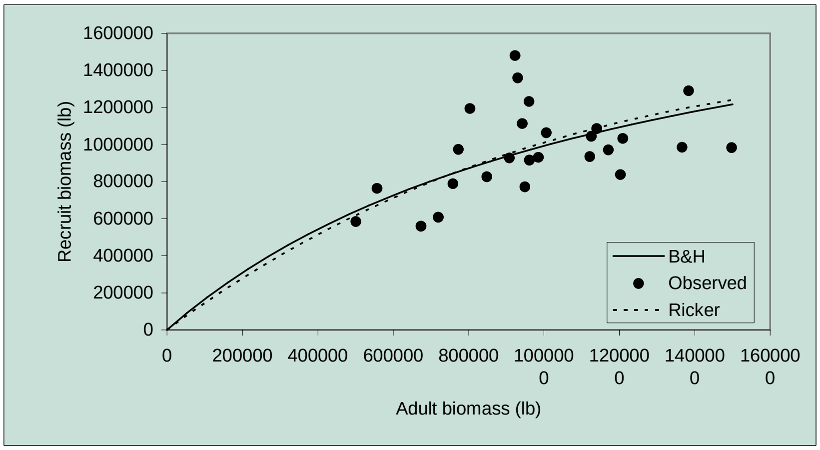


Figure 5. Stock recruitment relationships relating estimated adult biomass and recruitment three years later. There is no real difference identified between the Beverton and Holt and Ricker curves.

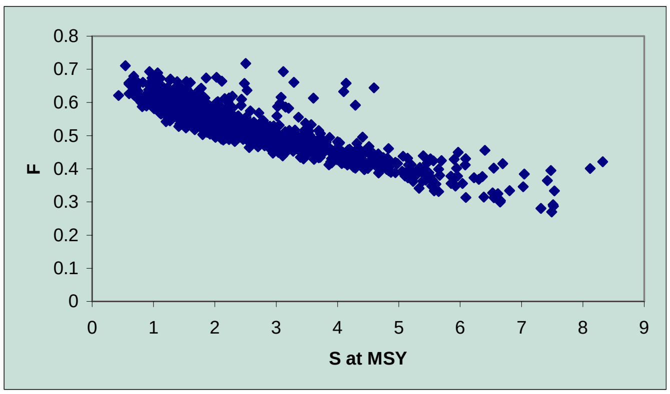


Figure 6. Estimated state of the fishery based on the fishing mortality and the spawning stock as a proportion of the spawning biomass at maximum sustainable yield. The individual points are derived from bootstrap simulations. The spread of points represent the uncertainty in the assessment. The relatively few points below S at 1.0 indicate the stock is not likely to be overfished. No appropriate reference point for F was determined.

Discussion

Using the August CPUE as the recruitment index, while making the model simpler to apply than the one suggested by Medley and Ninnes (1997), is probably less accurate. The results from Medley and Ninnes (1997) indicated that catchability varied year by year, probably as a result of the different distribution and density of new recruits, which would bias use of August CPUE alone.

Nevertheless, application of the model suggests that it will be possible to develop reference points for the monitoring data and thereby propose appropriate controls to maintain the long-term health of the fishery. While there is already adequate data to propose a limit reference point for the spawning stock size based on biological information, other reference points, notably a target, cannot be proposed without socio-economic and detailed policy issues being addressed. This should form the subject of further research and development.

The stock recruitment relationship (Figure 5) should be treated with caution. The model represents the fit between two variables estimated by another model, not direct observations. Taking into account model errors can make the observed slope in the assessment disappear, as it depends on only a few points. This can lead to arbitrarily high estimates of spawning stock size (Figure 6). While the upper level values should not be taken too seriously, the proportion of bootstrap values below 1.0 in Figure 6 should give some indication of the probability the stock is overfished. This could be interpreted as the chance that long-term yields would increase if fishing effort was lowered. As can be seen, while the chance is negligible, it is low.

It is recommended that the model is refitted with the original recruitment index with the specific purpose of developing a reference point and assessment procedure. This could be further enhanced by including other export data where available. However, to be meaningful, a strategy of control over this fishery must be developed. The conch fishery already has catch quotas and a similar quota system could be set up for lobster. However, this would not be universally popular and more co-operative management system should probably be sought. This would require greater participation of fishers in setting up a control.

3.9 REFERENCES

Medley PAH, Ninnes CH, 1997. A recruitment index and population model for spiny lobster *(Panulirus argus*) using catch and effort data. *Canadian Journal of Fisheries and Aquatic Sciences 54: 1414-1421.*

C. REPORT OF THE SHRIMP AND GROUNDFISH RESOURCE WORKING GROUP (SGWG)

Rapporteurs: Lara Ferreira & Paul Medley

1. The southern pink shrimp (*Farfantepenaeus notialis*) and Atlantic seabob (*Xiphopenaeus kroyeri*) fisheries of Trinidad and Tobago

1.1 MANAGEMENT OBJECTIVES

The management objective for the shrimp trawl fishery of the Government of the Republic of Trinidad and Tobago is "*full utilisation of the resource consistent with adequate conservation, and minimal conflict between the artisanal and non-artisanal components of the fishery*" (Fisheries Division and FAO, 1992).

1.2 STATUS OF STOCKS

Overall, all evidence suggests full to over exploitation of the two shrimp stocks (*Farfantepenaeus notialis* and *Xiphopenaeus kroyeri*) assessed. In addition, some trawlers tend to capture very young, small shrimp, especially the artisanal fleet operating in the southern Gulf of Paria, and the semi-industrial fleet.

Based on a yield per recruit model for the two species combined, the current (year 2002) fishing effort of the trawl fleets directed at these species is estimated to be about 71% of the effort required to obtain the maximum yield from the fishery. This indicates close to full exploitation.

Biomass per recruit models developed for the females of each of the two species separately suggests that the *F. notialis* stock is fully exploited and the *X. kroyeri* stock is overexploited. At the current level of effort, the biomass of *F. notialis* remaining in the sea is estimated to be 39% of the unexploited biomass of this species, which is just about at the limit reference point of 40%. At the current effort, the biomass of *X. kroyeri* is 22% of the unexploited biomass of the species, i.e. below the limit reference point. The effort exerted on this species would have to be reduced to less than 60% of the current level in order to bring the biomass up to an acceptable level (i.e. 40% of the unexploited biomass).

These results on the current state of the fishery in terms of level of exploitation and the spawning stock biomass are considered preliminary due to the limitations of the data and the models presented in Section 1.4.1.

1.3 MANAGEMENT ADVICE

The results obtained from the current assessments regarding the status of the stocks, although considered preliminary due to uncertainties in the assessment, indicate poor exploitation patterns by some gears and are generally consistent with results obtained from previous assessments of the trawl fishery (Die *et al.* 2004; Seijo *et al*. 2000; Alió *et al*. 1999; Lum Young *et al.* 1992a). A precautionary approach should therefore be applied to the management of the trawl fishery based on the best scientific evidence available as outlined in the FAO Code of Conduct for Responsible Fisheries (1995).

The recommendation is therefore to control the fishing effort and gear types to improve selectivity and exploitation rates for these stocks. At the very least, effort should be controlled by limiting the numbers of trawlers with a view to reduction in fleet size. This will require the implementation of a licensing system for trawlers and updating of the fisheries legislation to facilitate a limited entry fishery. In the absence of the appropriate legislation, a Cabinet decision was taken in 1988 to prohibit the entry of new artisanal as well as non-artisanal trawlers into the fishery. This has been enforced only to some extent for the industrial fleet. Modelling/research should be continued to estimate the optimum fishing mortality, so that fishing effort and fleet size can be adjusted accordingly.

In addition, the managers must look at ways of controlling gear selectivity with a view to focusing mortality on larger shrimp and, where this is not possible, decrease mortality on small shrimp in the longer term. This can be done through the implementation of closed areas / seasons to protect young and spawning shrimp, as well as increased mesh sizes to target larger shrimp.

A management regime is currently in place for the trawl fishery involving areas of operation and minimum mesh size as specified in the Fisheries [Control of Demersal (Bottom) Trawling Activities] Regulations 2001. Trawling is subject to a zoning regime in the Gulf of Paria according to trawler type, and areas where trawling is permitted and prohibited on the other coasts are also specified. These were implemented largely to reduce conflict among the various trawler fleets, as well as between trawlers and vessels employing other gears. However, if strictly enforced, the regulations should also help the sustainability of the stocks.

It should be noted that the management objectives for this fishery outlined in the policy document and management plan are very broad. It is strongly recommended that managers set appropriate and specific reference points for the fishery, that is, constraints within which the fishery must operate. Key issues are how the fishery will be monitored and how and what controls can be applied to affect the performance. This should be addressed through discussions among all stakeholders. The reference points need not necessarily be complex measures, but could be estimated for simple controls which can be routinely collected easily. This may mean further length frequency sampling of shrimp is not necessary, but may still be desirable for accurate assessment and monitoring. The performance or state of the fishery (in terms of level of exploitation or spawning stock biomass for example) is estimated by analyzing data collected using appropriate assessment models. The management would then implement fishery controls to maintain the fishery state at the desired level in relation to the reference point. A clear link would therefore exist between the assessment and management actions.

1.4 STATISTICS AND RESEARCH RECOMMENDAIONS

1.4.1 Data Quality

The suggestion is to be cautious with management advice based on the results of the current assessment. The results should be considered preliminary due to limitations of the data and the models. The length frequency dataset contains gaps due largely to logistical problems resulting in

periods of time without sampling. The largest gap exists for the industrial fleet for which length sampling was conducted only from October 1998 onwards.
Gaps in the dataset were filled using generalized linear models (GLMs). The models use averages across years, months, and gears within a length class to correct for these terms. The GLMs are not responsive to catch composition changes caused by the population dynamics hence ignore the time series effect with cohorts in populations. They do not project from month to month and length class to length class. This is important since the individuals belonging to a particular length class in one month would belong to a larger length class in a subsequent month.

Due to the very large dataset and the limitations of MS Excel in which the assessment models were developed, trawl type/fishing area influences could not be examined fully.

Another source of uncertainty in the assessment was the growth parameters used which were taken from the available literature in the absence of parameters from the Trinidad and Tobago fishery and even the other shrimp fisheries on the Guiana-Brazil continental shelf.

1.4.2 Research

The assessment models used here can be refined to provide better estimates of selectivity and fishing mortality by trawl type and fishing area and hence make the results more reliable. In this regard the following recommendations for future work are provided.

(1) Develop a population model, using alternative software, to fit the available observed length frequency data. This "synthesis" model would attempt to follow cohorts through time and would adjust the best fit directly to the observations rather than via complex estimates of catches by length class as obtained from the GLMs used in the current assessment.

The new model would be able to handle the very large dataset more effectively than MS Excel and would accommodate the use of monthly catch by trawl type/fishing area instead of catch summed across all trawl types/fishing areas as in the current model.

(2) Determine growth parameters.
In the short term, an attempt should be made to estimate growth parameters from the length frequency data using such software as ELEFAN, FISAT or Length Frequency Distribution Analysis (LFDA). If this does not prove to be very successful, the growth parameters can be determined in the longer term through the conduct of independent studies such as tagging. A research vessel can be used to tag shrimp and a reward offered to fishermen to bring in the tagged shrimp.

In addition, uncertainty in the growth parameters can also be dealt with by conducting sensitivity analyses within a range of realistic values for the growth parameters in order to determine how different values affect the results given by the model.

(3) Conduct exploratory analyses to determine any correlations between recruitment and environmental variables such as rainfall and river outflows from South America. Results of these analyses may assist in determining closed seasons for the fishery.

1.5 STOCK ASSESSMENT SUMMARY

The assessments performed for *F. notialis* and *X. kroyeri* using data for the period 1992 to 2002 can be summarized as follows.

(1) Missing catches by length for months when shrimp lengths were not sampled were estimated using generalized linear models (GLMs).

(2) Catch-at-length data were converted to catch-at-age using an age-length key constructed as a probability matrix from the Von Bertalanffy growth model.

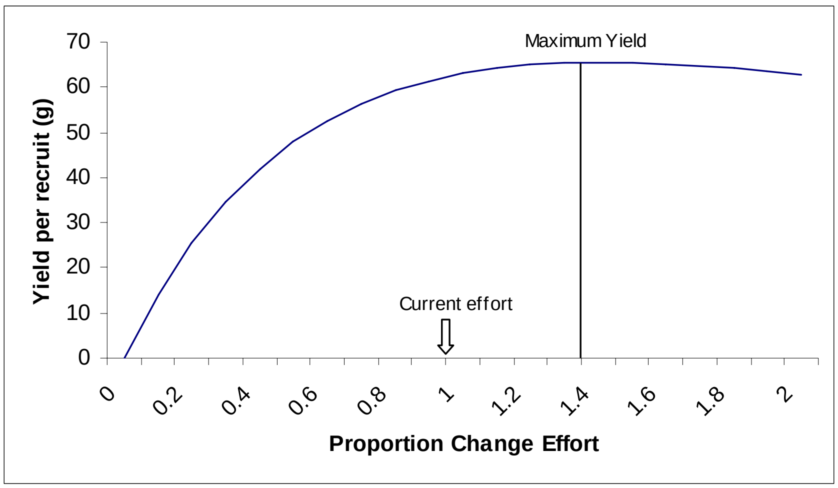
(3) Catch-at-age data were used in a separable Virtual Population Analysis (VPA) model to obtain estimates of gear selectivity, fishing mortality, and recruitment.

(4) Outputs from the VPA model were used in Beverton and Holt's yield per recruit and biomass per recruit models to determine the current state of the fishery.

(5) Initial exploratory analyses were conducted to determine any correlations between shrimp recruitment and rainfall.

The main results of the assessments can be summarized as follows.

(1) The shrimp stocks are fully- to over-exploited. The yield per recruit for the two species combined suggests that the stocks are very close to full exploitation with the fishing effort at the maximum yield being 1.4 times higher than the current effort. The biomass per recruit for the *F. notialis* females suggests that the stock is fully exploited while the biomass per recruit for the *X. kroyeri* females suggests that this stock is overexploited.



(2) Some trawlers tend to capture very young, small shrimp, especially the artisanal fleet operating in the southern Gulf of Paria, and the semi-industrial fleet.

1.6 SPECIAL COMMENTS

The shrimp stocks of Trinidad and Tobago are assumed to be shared with neighbouring Venezuela and hence any assessment of these stocks should ideally be done jointly with Venezuela. Such joint assessments could be attempted for *F. subtilis* and *L. schmitti,* which are dominant in the landings of both Trinidad and Tobago as well as Venezuela. However *F. notialis* and *X. kroyeri*, which are important for Trinidad and Tobago, are not dominant species in the landings of Venezuela, and data are not available for input to such an assessment, hence the reason for the focus on these two species in the absence of data from Venezuela.
Joint assessments using shrimp data from both countries have been conducted in the past (Die *et al.* 2004, Seijo *et al.* 2000, Alió *et al.* 1999) with management recommendations being applicable to all fleets.

1.7 POLICY SUMMARY

The Government's management objectives and main policy directions as outlined in the marine fisheries policy document (Fisheries Division and FAO 1994) and the goals outlined in the strategic plan (Fisheries Division 2002) are given below. The objectives for management are to:

(1) Implement efficient and cost-effective management;
(2) Ensure through proper conservation and management that fisheries resources are not endangered by overfishing;
(3) Ensure that the exploitation of the fisheries resources and the conduct of related activities are consistent with ecological sustainability;
(4) Maximise economic efficiency of commercial fisheries;
(5) Ensure accountability to the fishing industry and the community at large for fisheries management;
(6) Achieve appropriate cost-sharing arrangements between all the beneficiaries of sound fisheries management.

In the interest of the sustainable management of the fisheries resources, the Government is committed to the establishment of monitoring systems, development of management plans and establishment of the regulatory framework. The Government recognizes the importance of empowering stakeholders through the provision of information, education and training, and the involvement of these stakeholders in decision-making as regards policies and management plans.

The current assessments address primarily objective (2). The Government recognises that a major factor contributing to over-fishing and over-capitalisation is the present “Open Access” regime which allows unregulated fishing effort. The Government, in association with the fishing industry, will attempt to manage fishing effort on the resources by controlling the number and type of local vessels within a given limit, and by implementing time and area closures, and fishing gear changes. The Government will embark on a licensing programme for all commercial fishing vessels as a means of monitoring the effort applied to the fisheries. Bearing in mind the stability fishing has traditionally provided to rural communities, the Government will give priority to the maximisation of employment opportunities through the development of projects for those displaced from the fishery due to effort limitations. The Government will also, through negotiation with neighbouring countries, aim to reduce levels of fishing effort on shared fishing grounds. It will also increase its capacity for fisheries surveillance to prevent unauthorised fishing operations in the waters of Trinidad and Tobago. With regard to financial assistance to the fishing industry, the Government intends to phase out many elements of the concessions, rebates and incentives since increased fishing activity is not to be encouraged.

1.8 SCIENTIFIC ASSESSMENTS

1.8.1 Description of the Fishery

Shrimp resources are exploited mainly by the trawl fleet which currently comprises 102 artisanal, ten (10) semi-industrial and 20 to 25 industrial trawlers (2003 Fishing Vessel Census). The artisanal vessels are pirogues 6.7-10.4 m in length with either an inboard diesel engine or outboard engines. These vessels manually deploy one stern trawl. The semi-industrial trawlers are 9.3-13.1m in length with 165-174hp inboard diesel engines. These use a single net operated by a hydraulic winch. The industrial vessels use two nets attached to twin outriggers. The nets are set and retrieved using a hydraulic (double-drum) winch. The vessels are 18.7-24.3 m in length and usually have 365 hp inboard diesel engines.

All trawlers operate in the Gulf of Paria on the west coast of Trinidad. The industrial trawlers, and to a much lesser extent the semi-industrial trawlers, also operate west of Saut D'eau on the north coast and in the Columbus Channel on the south coast.

The trawl fleet targets: five shrimp species namely *Farfantepenaeus subtilis*, *F. notialis*, *F. brasiliensis*, *Litopenaeus schmitti*, and *Xiphopenaeus kroyeri*; as well as associated groundfish namely *Micropogonias furneri* and *Cynoscion jamaicensis*. Estimated landings for the entire trawl fleet in 2002 were 940t of shrimp valued at TT$23.9 million and 1,005t bycatch (groundfish) valued at TT$4.8 million. More than half of the shrimp (55%) was landed by the industrial fleet, 33% was landed by the artisanal fleet, and 12% by the semi-industrial fleet. Over the period 1992 to 2002, the shrimp landings comprised 38% *F. subtilis*, 31% *F. notialis*, 20% *L. schmitti*, 10% *X. kroyeri*, and 1% *F. brasiliensis*. The artisanal fleets operating in the Gulf of Paria catch *F. notialis*, *F. subtilis*, *L. schmitti*, and *X. kroyeri* with *L. schmitti* being particularly dominant in the catches from the northern Gulf. Catches from Venezuela by the artisanal fleet from Trinidad comprise largely *F. subtilis* and *L. schmitti*. *F. notialis* is the dominant species landed by the semi-industrial fleet with smaller amounts of *F. subtilis* and *L. schmitti* also being landed. The industrial fleet lands predominantly *F. subtilis* and *F. notialis*.

1.8.2 Overall Assessment Objectives

The main objective was to analyse the available data on the shrimp trawl fleet and to build a stock assessment approach able to give management advice for this fishery. Data exist to estimate the total shrimp catch and fishing effort by each trawl type / fishing area category. In addition a biological sampling programme was conducted between 1992 and 2002 to collect length frequency data on each of the five species. These data were fitted to a catch-at-age model, which provided estimates of recruitment and fishing mortality, that were then used to estimate reference points in yield per recruit and biomass per recruit models. Rainfall data for the same period were also available which could be used to determine whether there was any correlation with shrimp recruitment. Separate models were fitted for each sex for each of the two species *F. notialis* and *X. kroyeri*.

1.8.3 Data Used

Name	Description
Total shrimp catch and	Catch and effort data were collected by trip on 20 days for the

effort data by year, month and trawl type / fishing area for 1992-2002	month at particular landing sites around Trinidad. These data are first raised to account for non-enumerated days at the site. These first-raised data are then raised to account for vessels at non-enumerated sites. This second level of raising is based on a frame survey of vessels carried out periodically.
Length frequency data by species, sex, year, month, trawl type / fishing area for 1992-2002	Samples were taken from landed catches and separated by species, sex and carapace length. Each sample is first raised to the total landing of the vessel sampled. First-raised samples are summed by month and trawl type / fishing area and then raised to the total landing of that trawl type / fishing area in that month.
Rainfall data for 1992-2002	Total monthly rainfall for Piarco Airport, Trinidad prepared by the Trinidad and Tobago Meteorological Service

1.8.4 Assessment 1

Objective

The objective was to estimate missing catch-at-length data in preparation for a catch-at-age model assessment.

Method/Models/Data

Missing catch-at-length data by year, month, species, sex and trawl type / fishing area were estimated based on a generalized linear model (GLM). For each species and sex a log-linear model was used to estimate expected catches based on the total shrimp catch (all species), year, month and gear terms for each length class. Separate models for each length class were necessary as the equivalent full interaction terms between length class and all other parameters would require too many parameters to be fitted at once. The separate models fitted were the same as single models with full interaction terms except that the error was not shared between length classes, but estimated separately for each model. Otherwise, only main terms were used in the linear predictor and no interactions between total catch, year, month or gear were accounted for. There was no indication that any such terms were significant, but this could not be rigorously tested (for a full explanation of Generalized linear Models see McCullagh and Nelder 1989). This means that, for example, the model will account for changes between years and changes between months, so if January usually has a higher number of shrimp in a size class than February, the model will use this. The interaction terms between month and year would mean that the model would estimate the number of shrimp in each month separately. Because we want to use the model to estimate unrecorded catches, we want to try to use the seasonal and other patterns apparent in main terms to help estimate the missing samples.

The expected catch in numbers for a particular species and sex of a particular length class taken in a particular year and month by a particular trawl type / fishing ground is equivalent to:
(Total Catch Weight of all Shrimp Species for the particular year/month/gear) x Exp(Year + Month + Gear).
where Exp refers to the exponent (from the log-linear link function), and the Year, Month and Gear refer to the main terms in the linear model. The gear/fishing ground refers to the type of fishing and general area where the fishing is conducted. The fishing ground and gear type are confounded and cannot be separated.

The model allowed the expected catch in any given cell to be estimated given the known variables. Where possible the original data were used, but the expected values were used to fill in all missing data.

Results

The models provided a reasonable fit. However, the most important issue is not whether the model fits the data so much as the effects that model errors have on the subsequent stock assessment. These were not explored so that it is difficult to assess how potential errors might affect assessment results. In particular, expected catch-at-length were estimated from the GLM for all missing observations. The species X. kroyeri is taken predominantly by the artisanal fleets in the South Gulf, whereas F. notialis appears to be taken by the semi-industrial fleet (Figure 1). In the case of *X. kroyeri*, the majority of the catch is taken by the artisanal fleet operating in the south Gulf of Paria (79% of the females and 67% of the males). In the case of the *F. notialis* males the majority of the individuals (60%) is captured by the semi-industrial fleet while in the case of the females 41%, 35%, and 20% are captured by the industrial, artisanal fleet operating in the south Gulf, and the semi-industrial fleets, respectively.

Discussion

Although the GLM is adequate for the preliminary analysis, it is neither the only way to estimate missing data, nor the best way. Other ways include ad hoc methods of "borrowing" length composition data from adjacent cells as was done for the assessment of *F. subtilis* using these data (Die *et al* 2004). However, such procedures tend to be more complex and the statistical implications difficult to understand. The GLM approach is simpler, but should still take account of some local effects and therefore is probably an improvement on ad hoc procedures. Unlike ad hoc methods, it can also be used in procedures to estimate the errors associated with the method for estimating catches, such as “bootstrapping” or other Monte Carlo simulation procedures.

Although the GLM approach is easier to understand than other ad hoc procedures, it is not responsive to catch composition changes caused by the population dynamics. This is an important loss of information to the subsequent modeling and could well introduce bias. Alternative smoothing techniques to interpolate data, such as generalized additive models (Hastie and Tibshirani, 1990), could be better.

The best way would be to fit a model to the actual available observed data, such as would be used in a “synthesis” model. In this case, a catch-at-length model would be fitted to the total catch and length frequency sample data. The data would not be manipulated and there would be no need for the two phase process required here to estimate catches. This would allow the model to adjust the best fit directly to the observations rather than via some complex estimates. Results from models fitted to the raw data could be different than those based on processed information. As a result of these issues, analyses using these data should be considered preliminary although they should still provide general results indicating how management should plan for the future. The synthesis modeling approach should be developed in the future.

1.8.5 Assessment 2

Objective

The objective was to fit a catch-at-age model (VPA) to the available data to obtain estimates of selectivity, fishing mortality, and recruitment.

Method/Models/Data

The catch numbers by length class for a particular species and sex for each year and month obtained from the length frequency sampling, with gaps filled using GLM, were summed across all trawl types. These catch-at-length data were converted to catch-at-age using an age-length key constructed as a probability matrix from the Von Bertalanffy growth model. The catch-at-age data were then used in a separable VPA model where catches are assumed to be known exactly. The method thus requires known catch-at-length. In reality, all total catches were estimated, as described in Section 1.8.3. The model was implemented in an Excel spreadsheet.

Construction of the Age-Length Key

The age length key is a matrix of probabilities. Each cell in the matrix is the probability that a fish is within the age and size class defined. It is calculated from the joint log-normal distribution where the mean is given by the age at length from the deterministic von Bertalanffy growth model. The probability is then apportioned to discrete age and size classes by integration.

$$P(c) = \int_{a_c}^{a_{c+1}} \int_{s_c}^{s_{c+1}} N(a, s | \mu, \sigma)\, ds\, da \tag{5}$$

where $P(c)$ = probability that a shrimp is in class c with size and age lower and upper limits as s_c, s_{c+1}, a_c, a_{c+1} respectively. The mean log-length at age is given by the log of the von Bertalanffy growth curve:

$$\mu_a = \ln(L_\infty) + \ln\left(1 - e^{-K(a-t_0)}\right) \tag{6}$$

where a is the age, and L_∞, K and t_0 are the standard von Bertalanffy growth parameters. Other probability distributions besides the log-normal could be used, but the log-normal is convenient and assumes the variance in length increases with age, which is likely.

The proportion of fish of a particular age in any length class were calculated as the difference between the cumulative normal distribution of the two log-length class boundaries. This function is available in MS Excel (*NormSDist((x-μa)/σ)*). This represents the inner integration in equation (1). A numerical approximation to the integral (Simpson's rule) over one year's aging was applied to approximate the outer integral in equation (1). So the proportion of cohort age a in length class i (p_{ai}) was calculated as:

$$\begin{aligned} p_{ai} = \tfrac{1}{2}\Big[&\big(\mathrm{N}(\ln(l_{i+1});\, \mu_a, \sigma) - \mathrm{N}(\ln(l_i);\, \mu_a, \sigma)\big)/3 \\ &+ \big(\mathrm{N}(\ln(l_{i+1});\, \mu_{a+0.5}, \sigma) - \mathrm{N}(\ln(l_i);\, \mu_{a+0.5}, \sigma)\big)\, 4/3 \\ &+ \big(\mathrm{N}(\ln(l_{i+1});\, \mu_{a+1}, \sigma) - \mathrm{N}(\ln(l_i);\, \mu_{a+1}, \sigma)\big)\, /3\Big] \end{aligned} \tag{7}$$

where N( ) is the cumulative normal distribution, l_i is the lower limit for length class i. The probability that a shrimp is in any particular age group, given its length class, is calculated as the probability (equation 3) normalized by the sum of probabilities over the age groups for this size. That is, we know the shrimp is in this size group, but the age group remains unknown. The rows of probabilities for each length class can be combined into a matrix. A row of catches at length can then be converted to catches at age by matrix multiplication:

$$C_{lt}\, P = C_{at} \tag{8}$$

where C_{lt} = Catch-at-length row vector for a particular month, P= the age-length key matrix which has rows summing to 1.0, and C_{at} = the catch-at-age row vector resulting from the conversion.

The growth model parameters, weight-length conversion parameters and natural mortality were obtained from previous workshop reports.

Table 1. Parameters used for the catch-at-length model. The growth model was used to convert length to age. L_∞ (mm) was estimated as part of the model. All other parameters were fixed at the values shown. These are the approximate appropriate values expected for this species based on its life history. The Sigma (Coefficient of variation) measures the variability of length from the mean given by the von Bertalanffy growth equation.

Growth Model Parameters				Natural Mortality
K ($Month^{-1}$)	**L_∞ (mm)**	**T_0 (Months)**	**Sigma (CoV)**	**M ($Month^{-1}$)**
0.2	152.71	0	0.1	0.2
Weight-Length Conversion				
a		**b**		
0.00000876		3.064		

<u>Fitting the Population Model</u>

A separable VPA approach is used to fit the catch-at-age model. Fitting takes place at two levels. Firstly, the population model is fitted using the available catches assuming they and the natural mortality rate are known exactly. This leaves a single parameter to fit, which in this case is the initial recruitment rather than the "terminal F", although the result is the same. At the higher level the selectivity parameters are fitted to the "observed" fishing mortality from the population model using the observed fishing effort.

$$
\begin{aligned}
P_1 &= P_0 e^{-M} - C_0 e^{-0.5M} \\
P_2 &= P_1 e^{-M} - C_1 e^{-0.5M} = \left(P_0 e^{-M} - C_0 e^{-0.5M}\right)e^{-M} - C_1 e^{-0.5M} \\
&= P_0 e^{-2M} - C_0 e^{-1.5M} - C_1 e^{-0.5M} \\
&\vdots \\
P_a &= P_0 e^{-aM} - \sum_{t=1}^{a} C_{t-1} e^{-(t-0.5)M}
\end{aligned}
\tag{9}
$$

and in natural logarithm terms

$$
\Pi_a = Ln(P_a) = Ln\left(e^{-aM+\Pi_0} - \sum_{t=1}^{a} C_{t-1} e^{-(t-0.5)M} \right) \tag{10}
$$

$$
LnF_a = Ln(\Pi_a - \Pi_{a+1} - M)
$$

The aim is to find an initial population that will minimise the squared difference between the log fishing mortalities from the population model and the log fishing mortalities estimated from a selectivity curve and effort data.

$$
L(\Pi_0) = \left(Ln(q_a f_t) - LnF_a\right)^2 \tag{11}
$$

$$
\frac{dL}{d\Pi_0} = -2\left(Ln(q_a f_t) - LnF_a\right)\frac{dLnF_a}{d\Pi_0} \tag{12}
$$

and the second derivative can be approximated by

$$\frac{d^2L}{d\Pi_0{}^2} \approx 2\left(\frac{dLnF_a}{d\Pi_0}\right)^2 \qquad (13)$$

$$\frac{d^2L}{d\Pi_0{}^2} = \{\Pi_0\}_{old} - \left[\sum_{a=0}^{A}\left(Ln(q_a f_t) - LnF_a\right)\frac{dLnF_a}{d\Pi_0}\right]\left[\sum_{a=0}^{A}\left(\frac{dLnF_a}{d\Pi_0}\right)^2\right]^{-1}$$

$$P_a\left(1-e^{-Z_a}\right) = \frac{C_a Z_a}{F_a} = C_a\frac{M}{F_a} + C_a \qquad (14)$$

and, again based upon Pope's approximation,

$$P_a\left(1-e^{-Z_a}\right) \approx P_a\left(1-e^{-M}\right) - C_a e^{-0.5M} \qquad (15)$$

and by substitution and rearranging, we get:

$$C_a\left(1+\frac{M}{F_a}+e^{-0.5M}\right) + \left(1-e^{-M}\right)\sum_{t=1}^{a} C_{t-1}e^{-(t-0.5)M} = P_0\left(e^{-aM} - e^{-(a+1)M}\right) \qquad (16)$$

Given the fishing mortality at each age (F_a), the left hand side is determined for each age in a cohort and can be used as the dependent variable in a regression. The recruitment for the cohort (P_0) can be estimated using least-squares as:

$$\hat{P}_0 = \frac{\sum_a\left(C_a\left(1+\frac{M}{F_a}+e^{-0.5M}\right) + \left(1-e^{-M}\right)\sum_{t=1}^{a} C_{t-1}e^{-(t-0.5)M}\right)\left(e^{-aM} - e^{-(a+1)M}\right)}{\sum_a\left(e^{-aM} - e^{-(a+1)M}\right)^2} \qquad (17)$$

This estimate is then further refined using a Newton-Raphson algorithm and the catch equation rather than Pope's approximation.

Link Model

The link model connects the population model to the observations, in this case fishing effort. A separable VPA model was used to divide up the sources of fishing mortality into the exploitation rate (effort) and selectivity at age. The expected effort can be calculated from the model as:

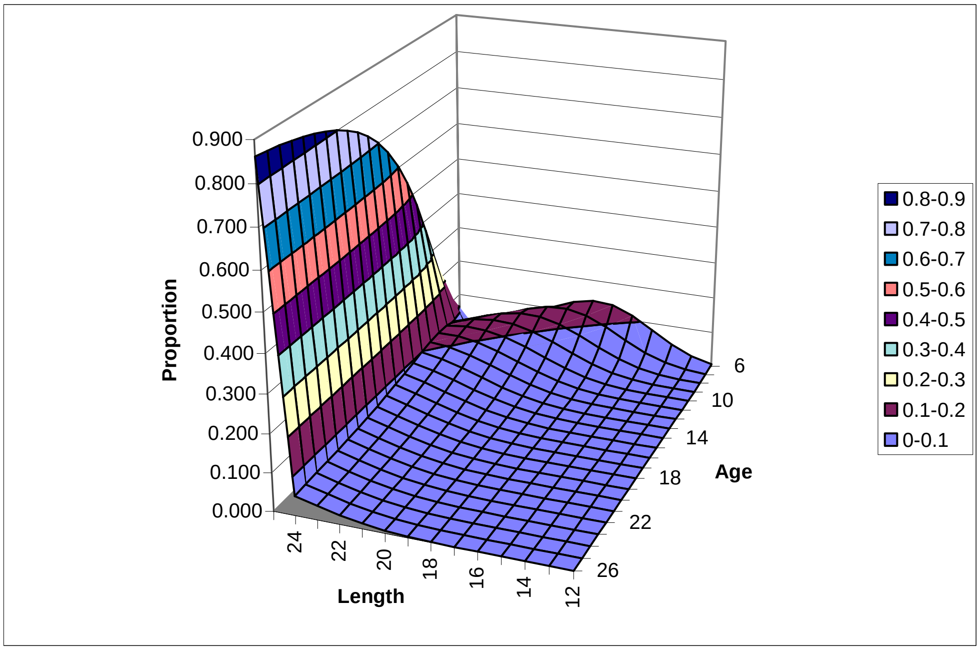
$$E(\ln(f_t)) = \ln(F_{at}) - \ln(S_a) \qquad (18)$$

where S_a is the selectivity at age. The model can then be fitted by minimising the squared difference between the observed and expected log-effort, thereby obtaining the log-normal maximum likelihood estimates. The results should be very similar to fitting *ln(CPUE)* to the log population size. The fishing mortality model should be better where the fishing mortality (i.e. effort) is very high within a month, but in this case the differences are trivial and the results should be very similar to previous models.

The model was fitted in a spreadsheet. The least squares (log normal maximum likelihood) estimates for selectivity can be found directly through calculation. The selectivity is simply the difference between the average log fishing mortality (at age) and the average log effort for each age. The remaining parameters were found using Solver add-in software in MS Excel.

The model was fitted excluding an outlying month, June 1999, which appears to have unusual CPUE data. These and other months in the time series need to be checked. In particular, catches are assumed accurate in the model and care should be taken that all removals from the population are recorded and used.

Growth Parameters



Example age length key for male *X Kroyeri* based on the growth parameter estimates. The graph indicates the proportion of shrimp at each age are distributed among the length groups. The key can conversely be used to convert from length back to age by redistributing the length sample among ages based upon these proportions. The spread of proportions indicate the uncertainty in converting from length to age and is provided as an additional parameter.

Initial growth parameters used in the model for *F. notialis* and *X. kroyeri* were obtained from Shepherd, D. and N.M. Ehrhardt (2000). These growth parameters as well as the recruitment age could be adjusted within the model to obtain the best possible fit to the model. The final parameters used are given in Table 1.

Table 1. **Input parameters to the catch-at-age model.**

Input Parameters	*F. notialis*		*X. kroyeri*	
	Male	Female	Male	Female
L_∞ (carapace length in mm)	34	44	25	30
K	0.20	0.20	0.15	0.15
t_0	0	0	0	0
M	0.05	0.05	0.05	0.05
Recruitment age (mths)	2	1	10	6

Results
The model provides a reasonable fit to the data for the species and sexes examined. Problems may have been introduced through the use of the growth model and the calculation of catch at age. The length of a shrimp does not indicate its age exactly. In particular, as shrimp grow more slowly the age implied by the length becomes increasingly uncertain.

Selectivity plots obtained for each species and sex by gear type are given in Figures 2-5. The general results from the assessment indicate that the fleets are catching predominantly small shrimp. Recruitment appears to have been relatively stable, supported by the lack in any change in the CPUE over this period.

The autocorrelation function for sequential summed square errors associated with each month and each cohort was determined for each species/sex examined. In general, there is no strong pattern associated with square errors between months. This suggests there is no remaining time series pattern in the data. In contrast, cohort summed square errors have a distinct residual pattern. The total error associated with each cohort is strongly correlated with the error in the next and subsequent cohorts. This pattern is the likely result of errors introduced by catch data and a failure of the population dynamics model to explain size composition changes**.**

Selectivity of female *F. notialis* by trawl type/fishing area - The fishery seems to catch predominantly small individuals with the artisanal (south Gulf) fleet catching the smallest individuals. The artisanal (north Gulf) fleet exhibits a lower selectivity for female *F. notialis* than any of the other fleets (Figure 2).

Comment [PM1]: Just move caption stuff to text. However, try not to just repeat a description of what the figure shows. This is not helpful. Use figures to make points.

Selectivity of male *F. notialis* by trawl type/fishing area. - The selectivity is much higher for the semi-industrial fleet than any of the other fleets reflecting its much higher catches of this species. The artisanal (south Gulf) fleet selects only very small individuals. The artisanal (north Gulf) and industrial fleets select the larger individuals, though the selectivity for these fleets is very negligible (Figure 3).

Selectivity of female *X. kroyeri* by trawl type/fishing area The selectivity for the artisanal (south Gulf) fleet is much higher than for any of the other fleets. This fleet catches predominantly small individuals with the semi-industrial fleet selecting larger individuals and the industrial fleet selecting even larger individuals. The industrial fleet has the most even selectivity. The artisanal (north Gulf) fleet has a very low selectivity for this species, and selects the larger individuals (Figure 4).

Selectivity of male *X. kroyeri* by trawl type/fishing area - As with the females of this species, the selectivity of the males by the artisanal (south Gulf) fleet is much higher than any of the other fleets. This fleet selects predominantly small individuals with the semi-industrial fleet selecting larger individuals and the industrial fleet selecting even larger individuals. The selectivity for the artisanal (north Gulf) fleet is negligible (Figure 5).

Monthly recruitment (in numbers) of female *F. notialis* for 1992-2002 estimated from the catch-at-age model - The initial very high recruitment at the start of the series and decline in recruitment at the end are probably artifacts of the problems in the data and model. Recruitment is relatively stable over the period and in the region of about one to two million individuals per month (Figure 6).

Monthly recruitment (in numbers) of male *F. notialis* for 1992-2002 estimated from the catch-at-age model - The initial very high recruitment at the start of the series and decline in recruitment at the end are probably artifacts of the problems in the data and model. Recruitment is relatively stable over the period and in the region of about one to 2.5 million individuals per month (Figure 7).

Monthly recruitment (in numbers) of female *X. kroyeri* for 1992-2002 estimated from the catch-at-age model - A decline in recruitment over the period is indicated with the maximum monthly recruitment at the beginning of the period being over 3 million and the maximum towards the end of the time period being half this amount (Figure 8).

Monthly recruitment (in numbers) of male *X. kroyeri* for 1992-2002 estimated from the catch-at-age model - Recruitment is relatively stable over the period and in the region of about 23 to 56 million individuals per month though it was higher in the last year of the period reaching to over 80 million individuals (Figure 9). This probably indicates the model as failed to fit the data. Fisheries models tend to estimate very large population sizes when they cannot link higher or lower catches to decreases and increases in the population size. Using maximum likelihood fitting procedures, population sizes can then become arbitrarily high and fishing mortality very low as the model can find no impact of the fishery on the stock.

Discussion

The model gave estimates of the fleet selectivities and recruitment. These estimates are not unreasonable. The critical result is that vessels are tending to capture very young shrimp that are also very small. This is so possibly for all fleets in the case of *F. notialis* and in particular the artisanal fleet operating in the south Gulf of Paria in the case of *X. kroyeri*. This is a clear indication that improved economic returns could be obtained from changing fleet selectivity towards larger shrimp and/or adjusting total fishing mortality. Improving the model is still likely to indicate a change in selectivity would benefit the fishery, even if better quantitative estimate would come available. Therefore clear management advice would be to look at ways at controlling selectivity and fishing mortality with a view to focusing mortality on larger shrimp and, where this is not possible, decreasing mortality on small shrimp in the longer term.

1.8.6 Assessment 3

Objective

The objective was to determine the status of exploitation of the stocks using yield per recruit and biomass per recruit models.

Method/Models/Data

Beverton and Holt's yield per recruit and biomass per recruit were determined for a range of effort levels relative to the current effort (set as 1.0) which was taken to be the average monthly effort for 2002. A multi-species, multi-gear yield per recruit model was developed (Figure 10) as well as yield per recruit models for the two species combined for each of the trawl type/fishing area categories (Figures 11-14). Biomass per recruit was done for the females of each of the two species (Figures 15 and 16). The multispecies multi-gear yield per recruit is the same as single species single gear, except we set up the different sources of fishing mortality and carrying out the yield-per-recruit simultaneously among species. The yield-per-recruit is applied as described in Sparre and Venema (1992). However in this case we adjust the fishing mortalities based on age, species and gear. Age groups are modeled sequentially, where as species are modeled separately.

$$F_{asg} = q_{as} f_g$$

where subscripts a = age, s = species and g = gear. The selectivity parameters q_{as} were estimated by the catch-at-age models. The exploitation rate by gear, f_g, was obtained from data as effort by gear. However, it could also presumably be controlled by management. Yields-per-recruit by species and gears can then be estimated.

The input parameters for these models include the growth parameters, natural mortality, and the recruitment age (Table 1), parameters in the length weight relationship for each species and sex taken from Lum Young *et al.* (1992), and selectivity at age by trawl type/fishing area estimated by the population model for each species and sex.

Results

Yield-per-recruit for *F. notialis* and *X. kroyeri* for all trawl types combined. The maximum YPR occurs at 1.4 times the current effort (Figure 10). This suggests that the stocks are close to full exploitation.

Yield-per-recruit for the artisanal trawl fleet operating in the north Gulf of Paria for *F. notialis* and *X. kroyeri* combined - The maximum YPR occurs at less than 60% of the current effort (Figure 11). That is, the yield from this gear will improve with a decrease in effort across all gears as it clear competes with other gears over-exploiting the same species. This will occur where other capture small individuals and therefore prevent gears with better selectivity from operating effectively.

Yield-per-recruit for the artisanal trawl fleet operating in the south Gulf of Paria for *F. notialis* and *X. kroyeri* combined - It does not appear that the stocks are anywhere close to being fully exploited by this gear (Figure 12). However, as already noted, the results are probably unreliable as the model does not appear to detect the fishing impact on the stocks mainly exploited by this gear and it is probable that parameters are correlated (aliased). Being unable to measure the impact of the gear either means it is small, which is unlikely, or that the model has failed in some way. In either case, this result is unreliable and requires further investigation.

Yield-per-recruit for the semi-industrial trawl fleet for *F. notialis* and *X. kroyeri* combined - The maximum YPR occurs at 1.7 times the current effort (Figure 13). This suggests that the stocks are close to being fully exploited by this gear.

Yield-per-recruit for the industrial trawl fleet for *F. notialis* and *X. kroyeri* combined - The maximum YPR occurs between 50-60% of the current effort (Figure 14). This suggests that there is over-exploitation of the stocks by this gear type.

Biomass-per-recruit for female *F. notialis* - At the current effort the biomass per recruit is 39% of the corresponding estimate for the unexploited stock (Figure 15). This suggests that the stock is fully exploited.

Biomass-per-recruit for female *X. kroyeri* - At the current effort the biomass per recruit is 22% of the corresponding estimate for the unexploited stock (Figure 16). This suggests that the stock is over-exploited. Fishing effort would have to be reduced to about 60% of the current level in order for the biomass per recruit to be at an acceptable level of 40%.

Discussion

The yield per recruit for the two species and all fleets combined show the stocks to be close to the maximum yield and hence close to full exploitation. The yield per recruit models for the individual trawl types must be considered preliminary with respect to quantitative estimates. Not only are other species not considered, but problems in estimating parameters make any advice on this premature. Better fitting models may well estimate smaller population sizes and lead to lower optimum effort levels than those indicated. We need to be able to detect the decline in stock size due to be sure our estimates are reasonable. This has not been shown in all cases. Nevertheless, results indicate preparations must be made to control fishing effort and gear types to improve selectivity and exploitation rates for these stocks. Despite the models' problems, they indicate poor exploitation patterns by some gears.

Biomass per recruit for a range of exploitation levels refers to the biomass of the female of the species as a proportion of the biomass of the unexploited stock. The rule of thumb is that the biomass per recruit should not fall below the limit reference point of 40% of the biomass of the unexploited stock. (Mace and Sissenwine, 1993). Based on this, the biomass per recruit analyses show the *F. notialis* stock to be fully exploited and the *X. kroyeri* stock to be overexploited.

1.8.7 Assessment 4

Objective

The objective was to determine whether there was any correlation between rainfall and shrimp recruitment.

Method/Models/Data

Cross correlations were done between total monthly rainfall data obtained from the Piarco Airport in Trinidad and recruitment estimated from the population model for each species and sex.

Results

The patterns observed for the two species were different, with similar patterns obtained for the males and females of the same species.

Cross correlation function between *F. notialis* recruitment and rainfall - A negative correlation was observed one month after the rainfall (Figure 17).

Cross correlation function between *X. kroyeri* recruitment and rainfall - A positive correlation was observed three months after the rainfall (Figure 18).

Discussion

Regarding the impact of environmental parameters on recruitment, different correlation patterns were observed for the two species in recruitment and rainfall variables. However, correlations observed were not very strong and do not imply cause and effect. Recruitment is probably seasonal and related more to the effects of the rainfall rather than caused by local rainfall

1.9 REFERENCES

Alió, J.J., D. Die, L. Ferreira, K. Gooriesingh, S. Kuruvilla, L. Maharaj, L.A. Marcano, I. Ramnarine, and A. Richardson-Drakes. 1999. Penaeus subtilis stock within the Orinoco and Gulf of Paria region. In: FAO/Western Central Atlantic Fishery Commission. National reports presented and stock assessment reports prepared at the CFRAMP/FAO/DANIDA Stock Assessment Workshop on the shrimp and Groundfish Fisheries on the Guiana-Brazil shelf. Port of Spain, Trinidad and Tobago, 7-18 April 1997. FAO Fisheries Report. No. 600. Rome:FAO.

Die, D.L., J. Alió, L. Ferreira, L. Marcano, and S. Soomai. 2004. Assessment of demersal stocks shared by Trinidad and Tobago and Venezuela. *FAO/FishCode Review*. No. 3. Rome, FAO. 21p.

FAO. 1995. Code of Conduct for Responsible Fisheries. FAO; Rome (Italy). 41p.

Fisheries Division; Food and Agriculture Organisation of the United Nations (FAO). 1992. Draft management plan for the shrimp trawl fishery of Trinidad and Tobago. Management report of the project for the Establishment of Data Collection Systems and Assessment of the Fisheries Resources. FAO/UNDP: TRI/91/001/TR26. Ministry of Agriculture, Land and Marine Resources; Port of Spain (Trinidad and Tobago). 20 p.

Fisheries Division; Food and Agriculture Organisation of the United Nations (FAO). 1994. Policy directions for marine fisheries of Trinidad and Tobago in the 1990s. Draft. Project TCP/TRI/2352[A]. Ministry of Agriculture, Land and Marine Resources; Port of Spain (Trinidad and Tobago). 123 p.

Fisheries Division, Ministry of Agriculture, Land and Marine Resources. 2002. Draft Strategic Plan 2002/ 2005. ?? p.

Flores Hernández et al., 200?. Ecologica y dinamica poblacional del camaron siete barbas Xiphopenaeus kroyeri y(Heller, 1862) de la Laguna de Terminos, Sur del Golfo de Mexico.

Hastie, T.J. Tibshirani, R.J. 1990. Generalized Additive Models. Chapman and Hall, New York.

Lum Young, P., L. Ferreira and L. Maharaj. 1992a. Preliminary stock assessment for the shallow water shrimp trawl fishery in the "Special Fishing Area" adjacent to the mouth of the Orinoco River (Venezuela). Technical report of the project for the Establishment of Data Collection Systems and Assessment of the Fisheries Resources. FAO/UNDP: TRI/91/001/TR9. Port of Spain, Trinidad and Tobago: Ministry of Agriculture, Land and Marine Resources.

Lum Young, P., L. Ferreira and L. Maharaj. 1992b. Morphometric relationships for five species of Western Atlantic tropical shrimp occurring in the Trinidad and Tobago Trawl Fishery. Tech. Rep. FAO/UNDP: TRI/91/001/TR13 “Establishment of Data Collection Systems and Assessment of the Fisheries Resources”. 31p.

Mace, P.M. and Sissenwine M.P. 1993 How much spawning per recruit is enough? pp. 101-118. In: Smith, S.J. JJ. Hunt and D. Rivard [ed.] Risk evaluation and biological reference points for fisheries management. Can. Spec. Publ. Fish. Aquat. Sci. 120.

McCullagh, P. Nelder, J.A. 1989. Generalized Linear Models. Second Edition. Chapman and Hall, New York.

Seijo, J.C., L. Ferreira, J. Alió, and L. Marcano. 2000. Bio-economics of shrimp fisheries of the Brazil-Guyana Shelf: dealing with seasonality, risk and uncertainty. In FAO/Western Central Atlantic Fishery Commission. Report of the third Workshop on the Assessment of Shrimp and Groundfish Fisheries on the Brazil-Guianas Shelf . Belém, Brazil, 24 May - 10 June, 1999. FAO Fisheries Report. No. 628. Rome, FAO. 2000. pp 173-185.

Shepherd, D. And N.M. Ehrhardt (2000). Assessments of shrimp fisheries of Guyana. Report of the Third Workshop on the Assessment of Shrimp and Groundfish Fisheries on the Brazil-Guianas Shelf. Belém, Brazil, 24 May – 10 June 1999. FAO Fisheries Report. No. 628. pp105-109.

Sparre P. and Venema, S. 1992. Introduction to Tropical Fish Stock Assessment. Part 1 Manual. FAO Fisheries Technical paper 306/1.

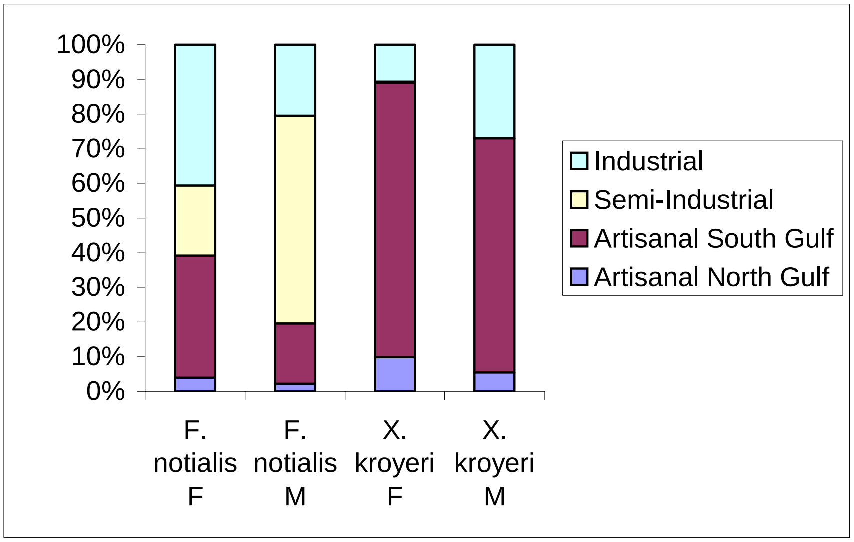


Figure 1. Percentage of individuals of each species and sex captured by the various trawl type/fishing area categories over the entire period 1992-2002.

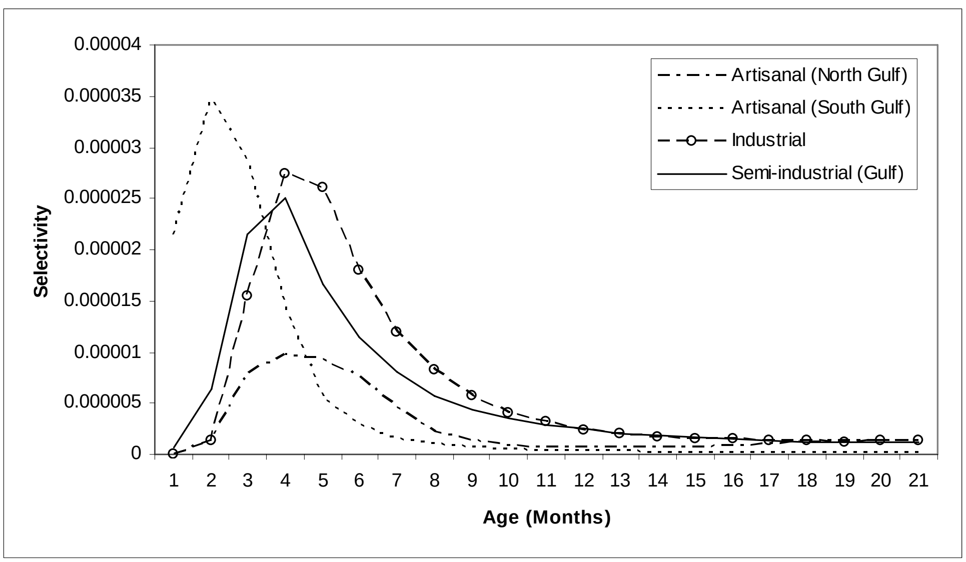


Figure 2. Selectivity of female *F. notialis* by trawl type/fishing area.

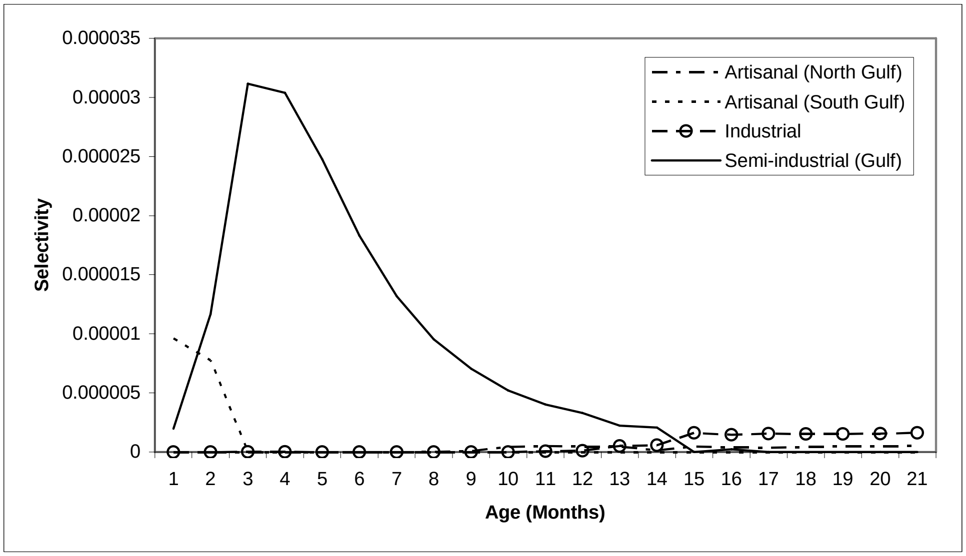


Figure 3. Selectivity of male *F. notialis* by trawl type/fishing area.

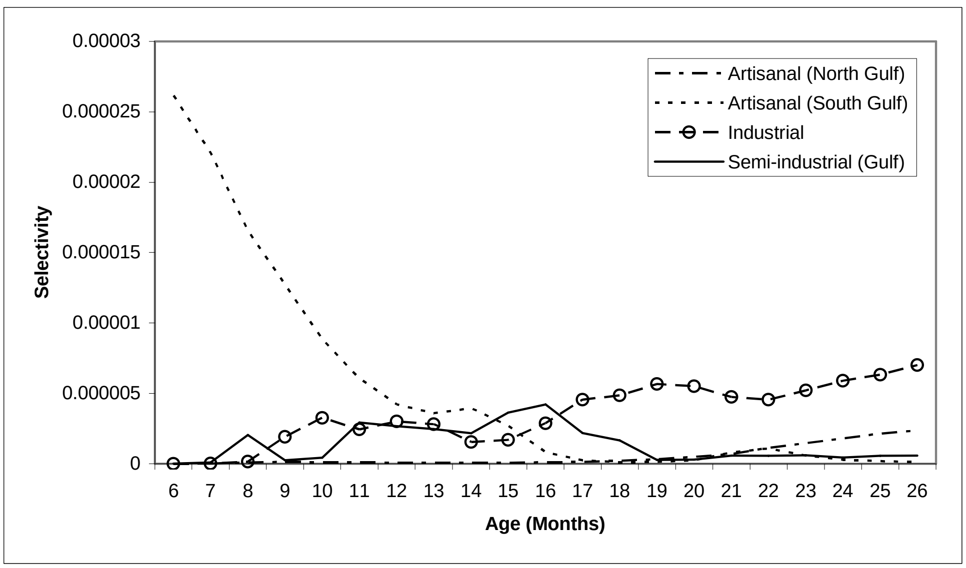


Figure 4. Selectivity of female *X. kroyeri* by trawl type/fishing area.

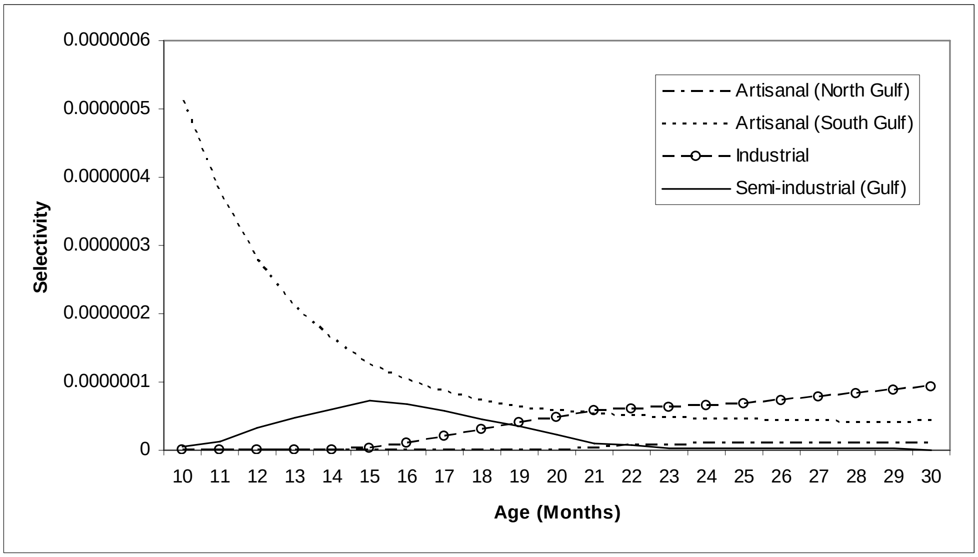


Figure 5. Selectivity of male *X. kroyeri* by trawl type/fishing area.

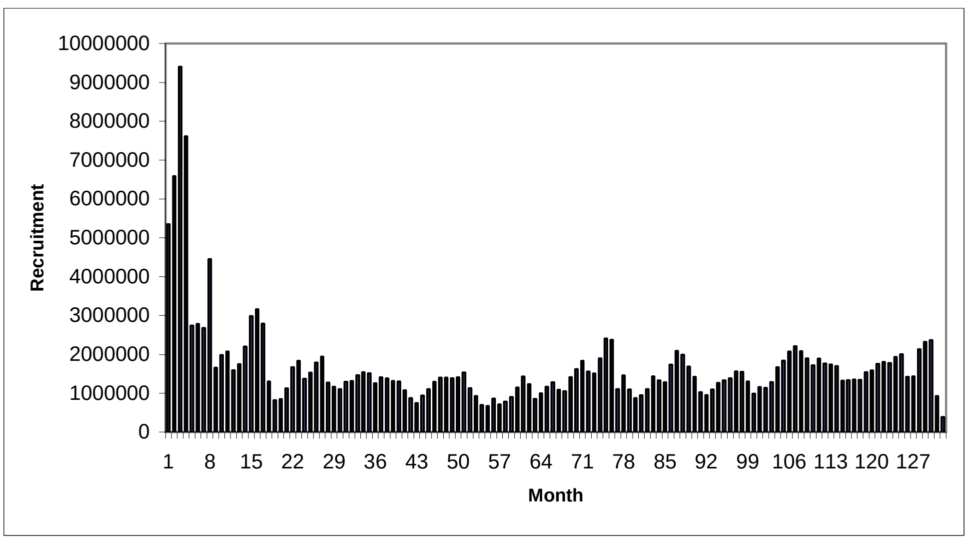


Figure 6. Monthly recruitment (in numbers) of female *F. notialis* for 1992-2002 estimated from the catch-at-age model.

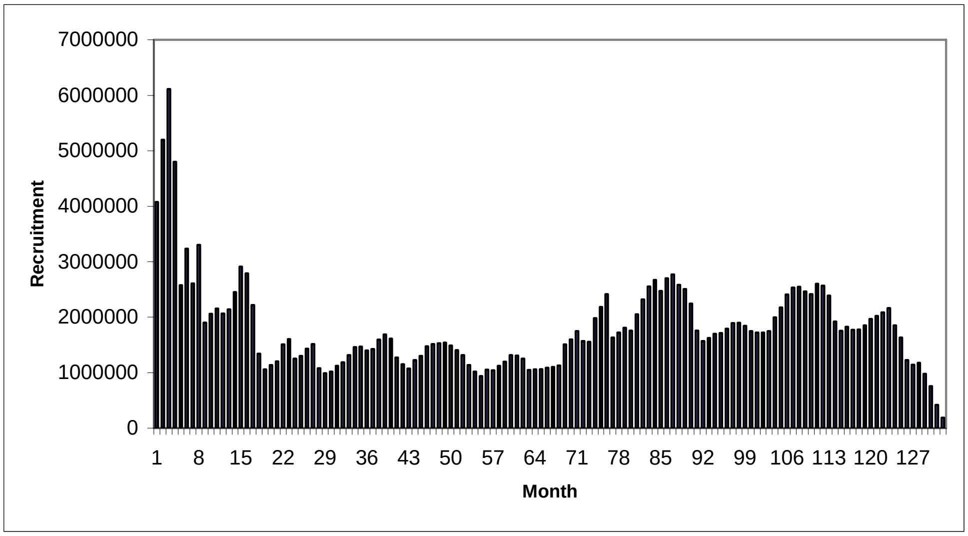


Figure 7. Monthly recruitment (in numbers) of male *F. notialis* for 1992-2002 estimated from the catch-at-age model.

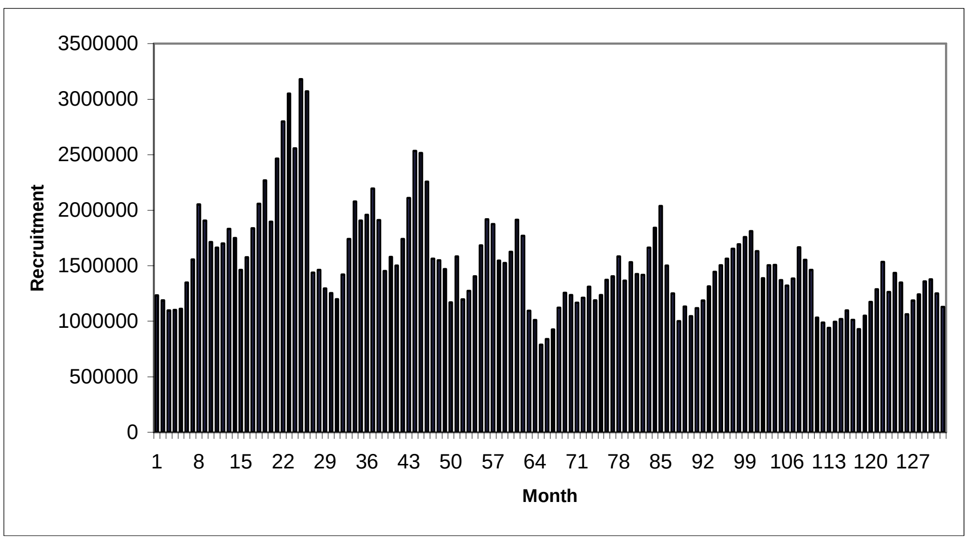


Figure 8. Monthly recruitment (in numbers) of female *X. kroyeri* for 1992-2002 estimated from the catch-at-age model.

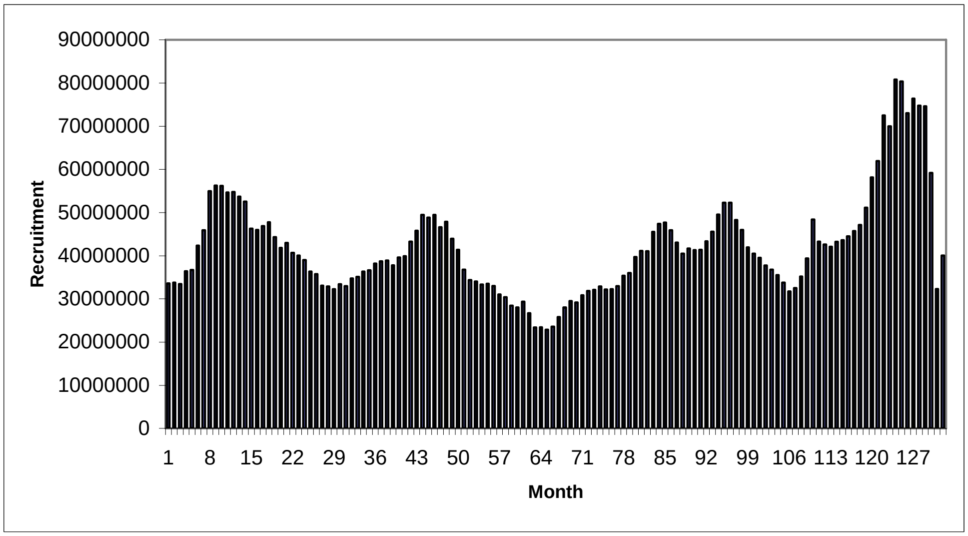


Figure 9. Monthly recruitment (in numbers) of male *X. kroyeri* for 1992-2002 estimated from the catch-at-age model.

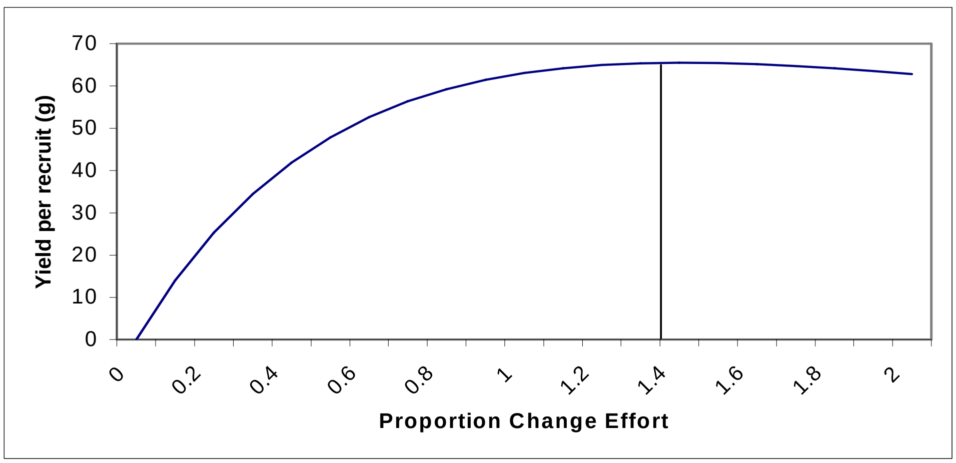


Figure 10. Yield-per-recruit for *F. notialis* and *X. kroyeri* for all trawl types combined.

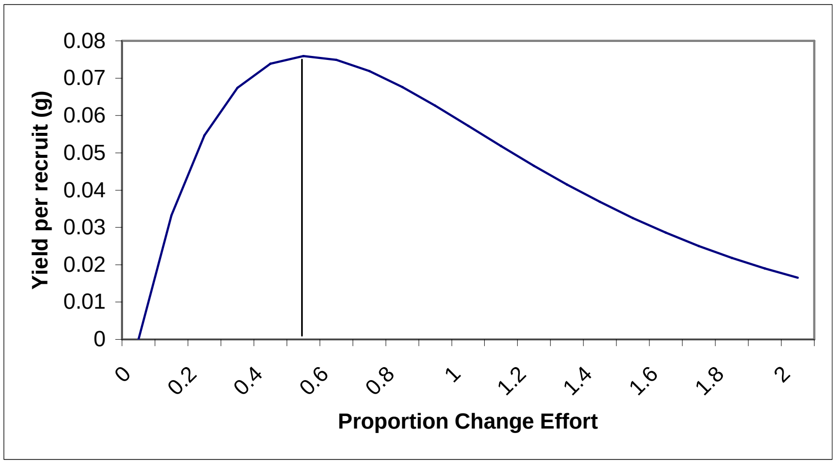


Figure 11. Yield-per-recruit for the artisanal trawl fleet operating in the north Gulf of Paria for *F. notialis* and *X. kroyeri* combined.

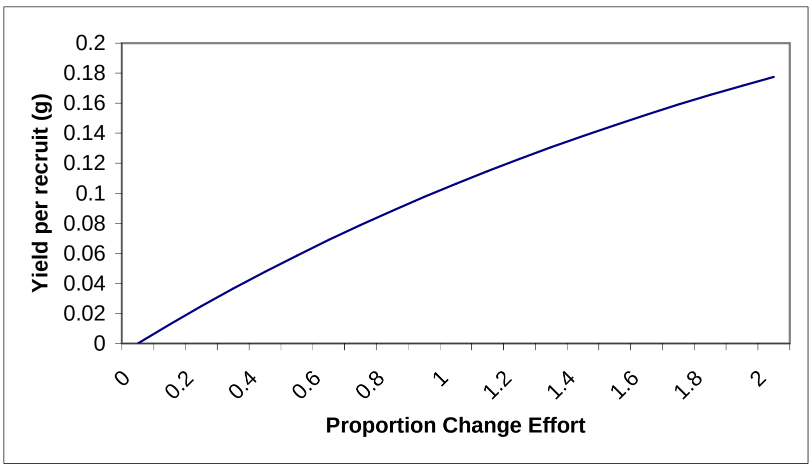


Figure 12. Yield-per-recruit for the artisanal trawl fleet operating in the south Gulf of Paria for *F. notialis* and *X. kroyeri* combined.

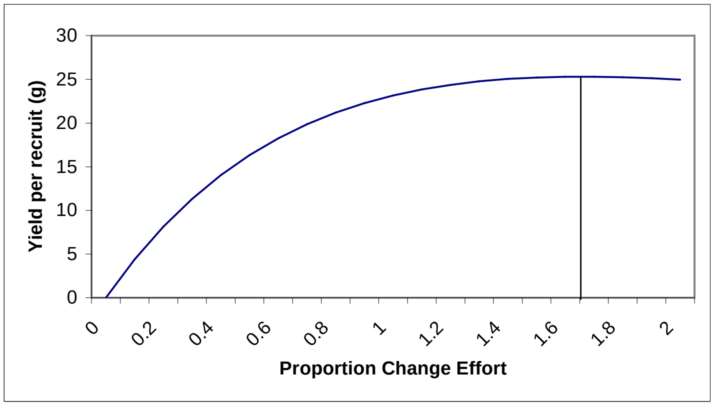


Figure 13. Yield-per-recruit for the semi-industrial trawl fleet for *F. notialis* and *X. kroyeri* combined.

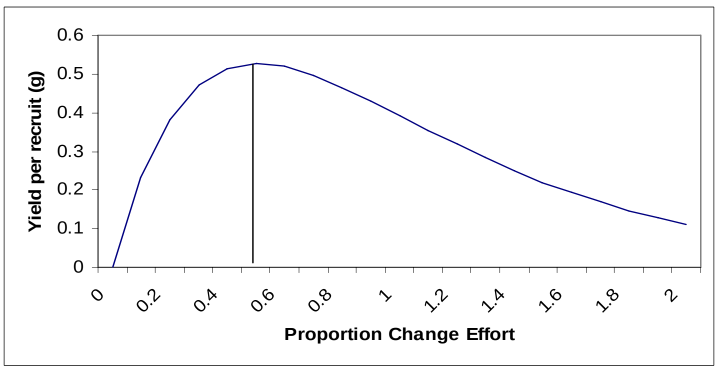


Figure 14. Yield-per-recruit for the industrial trawl fleet for *F. notialis* and *X. kroyeri* combined.

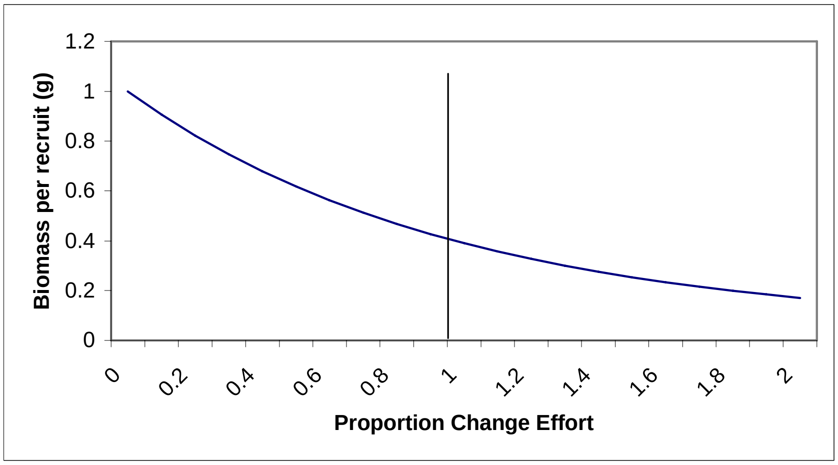


Figure 15. Biomass-per-recruit for female *F. notialis*.

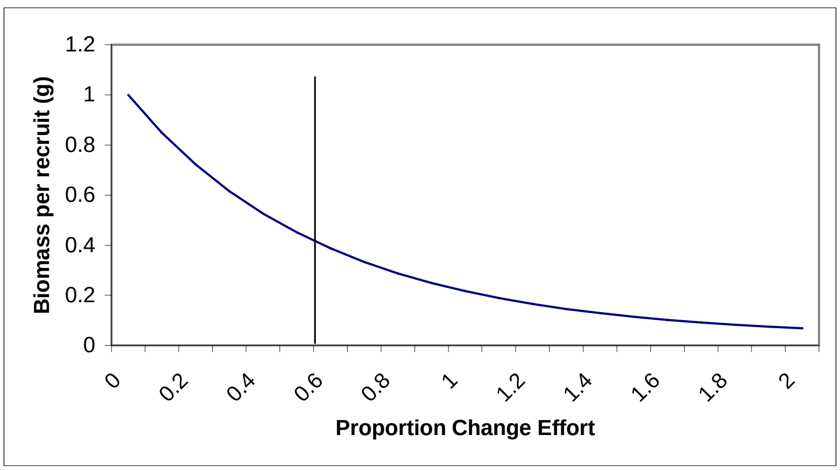
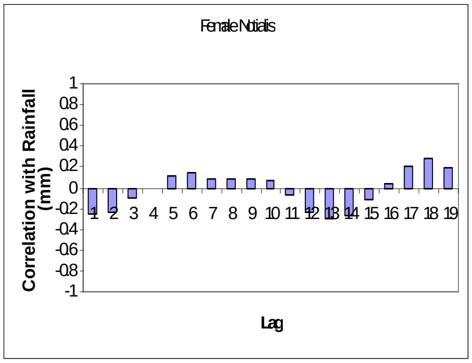


Figure 16. Biomass-per-recruit for female *X. kroyeri*.



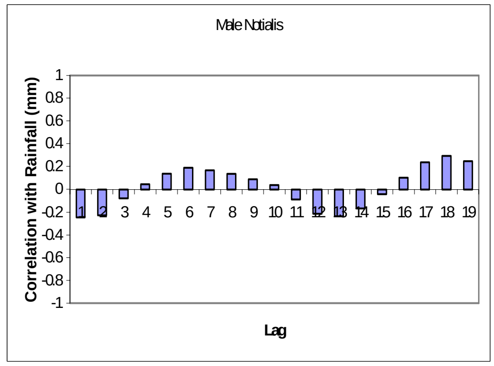
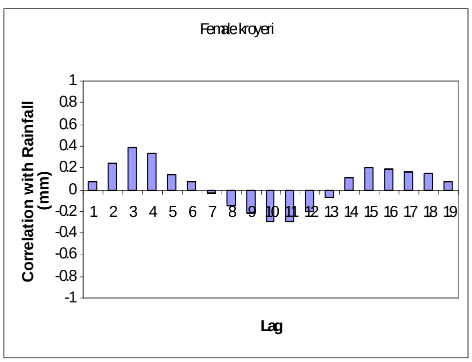


Figure 17. Cross correlation function between *F. notialis* recruitment and rainfall.



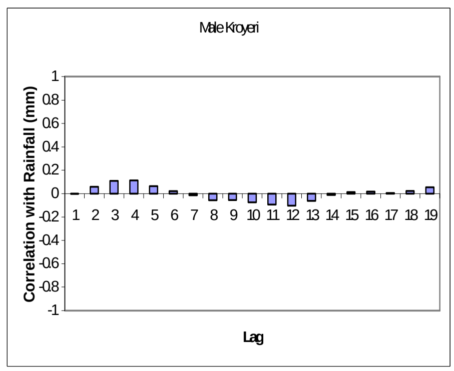


Figure 18. Cross correlation function between *X. kroyeri* recruitment and rainfall.

D. REPORT OF THE SMALL COASTAL PELAGIC FISH RESOURCE WORKING GROUP

Rapporteurs: C. Isaac and S. Singh-Renton

1. Bigeye scad (*Selar crumenophthalmus*), mackerel scad (*Decapterus macarellus*), and round scad (*D. tabl and D. punctatus*) - fisheries of St. Vincent and the Grenadines and Grenada

1.1 MANAGEMENT OBJECTIVES

No specific management objectives are documented for the scad fisheries of St. Vincent and the Grenadines and Grenada. General management objectives used to guide the 2004 analysis include:

(i) Develop and increase the potential of marine living resources to sustainably meet human nutritional needs, as well as social, cultural, economic and development goals.

(ii) Maintain or restore populations of marine species at levels that can produce the maximum sustainable yield as qualified by relevant environmental and economic factors, taking into consideration relationships among species.

(iii) Promote scientific research with respect to fisheries resources.

1.2 STATUS OF STOCKS

The status of each of the three scad species remains undetermined, as it was not possible to complete quantitative assessments with the available data. In view of the importance of these fisheries to local food security in St. Vincent and the Grenadines and Grenada, a precautionary approach to management is warranted.

1.3 MANAGEMENT ADVICE

i) Available data could not be used to conduct quantitative assessments of the three scad species, and hence it was not possible to develop specific fishery management recommendations for the associated fisheries at this time.

ii) Consequently and consistent with international law, a precautionary management approach is advised. This could entail a limitation of fishing effort to present levels or, if not practical at least controlled and cautious expansion of fishing effort, until the status of the resources could be evaluated with confidence.

iii) Additionally, the Fisheries Divisions should maintain accurate records of fishing licences issued for this fishery, as well as seek to improve statistical monitoring of the fishery as outlined in the subsequent sections of this report.

1.4 STATISTICS AND RESEARCH RECOMMENDATIONS

1.4.1 Data quality

i) In the short-term, sampling methods should be reviewed to determine the extent of the problem of double-reporting of landings in St. Vincent and the Grenadines and Grenada, and the possibility of eliminating this problem altogether.

ii) The overall sampling strategy for these fisheries needs to be improved to obtain more representative statistical coverage of fishing activities.

iii) The collection of effort data, as well as social, economic, and environmental data will improve future attempts to evaluate these fisheries.

iv) Data raising methods should be reviewed to determine their current level of accuracy, and improved to reflect more closely the full extent of fishing activities.

1.4.2 Research

i) There is a need to determine the extent to which these resources are shared by countries within the region, and to understand fish movement and migration patterns. Such studies are probably best coordinated at the regional level.

ii) The apparent vulnerability of scads and other small coastal pelagic fish resources to environmental conditions needs to be fully understood, as well as the likely impact of this on management approaches being considered.

iii) There is a need to determine if fish are more vulnerable to fishing gears when they are immature or when they are in spawning condition. The identification of spawning periods would also help to inform the development of an appropriate management strategy. Fisheries Divisions and Departments should try to gather maturity data can be collected during routine sampling of fishing operations.

1.5 STOCK ASSESSMENT SUMMARY

1.5.1 Bigeye scad – St. Vincent and the Grenadines and Grenada

i) Analyses were limited to a cursory examination of annual and monthly trends in landings of each species/ species grouping for the two countries.

ii) Landings of bigeye scad showed an overall decrease during the most recent 10-year period in both St. Vincent and the Grenadines and Grenada (Figure A). Given that the number of fishing vessels was assumed to remain relatively unchanged during this time period, the observed declines in landings may reflect real decreases in stock abundance and biomass.

iii) An apparent stronger multi-modal seasonal pattern was observed in landings of bigeye scad in St. Vincent and the Grenadines during the period 1979-1992, with peak harvests recorded in May-July. In the more recent period of 1993-2003, this seasonal pattern was not as strong, although higher landings were recorded in May-July also.

iv) In Grenada, the seasonal pattern in landings of bigeye scad was similar to that observed for St. Vincent and the Grenadines for the same period, becoming less marked through time. This trend was probably not unrelated to the decrease in total annual landings of this species during the time period concerned.

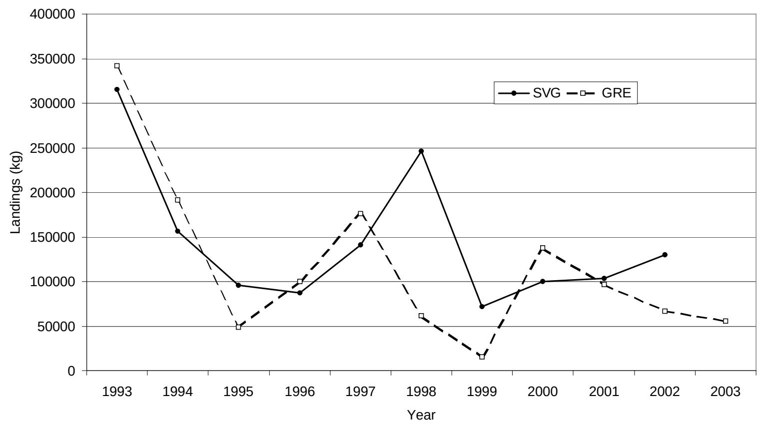


Figure A. Estimated annual total landings of bigeye scad during 1993-2003 in St. Vincent and the Grenadines and Grenada.

1.5.2 Mackerel scad - St. Vincent and the Grenadines

i) Landings of round scad have showed an overall increase during 1979-2003, with sharp increases recorded in two years, 1991 and 2001, approximately 10 years apart (Figure B). The 2002-03 landings were much lower than the unusually high level observed in 2001. Fishing effort is assumed to have constant during the period concerned, and if so, the resource is still in a good condition.

ii) Most of the landings were taken during the first half of the year, with this seasonal pattern being more distinct in and around the peak years of 1991 and 2001.

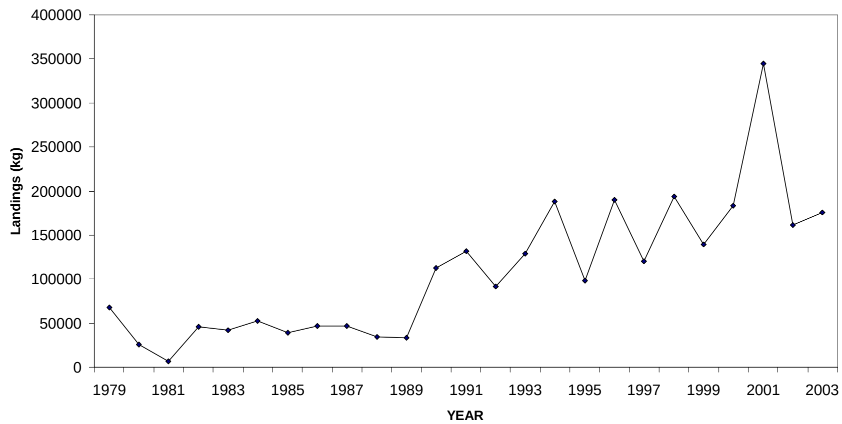


Figure B. Estimated annual total landings of mackerel scad in St, Vincent and the Grenadines for the period 1979-2003 (during 1979-1992, estimates were only for NKFM).

1.5.3 Round scad - Grenada

i) Landings of round scad showed a gradual decrease during 1993-2003 (Figure C).

ii) Round scad landings gradually increased to a maximum in July, after which landings decreased again gradually to a minimum in November. In the mid-1990s, a slightly lower peak in landings was observed in December in addition to the usual mid-year peak.

Figure C. Estimated annual total landings of round scad in Grenada for the period 1993-2003.

1.6 SPECIAL COMMENTS

i) In view of the complex distribution, both in space and in time, of small coastal pelagic fishing operations in the two countries, as well as the often remote and not easily accessible landing sites, current statistical sampling coverage of the fisheries is very low and believed not to be representative of the full range of fishing activities.

ii) The WG assumed that the landings data submitted on bigeye scad and mackerel scad did not include landings of other small coastal pelagic fish species.

iii) The WG assumed that the landings data submitted on round scad included landings of only *D. tabl* and *D. punctatus*.

iv) The WG assumed that the number of fishing vessels engaged in the scad fisheries of the two countries remained constant during the period 1993-2003.

1.7 POLICY SUMMARY

The Fisheries management plans of both countries indicate the governments' commitment to the conservation and sustainable use of fisheries resources for the benefit of the people of Grenada.

1.8 SCIENTIFIC ASSESSMENTS

1.8.1 Background or Description of the fishery

A number of small coastal pelagic fish resources are harvested within the region both commercially and for subsistence. The small coastal pelagic fish resources of current importance span at least six (6) genera and nine (9) species. Some of the more important species are the round scads (*Decapterus sp*.), bigeye scad (*Selar crumenophthalmus*), ballyhoo *(Hemiramphus sp)*, needle fishes *(Family: Blonidae)* and southern sennet *(Sphyraena picudilla)*. In some countries such as St. Vincent and the Grenadines, scads comprise a major portion of the total fish harvest, about 45% of all finfish landings. These species are of significant economic importance especially to rural communities and provide an essential local and affordable source of protein.
The main gear employed in the harvesting of scads is the beach seine**.** Beach seines are deployed at numerous (and often remote) beaches throughout the islands. The efficiency of the beach seine operation requires relatively unobstructed bottom conditions adjacent to sandy or pebble beaches. Usage of a seine is normally restricted to one or two nearby beaches and is usually kept stored inside a "seine boat" (most likely a "double ender"), which is anchored just offshore in the nearest sheltered bay.

A seine fishing operation is usually supervised by a Captain, assisted by several crew, some of whom function as 'Spotters'. The 'Spotters' are responsible for locating schools of fish within the bay and for directing the "casting" of the net to enclose a targeted school. There are also divers whose job it is to steer the seine nets clear of obstacles lying on the seabed. All members of the seine fishing team are involved in pulling the seine onto the beach. Persons from the community often voluntarily join in helping to haul the seine net. Only those persons "employed" by the captain are entitled to a share of the catch, but volunteers also normally receive small portions of fish as rewards for their assistance.

The catch, once landed, is immediately sold/delivered to vendors waiting on the beach. These vendors transport the catch using containers, e.g. tubs, or by vehicle for sale at more distant locations.

In several CRFM countries, fishing opportunities in the beach seine/small coastal pelagic fishery are largely governed by a system of customs referred to as Territorial Use Rights in Fisheries (TURF) (Finlay, pers comm.). This system has been developed over several generations. The TURF rules are generally respected and adhered to, and include a working system for conflict resolution.

In Grenada and St. Vincent and the Grenadines, some scad landings are "routed" through established fish markets (e.g. Melville Street Fish Market and New Kingstown Fish Market in Grenada and St. Vincent respectively), and this allows for the capture of total landings at these sites. National total estimates of landings are computed using a raising factor. In the case of Grenada, sampled data are simply multiplied by 1.75. Data on actual catches and effort (effort needs to be defined for this fishery), and on biological and environmental parameters, are not collected. The environmental data may prove to be important to this fishery given its proximity to land and populated areas.

1.8.2 Overall Assessment Objectives

Given the limited data available to the WG, only yearly and monthly trends in landings were examined, and compared where relevant.

1.8.3 Data Used

Data on landings only are collected at selected sites in the two countries. After a major refurbishment of the New Kingstown Fish Market (NKFM) in St. Vincent was completed in 1991, this increased the amount of locally caught fish being brought to and landed at Kingstown. In the case of the small coastal pelagic resources, fish could also be brought over land, and this is thought to have resulted in double recording of landings in some instances. A similar problem occurs in Grenada when fish are brought for sale at the main markets. Additionally, specified species categories are believed to include more than one species, e.g. in Grenada, the two species *Decapterus tabl* and *D. punctatus* are both recorded as round scad. These sources of error in the data should be noted.

Name	Description
Landings data	The sampled landings are recorded by data collectors based at selected landing sites, and by data collectors based at established markets. Monthly and annual estimates of total landings were calculated using raising factors. Data on bigeye scad and mackerel scad were available for St. Vincent and the Grenadines for the period 1979-2003. In this case, data collected during the period 1979-1992 reflected only total landings at the New Kingstown Fish market (NKFM), while an attempt was made to provide nation-wide estimates of total landings during the period 1993-2003. Data on landings, by month and by year, of bigeye scad and round scad in Grenada for the period 1993-2003 were also made available for the analysis. Grenada's data were nation-wide estimates for the period 1993 to 2003.

	Fishing effort was assumed to have been relatively constant in both countries during the most recent 10-year period, 1993-2003.

1.8.4 Data analysis

Objective

a. Examination and comparison of annual and monthly (seasonal) trends in landings of bigeye scad in St. Vincent and the Grenadines and Grenada.
b. Examination of annual and monthly (seasonal) trends in landings of mackerel scad in St. Vincent and the Grenadines.
c. Examination of annual and monthly (seasonal) trends in landings of round scad in Grenada.

Method

Monthly and yearly estimates of total landings of bigeye scad were reviewed for errors and omissions, before preparing the dataset for analysis in Excel. In the case of St. Vincent and the Grenadines, the total landings data recorded for only NKFM during 1979-1992 were examined separately from the nation-wide estimates provided for the later period of 1993-2003.
Simple charts of the following were constructed in Excel:

(a) Line graphs of total landings versus year (all months combined) using
NKFM estimates for St. Vincent and the Grenadines for the period 1979-1992
Nation-wide estimates for St. Vincent and the Grenadines for the period 1993-2003
Nation-wide estimates for Grenada for the period 1993-2003.

(b) Bar charts of total landings versus month (all years combined) using
NKFM estimates for St. Vincent and the Grenadines for the period 1979-1992
Nation-wide estimates for St. Vincent and the Grenadines for the period 1993-2003
Nation-wide estimates for Grenada for the period 1993-2003.

(c) Stacked bar charts of total landings versus month for each year (a 3-dimensional plot) using
NKFM estimates for St. Vincent and the Grenadines for the period 1979-1992
Nation-wide estimates for St. Vincent and the Grenadines for the period 1993-2003
Nation-wide estimates for Grenada for the period 1993-2003.

The 3-dimensional plots of (c) above were useful for examining the constancy, in terms of intensity as well as timing, of the seasonal patterns observed in the plots of (b) above during the time periods under investigation.
Fishing effort was assumed to have been relatively constant in both countries during the most recent 10-year period, 1993-2003.

Results

<u>Bigeye scad</u>

Figures 1-2 show the annual trends in total landings of bigeye scad at NKFM during 1979-1992, throughout St. Vincent and the Grenadines during 1993-2003, and throughout Grenada during 1993-2003. Landings showed a slight increase at NKFM during the earlier time period, while landings appeared to decrease in both countries during the last 10 years. While figures 2a & 2b illustrated an overall declining trend, closer examination of these figures indicated that the steepest declines occurred just after 1993 (1994-1995), after which landings tended to fluctuate, though remaining at a much lower level than that obtained in 1993.

In examining the bar charts showing monthly landings, the earlier time period at NKFM indicated two periods of higher harvest levels, May-July and December-January (Figure 3a). The May-July peak was also apparent in the plot of the nation-wide data for the later period 1993-2003, with a second, less intense peak observed during January-February (Figure 3b). In Grenada, while higher harvest levels were also observed during May-June, and in January (Figure 4), the overall seasonal differences were less marked than that recorded for St. Vincent and the Grenadines.

The three-dimensional stacked bar charts of monthly trends throughout the time period indicated greater constancy from year to year during the earlier period at NKFM than during the most recent 10-year period (Figure 5). In both countries, the seasonal differences became less marked from 1993 onwards through time, which may or may not have been related to the overall decline in harvest levels also observed in the last few years (Figures 6a, b) and which was indicated in Figures 1-2.

<u>Mackerel scad</u>

In 1979, a total of approximately 67,000 kg of mackerel scad was landed at the NKFM in St. Vincent (Figure 7). Following this, mackerel scad landings decreased markedly during 1980-81 after which landings increased slightly again to a level of about 40-50,000 kg and remained more or less at this level until 1990 when landings increased sharply to a level of 112,463 kg. After this time, landings fluctuated but showed an overall gradual increase up to 2003. Landings peaked in 2001, at a level of 344,758 kg, but this performance was not sustained in 2002-03 (Figure 7).

During the period 1979-1992 at NKFM, mackerel scad landings tended to be highest during February-June and lowest during the months of October-December (Figure 8a). This pattern was also apparent in the later period 1993-2003 when estimates were provided for the whole country, although the highest catches in the first half of the year appeared to be taken during a more restricted time period, i.e. February-March rather than February-June (Figure 8b).

When the monthly trends were followed from year to year, it became apparent that strong monthly differences (seasonal patterns) occurred in only a few years (Figures 9a, b).

<u>Round scad</u>

Annual landings of round scad in Grenada decreased very slightly from 1993 to 2003 (Figure 10). The very low landings of round scad observed in 1999 is believed to have been the result of a cessation of fishing activities around the time of the regional 'fish kill' incident that occurred in that year. The 1999 value is therefore considered to be anomalous.

The seasonal pattern showed higher catches in the first half of the year, rising gradually from January to a clear peak in July, and decreasing again to lowest levels in November (Figure 11). A second, lower peak occurred in December. The mid-year peak was fairly consistent from year to year (Figure 12), but the lower peak in December was observed only around the mid-1990s (Figure 12).

Discussion

<u>Bigeye scad</u>

It is interesting to note that the annual trends in landings of bigeye scad were similar for both St. Vincent and the Grenadines and Grenada during the time period that could be compared, i.e. 1993-2003. Patterns in the observed fluctuations were also similar, with observed peaks in Grenada being followed by observed peaks in St. Vincent 1-2 years later. These observations suggest that local environmental conditions may influence the availability of the resource in the local fishing areas of both countries from year to year. It is also possible that such conditions, as well as climatic fluctuations, may cause slight shifts in species movement patterns on a larger, regional scale from year to year.

The assumption of a constant fishing effort in terms of numbers of fishing vessels, in both countries during the past 10 years is reasonable. Noting this, the general decreasing trend observed for both countries may reflect a real decrease in resource abundance and biomass. However, there may have been changes in sampling coverage, but this remains to be verified.

In the case of St. Vincent and the Grenadines, the less marked seasonal pattern during 1993-2003, compared to that observed during 1979-1992, may simply reflect the change in data raising methods applied in an attempt to develop nation-wide estimates of total landings. However, both countries showed comparatively strong seasonal differences in the early 1990s, and hence the less marked seasonal pattern observed in the late 1990s and up to 2003 may be more related to the overall declines in landings noted for both countries and hence possible real declines in resource abundance. If so, then improved monitoring of these fisheries should be an immediate management priority, as well as consideration of precautionary measures, such as limiting fishing effort to present levels.

Mackerel scad

During the past 10 years and apart from the very high peak observed in 2001, landings of mackerel scad have increased very gradually. The fishing effort, in terms of numbers of vessels, used to target bigeye scad would have been the same used to target mackerel scad. Hence, if fishing effort is assumed to have remained constant during the period, the observed gradual increases in landings is likely to be a reflection of increasing fishing efficiency.

The majority of landings were taken during the months of the dry season. This seasonal pattern was stronger in certain years, when very high landings were recorded during a 2-3 month period. Interestingly, the strongest seasonal patterns were observed in 1991 and 2001, an interval of 10 years, years in which the estimated landings were significantly higher than in other years. In the absence of additional data and information, these observations seem to imply that mackerel scad biomass and hence abundance may fluctuate in response to changing and cyclical environmental and/or climatic conditions. Availability of the resource to the fishery may be similarly affected.
Improved monitoring of this fishery is needed to determine if and when the fishery is reaching a stage of maturity. Additionally, management strategies would need to take into account the effects of environmental and possibly also climatic factors on resource abundance and availability.

Round scad

The fishing effort, in terms of numbers of vessels, used to target bigeye scad would have been the same used to target round scad in Grenada. Assuming no change in the number of vessels during 1993-2003, the observed gradual decline in landings of round scad could be interpreted as a decline in resource biomass and hence abundance. If fishing efficiency increased during the period as might be expected, the declining abundance of the round scad resource would be greater than the decline apparent from examining landings only.

The constancy of the seasonality pattern observed for round scad throughout the 10-year period, i.e. higher abundance during the first half of the year, rising to a definite peak around July, suggests that the annual abundance and/or availability of this species may be less affected by certain environmental factors than bigeye scad and mackerel scad. On the other hand, the observed peak in abundance in December during the mid-1990s may have been a consequence of special environmental and/or climatic conditions.

Clearly, there is a need to conduct studies to gain a better understanding of the biology and ecology of round scad, and to investigate the effects of environment factors on fish abundance and movement patterns.

As stated for the other scad species, improved monitoring of the fishery is warranted to facilitate quantitative assessment of the health of the resource, as well as the fishery, and to inform the development of appropriate management strategies. In the meantime, precautionary measures, such as limiting access to the fishery, are advised for the bigeye scad fisheries of Grenada and St. Vincent and the Grenadines, and for the round scad fishery of Grenada.

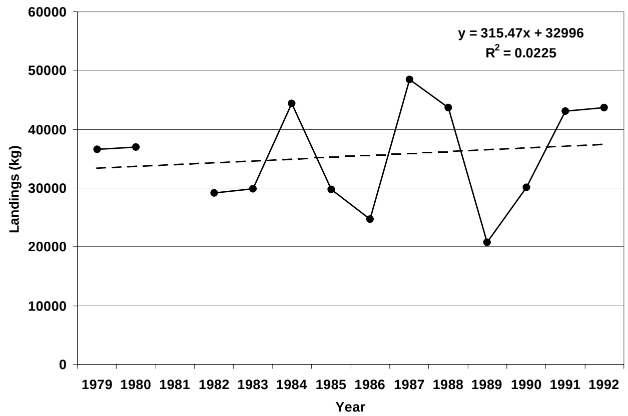
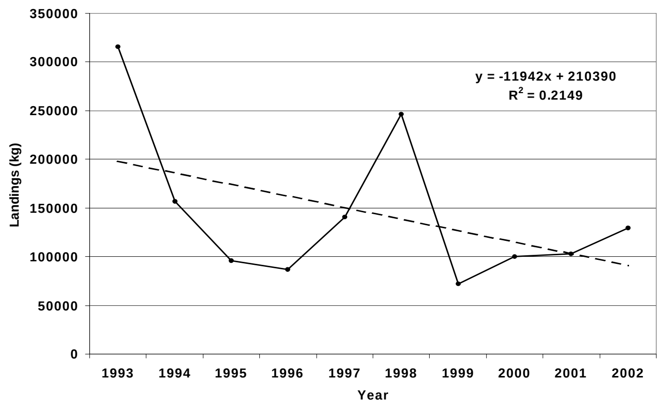
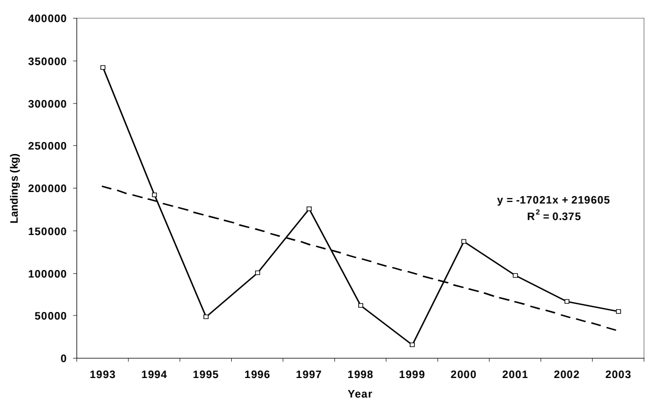


Figure 1. Estimated annual total landings of bigeye scad at NKFM during 1979-1992.



(a)



(b)

Figure 2. Estimated annual total landings of bigeye scad for (a) St. Vincent and the Grenadines and (b) Grenada during 1993-2003.

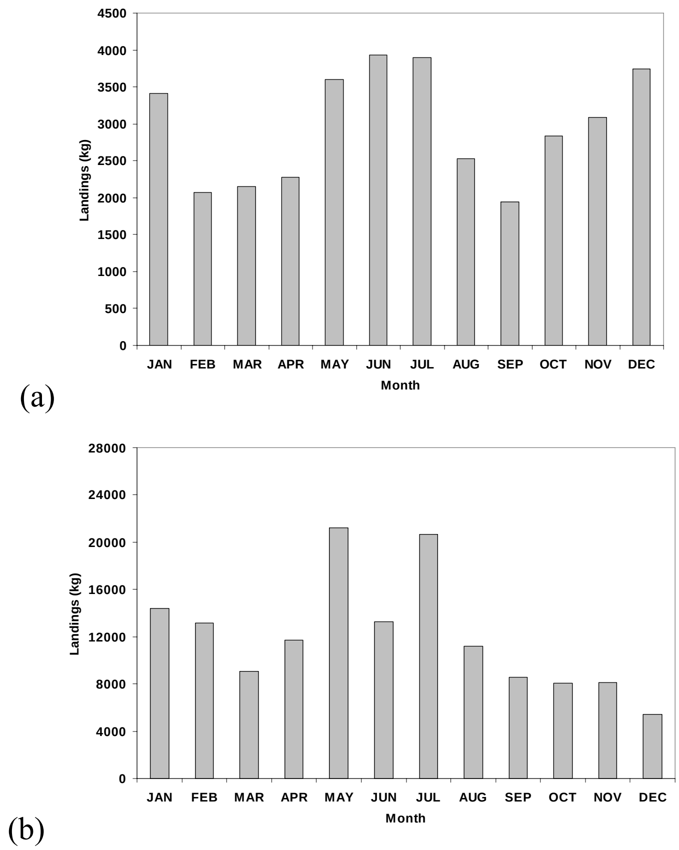


Figure 3. Average monthly landings of bigeye scad (a) at NKFM during 1979-1992, and (b) throughout St. Vincent and the Grenadines during 1993-2003.

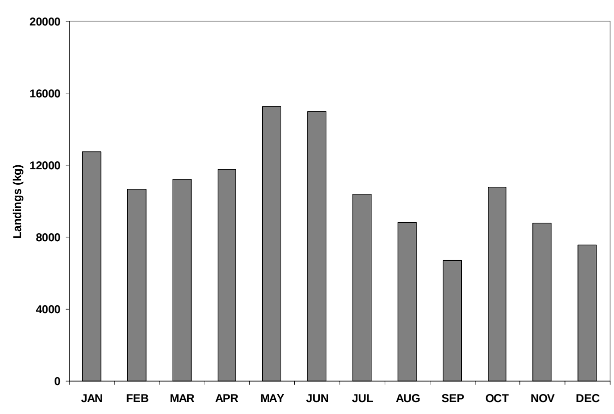


Figure 4. Average monthly landings of bigeye scad in Grenada during 1993-2003.

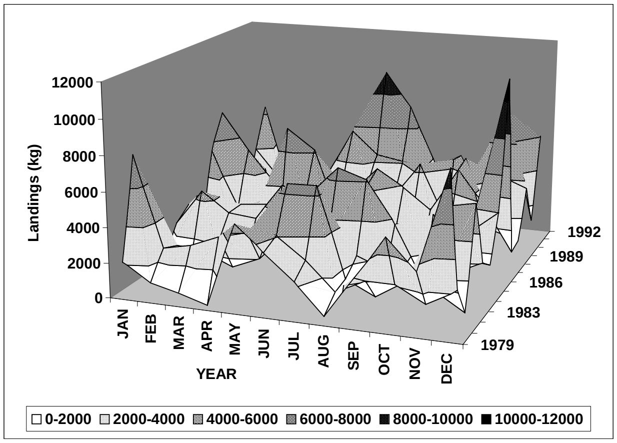
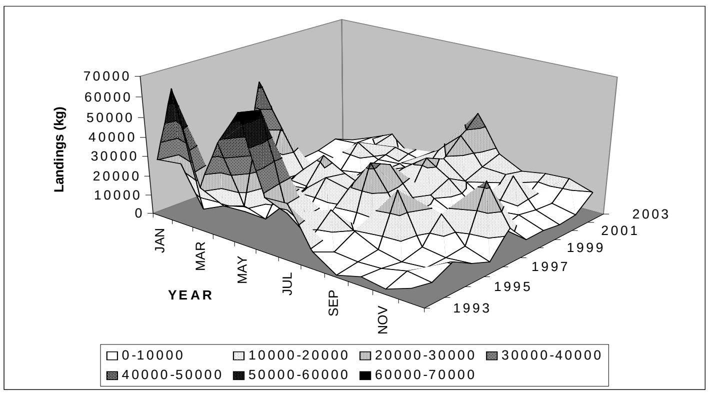
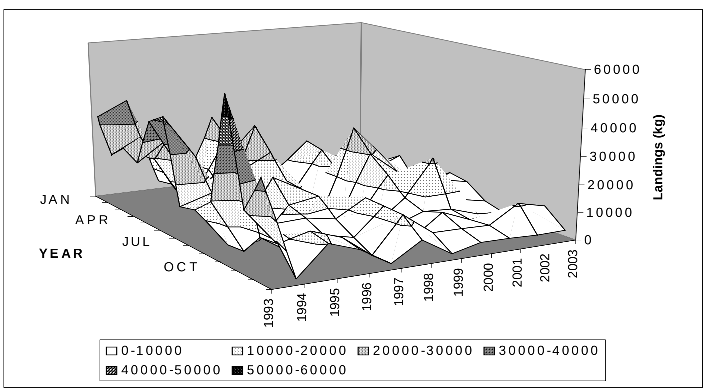


Figure 5. Monthly landings of bigeye scad at NKFM in each year during 1979-1992.



(a)



(b)

Figure 6. Monthly landings of bigeye scad throughout (a) St. Vincent and the Grenadines and (b) Grenada in each year during 1993-2003.

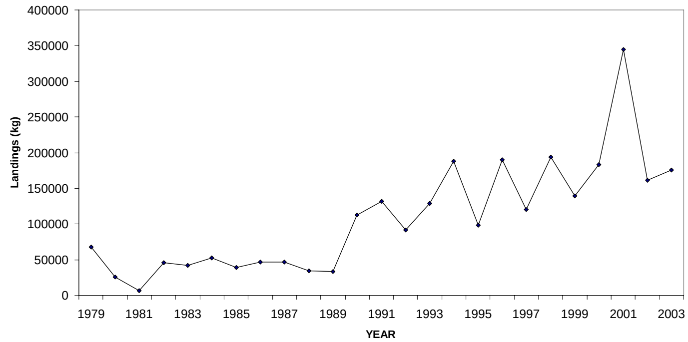
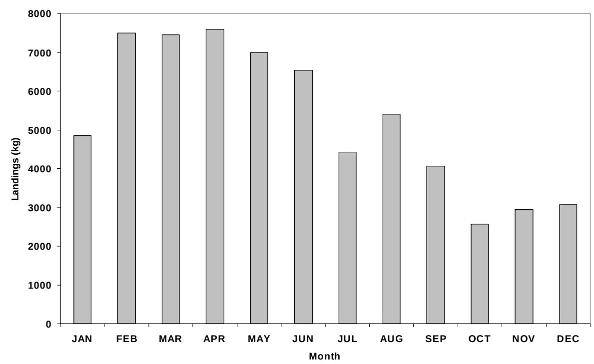
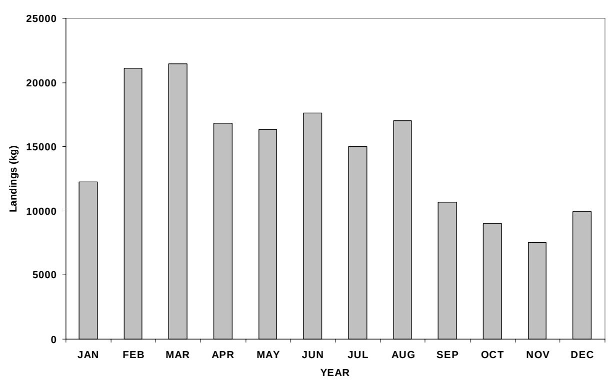


Figure 7. Estimated annual total landings of mackerel scad in St. Vincent and the Grenadines during 1979-2003 (with values reflecting total landings at NKFM only for the years of 1979-1992).

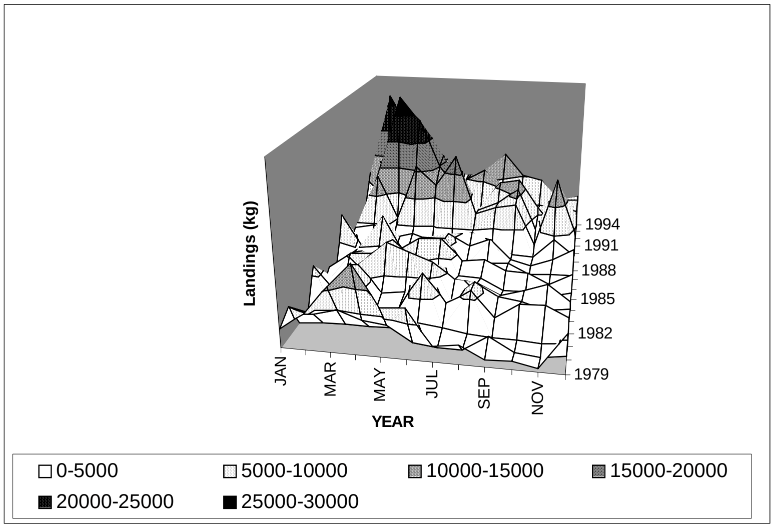


(a)

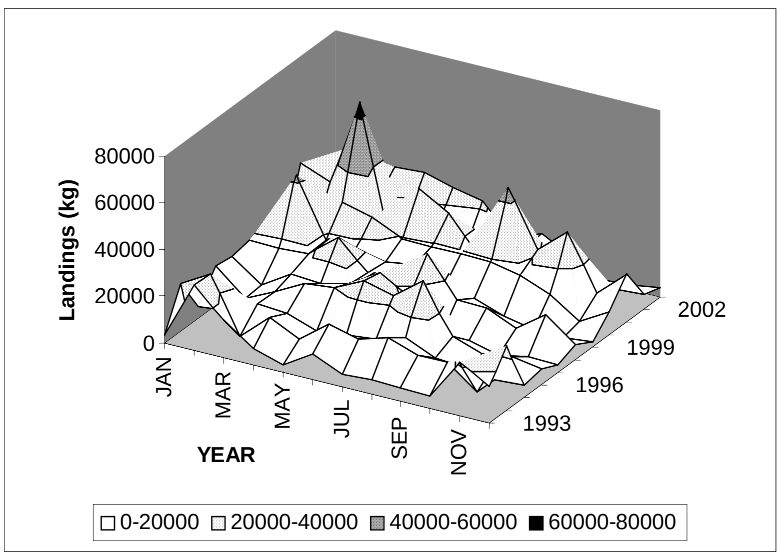


(b)

Figure 8. Average monthly landings of mackerel scad (a) at NKFM during 1979-1994 and throughout St. Vincent and the Grenadines during 1993-2003.



(a)



(b)

Figure 9. Average monthly landings of mackerel scad in each year (a) at NKFM during 1979-1994, and (b) throughout St. Vincent and the Grenadines during 1993-2003.

Figure 10. Estimated annual total landings of round scad in Grenada during 1993-2003.

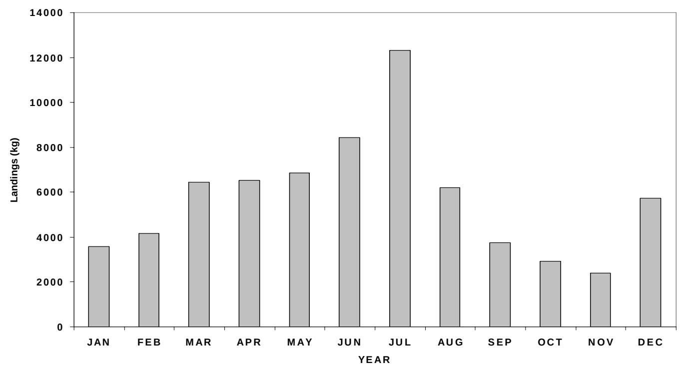


Figure 11. Average monthly landings of round scad in Grenada during 1993-2003.

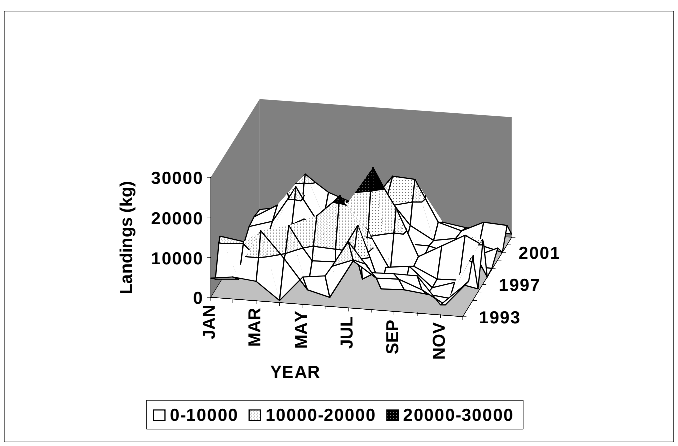


Figure 12. Average monthly landings of round scad in Grenada in each year during 1993-2003.

E. REPORT OF THE LARGE PELAGIC FISH RESOURCE WORKING GROUP (LPWG)

1. Serra Spanish mackerel (*Scomberomorus brasiliensis*) – fishery of Trinidad and Tobago

Rapporteurs: Louanna Martin and Joshua Sladek Nowlis

1.1 DESCRIPTION OF THE FISHERY

Scomberomorus brasiliensis, Serra Spanish mackerel, has a range in the Western Atlantic along the coasts of Central and South America from Belize to Rio Grande do Sul, Brazil (Collette and Russo, 1979).

In Trinidad, this fishery is the most widespread and also targets king mackerel (*Scomberomorus cavalla*) and Elasmobranchii (*Sphyrna tudes, Rhizoprionodon lalandii, Carcharhinus porosus,* and *C. limbatus*) it is the most abundant of the fish species caught by the commercial fisheries. It is targeted mainly by the artisanal fishery in which an estimated 1400 vessels are employed. (multigear and multi species).

Caught mostly by gillnets (multifilament and monofilament – 330 units in 1998), pelagic handlines (trolling, swtichering, a la vive) and demersal handlines (banking).

Fishery unmanaged - no constraints to increases in fishing effort.

Regulations specify the maximum length (274.5 m / 900 ft) and depth (4.6 m / 15 ft) and minimum mesh size (~11 cm / 4¼ inches diagonal stretched mesh) for gillnets. Maximum net dimensions and minimum mesh size are also specified for seines.

Spanish mackerel less than 305 mm (12 inches) may not be taken, sold or exposed for sale.

1.2 AVAILABLE DATA

1992 T&T Assessment (1972-1991)
(missing data for '74-'75, '79-'80, '83, '86,)
Serra Spanish mackerel catch weights from gillnets
Gillnet effort data (number of trips)
ICCAT Landings (1977-2002)
T&T Recent data (1995-2002)

1.3 ASSESSMENT METHODS

1.3.1 Model Structure and Tuning

Relatively little size- and even less age-composition data were available. Consequently, we were unable to model these aspects of the southern Caribbean Spanish mackerel fishery. Without this sort of information, our alternative was to use a surplus production model. This form of an assessment model treats each kg of fish equivalently, whether it is composed of several small fish or a part of a larger fish. In this way, it does not acknowledge potentially important differences in the population related to size- and age-structure, or differences among fishing sectors in the size-classes of fish they select.

The advantage of surplus production models include their simplicity and the feasibility of producing clean analyses. Prager (1994) took advantage of these properties when he developed a surplus-production model including covariates (ASPIC) based on the logistic, or Schaefer-Graham, model. This model allows the user to examine multiple data series using the covariance matrix among them, although this feature was not required in the present exercise. This exercise did take advantage of two other features of ASPIC: its assumption that estimates of catches are more certain than estimates of biomass (as indicated by catch-per-unit-effort) and its bootstrapping option. The bootstrapping module performs multiple runs of the assessment, each of which uses somewhat different catch levels. In this way it allows one to examine the consequences of this information being incorrect. The sensitivity identified here is a good indicator of general sensitivity of surplus production models, whose simplicity makes many of its parameter values closely interrelated. For each scenario, 1000 bootstrap runs were conducted.

Version 3.9.1 of ASPIC from the NOAA Fisheries Toolbox was used for these analyses. In this model, the user sets initial estimates of the starting biomass (relative to the biomass at MSY, B_{MSY}), the maximum sustainable yield (MSY), and the intrinsic population growth rate (r). The user may also specify which of these parameters should be estimated from the data series and which should remain fixed. For parameters being estimated, the user sets the reasonable range of values for them. Results that produce values above or below the reasonable range are thrown out.

For all Spanish mackerel runs, the initial estimate of starting biomass was set at B_{MSY}. However, exploratory runs, which allowed this parameter to be estimated in the model, produced final estimates of starting biomass well above unfished abundance. As a result, additional runs were performed holding the value of this parameter fixed at B_{MSY}. The initial MSY value was set at 8 million kg, the approximate average catch from the southern Caribbean over the past 25 years. The allowable range was specified as between 4 and 16 million kg. The initial estimate of the intrinsic population growth rate, r, was set at 0.25, which corresponded roughly with the results of two previous assessments (Henry and Martin 1992; MSAP 2003). It was allowed to range from 0.1 to 1.

1.3.2 Catches

Catch information was compiled from two sources, and data gaps were filled using a simple averaging algorithm. Catches from Trinidad spanning 1995-2002 were compiled from data that was available at the CRFM workshop. Earlier catches from Trinidad were taken from an earlier Trinidad Spanish mackerel assessment (Henry and Martin 1992). There were several years for which Trinidad catch information were not available at the stock assessment meeting (1974-75, 1979-80, 1983, 1986, and 1992-94). These gaps were filled using the average catches for up to three consecutive years before and after the gap. For example, the 1983 gap was filled by an average of catches from two years before and after because data from the third year was missing. Catches from the rest of the southern Caribbean and nearby Atlantic were taken from reports to the International Commission for the Conservation of Atlantic Tunas (ICCAT 2003; ICCAT 2004). Essentially, the data contained within these reports were updated to reflect updated landings from Trinidad (Figure 1).

1.3.3 Abundance Index

In the absence of fishery independent surveys, observer data, or adequate age-composition data, catch-per-unit-effort (CPUE) from the fishery is most often the best choice as an index of fish abundance. However, the use of fishery-dependent CPUE as an abundance index should be done with caution. Such use assumes that catchability stays the same over time but this may not be the case for two reasons. First, some fish stocks have the potential to maintain high CPUE as they decline, particularly stocks that form large aggregations (sardine REF). Second, fishing behavior may change, with the same gear used to target different species at different times. This second concern, at least, can be addressed to some extent by choosing a CPUE index carefully. Considerations for choosing a good index include finding a gear type that is used consistently to target the stock of interest and one from which extensive data exist.

Catch and effort data were available from Trinidad for several gear types (Figure 2). The CPUE indices from these gears showed some significant inconsistencies, requiring that either an average be used or some gears chosen over others. The gillnet fisheries were chosen because they are the most targeted gear at mackerels in Trinidad, and because they were the basis of data presented in the earlier assessment (Henry and Martin 1992). Consequently, their use facilitated inclusion of data from farther back in the history of this fishery (Figure 3). However, another limitation of this assessment was the fact that catch data was only available back to 1977. From 1977 to the present, CPUE appears to have declined (Figure 3). But, when earlier CPUE values are also viewed, it appears that 1977 was a spike in CPUE rather than the middle of a steady reduction (Figure 4). Finding and including earlier catch levels would allow the assessment to account for the earlier CPUE observations. This concern was addressed in the assessment to some extent in the consideration paid to setting the biomass levels in 1977.

1.4 ASSESSMENT RESULTS

1.4.1 Model Estimations of B_{1977}

The preliminary model run estimated the starting biomass (B_{1977}). It produced a model of the population which started a very high abundance, above average unfished levels, and brought it down to levels slightly above B_{MSY}, while fishing rates hovered near but rarely exceeded F_{MSY} (Table 1; Figure 5). This run showed generally good fit to the CPUE index from the Trinidad gillnet fishery (Figure 6). One thousand bootstrapped runs were also conducted using these same initial parameter estimates. The median biomass levels were quite similar from the bootstrap runs under the same starting parameter values (Figure 7). Under this scenario, the southern Caribbean Spanish mackerel stock appears to be above MSY biomass and below MSY fishing mortality rate levels. The status of the stock was sensitive to the estimates of catches, as indicated by the spread of values shown in different bootstrap runs (Figure 8). However, the median value was consistent with the base run and the spread of results were fairly narrowly constrained, yielding more confidence in the result.

This model did not match well with the results of the 1992 assessment, which indicated the stock in 1991 had dropped to levels of approximately 22 percent of unfished aboundance (Henry and Martin 1992), which would correspond to about 44 percent of B_{MSY} here. In contrast, these runs estimated the biomass to be from a couple to over 10 percent over B_{MSY} (Figures 5, 7). Because the previous assessment was based in part on size-composition data, the results were considered a useful benchmark by which to compare the current assessment. As a result, these runs were discarded in favor of models which fixed the initial biomass.

1.4.2 Models with B_{1977} Fixed at B_{MSY}

Further runs were conducted with the initial biomass levels fixed at B_{MSY}. The base run allowed an initial increase in biomass followed by declines to levels a bit below B_{MSY} (Table 1; Figure 9). This run also showed generally good fit to the CPUE indices (Figure 10). Although by definition the fit was not as good as when the model estimated B_{1977} (in which case it provided the best fit possible), the lack of fit was encouraging in that it was more consistent with the earlier CPUE data, which could not be incorporated directly into the assessment. The 1000 bootstrap runs produced similar results, with the median values only slightly more optimistic than the base model run (Figure 11). Under this scenario, the southern Caribbean Spanish mackerel stock appears to be a bit below MSY biomass and a bit above MSY fishing mortality rate levels. The status of the stock was sensitive to the estimates of catches, as indicated by the spread of values shown in different bootstrap runs (Figure 12). However, the median value was consistent with the base run and the spread of results were fairly narrowly constrained, yielding more confidence in the result.

These runs still overestimated 1991 biomass as compared to the 1992 Trinidad assessment, with these runs producing estimates of approximately 75% of B_{MSY} compared to 44% from that assessment. Nonetheless, this produced a closer match than the unconstrained B_{1977} model, discussed above. It should be nonetheless mentioned that the model is sensitive to the starting biomass level, a parameter surrounded by great uncertainty.

1.5 RECOMMENDATIONS

1.5.1 Research and Monitoring

(i) Earlier catches (back to 1972 or earlier if effort can be examined this far back)

(ii) CPUE measures from another part of the range of this stock. Age and size information—allow for comparing CPUE indices based on different selectivities, modeling different sectors of the fishery with this in mind (note gillnet vs handline, for example).

(iii) Spatial information—identifying key areas, understanding migration patterns and how fishing impacts in one part of the range may affect the fishery in another part.

1.5.2 Management

Scientific recommendations to managers should be shaped directly by the objectives managers want, or at least wan to consider, for a fishery. Absent such a framework within the Caribbean Regional Fisheries Mechanism (CRFM), some general analyses will be presented to guide consideration of management measures. In the future, it is strongly recommended that managers consider and specify management objectives. They may benefit in this process by discussion with scientists, who can help to point out the many socioeconomic and biological effects that fishing may have. In the future, it will also be helpful if managers can specify one or more alternative management procedures to be studied. These procedures establish specific rules that would govern catch limits based on the perceived status of a stock. Their detailed specification is invaluable in simulating future states of the fishery.

In the meantime, we can provide some broad advice about three general procedures: status quo (continuing fishing at current fishing mortality, and presumably, effort rates); F_{MSY} (reducing fishing mortality rates to the best estimate of the rate that would produce MSY); and 75 percent of F_{MSY}, a rule that governs a number of fisheries in the US because it provides a precautionary buffer against uncertainty but only requires a small sacrifice in long-term yields. The performance of each strategy was considered using projections of the fixed B_{1977} bootstrap runs. These runs produced a range of estimates for how catches and fish stock biomass would change into the future (Figs. 13-15).

These runs can be summarized using performance indices, which identify the strengths and weaknesses of management alternatives (Sladek Nowlis 2004). These indices should reflect the values that the public want to achieve from a fishery and the ocean ecosystems that support it. Absent more detailed objectives, we used seven indices that illustrated the relative strengths of the three management procedures in terms of short- versus medium- versus long-term concerns (Table 2).

Short-term concerns were quantified as the loss in catch that would be required to implement each of these policies. By its very nature, the status quo did not require any catch reductions. The F_{MSY} policy required moderate reductions while the $0.75F_{MSY}$ required more extreme reductions in the first year of implementation.

Medium-term concerns were quantified by comparing the catch expected after 10 years of policy (in 2012) compared to what they were in the last year of data, 2002. In addition to quantifying the losses that would be expected under the best model estimate, we also looked at what losses had 25% and 10% chances of being met or exceeded. In these comparisons, the three policies were more similar. In fact, the performance of status quo and F_{MSY} were essentially identical (although note that status quo would be in the process of dropping while F_{MSY} would be on the rise). The $0.75F_{MSY}$ policy produced lower catches in the medium-term but the differences were not great.

In the long-term, one could simulate catches past 10 years but doing so may seem of less relevance to managers because of the uncertainties involved. Alternatively, the long-term performance can be inferred by the stock biomass levels in 2013. As with future catches, we examined both the most likely estimate of stock biomass and levels that the stock had 25% and 10% chances of dropping to or below. In this long-term measure of success, the most conservative $0.75F_{MSY}$ policy outperformed the rest.

These analyses show that the status quo provides the best performance in the short-run and does relatively well in the medium-run, but is likely to produce problems in the long-run. In contrast, a conservative $0.75F_{MSY}$ policy would require short-term sacrifices, would continue to under-perform 10 years from now in terms of fish catches, but would provide the best long-term prospects for the southern Caribbean Spanish mackerel fishery.

1.6 REFERENCES

Henry, C, and L Martin. 1992. Preliminary Stock Assessment for the Carite Fishery of Trinidad. Technical Report of the Project for the Establishment of Data Collection Systems and Assessment of the Fishery Resources FAO/UNDP: TRI/91/001. Fisheries Division, Ministry of Agriculture, Land and Marine Resources, Trinidad and Tobago/Food and Agriculture Organization of the United Nations, Port of Spain (Trinidad & Tobago).

ICCAT. 2004. Report for the Biennial Period, 2002-03, Part II (2003), Vol. 2. International Commission for the Conservation of Atlantic Tunas, Madrid (Spain).

ICCAT. 2003. Report for the Biennial Period, 2002-03, Part I (2002), Vol. 2. International Commission for the Conservation of Atlantic Tunas, Madrid (Spain).

Mackerel Stock Assessment Panel (MSAP). 2003. Stock Assessment Analyses on Spanish and King Mackerel Stocks. NOAA Sustainable Fisheries Division Contribution SFD/2003-0008. National Oceanic and Atmospheric Administration, Miami, FL (USA).

Prager, MH. 1994. A suite of extensions to a nonequilibrium surplus-production model. Fishery Bulletin 92: 374-389.

Sladek Nowlis, J. 2004. Performance indices that facilitate informed, value-driven decision making in fisheries management. Bulletin of Marine Science, in press.

Table 1—Parameter values associated with different model runs.

Parameter	Base run, B_{1977} estimated	Bootstrap, B_{1977} estimated	Base run, B_{1977} fixed at B_{MSY}	Bootstrap, B_{1977} fixed at B_{MSY}
B_{1977}/B_{MSY}	2.356		1	1
MSY (kg)	7.811 m		7.858 m	
R	0.396		0.4077	
K (kg)	78.90 m		77.10 m	
B_{MSY} (kg)	39.45 m		38.55 m	
F_{MSY} (/yr)	0.198		0.2038	
B_{2003}/B_{MSY}	1.289	1.283 (median)	0.8436	0.8977 (median)
$F2002/F_{MSY}$	0.7646	0.7614 (median)	1.167	1.087 (median)

Table 2—Performance Indices.

Performance Indices	Strategy		
	Status quo	Fmsy	0.75Fmsy
SHORT TERM Catch loss 2003 from 2002	0%	13%	33%
MEDIUM TERM Catch loss 2012 from 2002 no error 25% chance 10% chance	 1% 16% 32%	 1% 17% 32%	 9% 24% 38%
LONG TERM Biomass in 2013 rel. to B_{MSY} no error 25% chance 10% chance	 83% 62% 48%	 98% 74% 59%	 120% 94% 79%

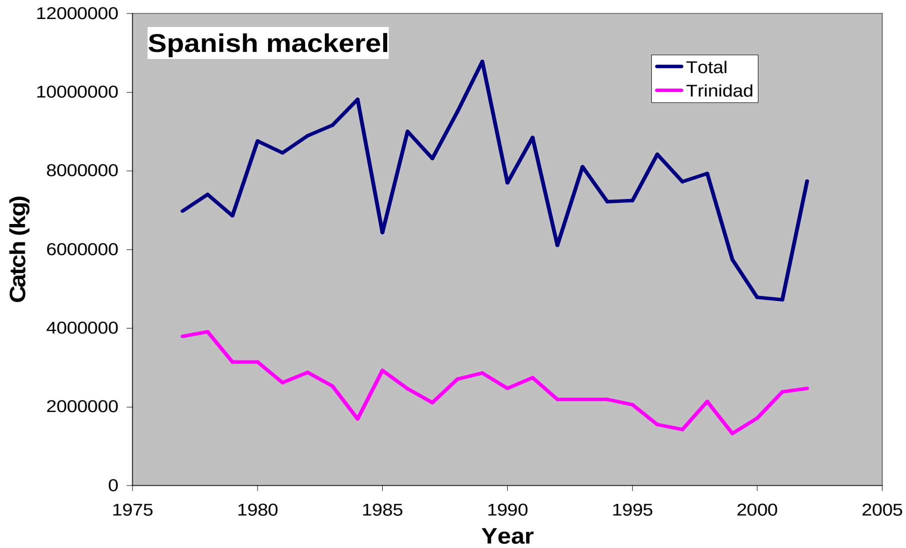


Figure 1. Catches from Trinidad (pink) and from all of the southern Caribbean and surrounding Atlantic (blue).

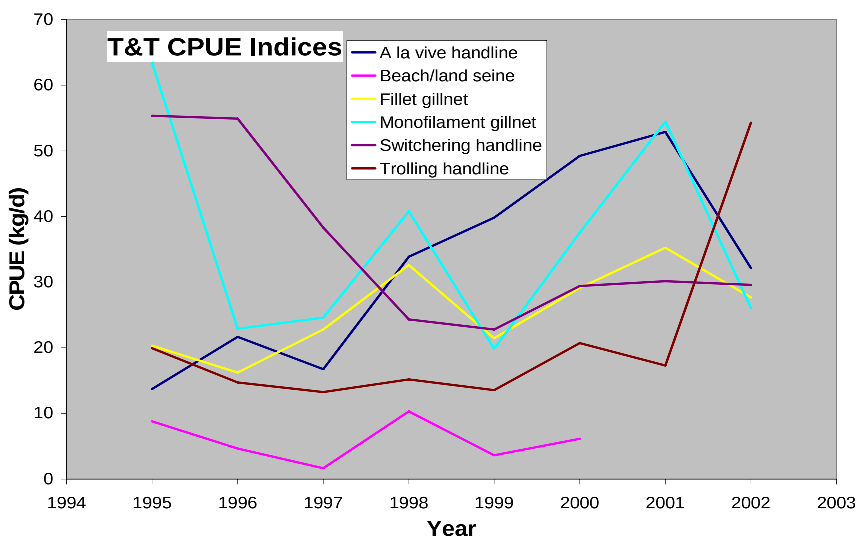


Figure 2. Catch Per Unit Effort Indices from Trinidad. CPUE measures, as an estimate of abundance, varied among different gear types used to catch Spanish mackerel

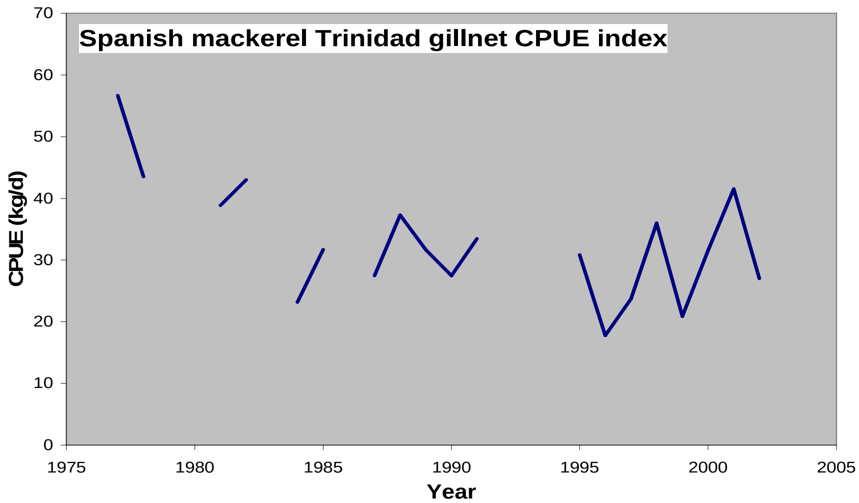


Figure 3. Catch Per Unit Effort from the Trinidad gillnet fisheries, 1977-2002.

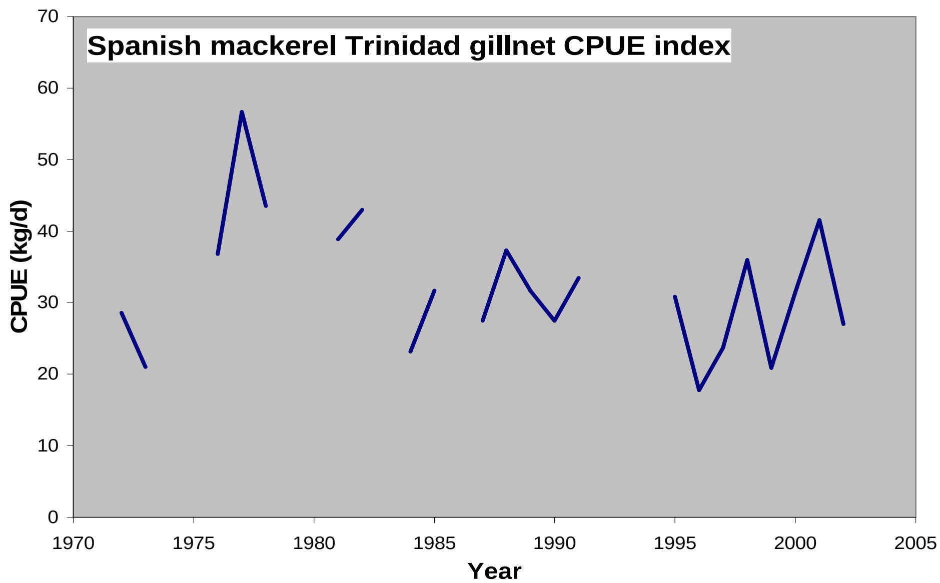


Figure 4. Catch Per Unit Effort from the Trinidad gillnet fisheries, 1972-2002. This figure illustrates that the apparent decline in abundance in 1977 may reflect an upswing in the population then rather than a persistent reduction.

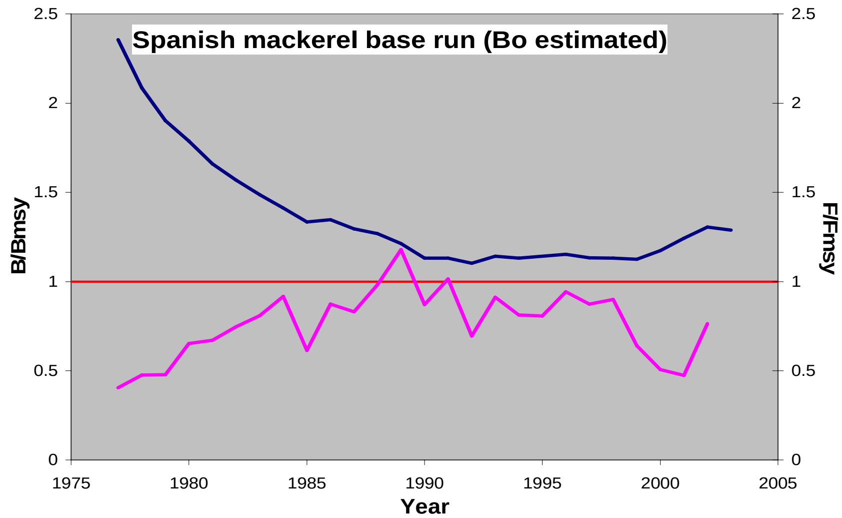


Figure 5. Base Run with B_{1977} Estimated in the Model. The blue line shows the biomass history, the pink line shows the fishing mortality rate history, and the red line indicates MSY levels.

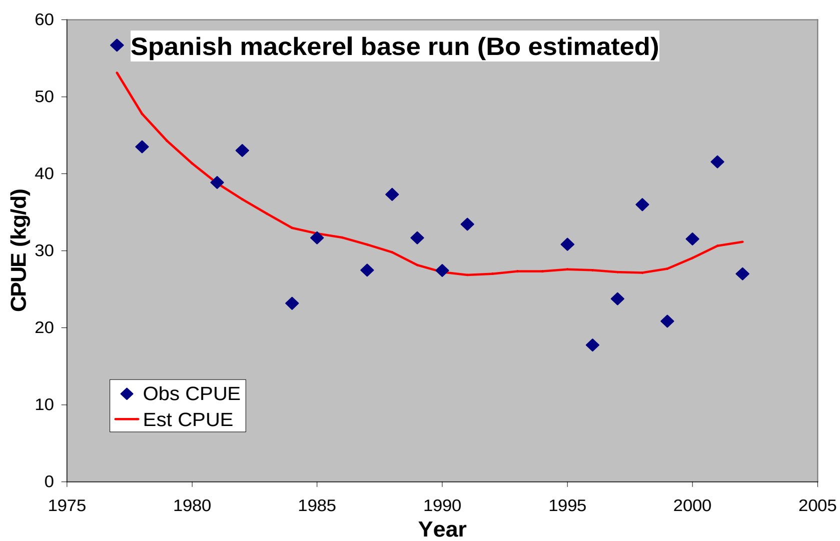


Figure 6. Fit of Base Run with B_{1977} Estimated to Trinidad gillnet CPUE Index. Blue points show observed values while the red line shows the values achieved in the fitted model.

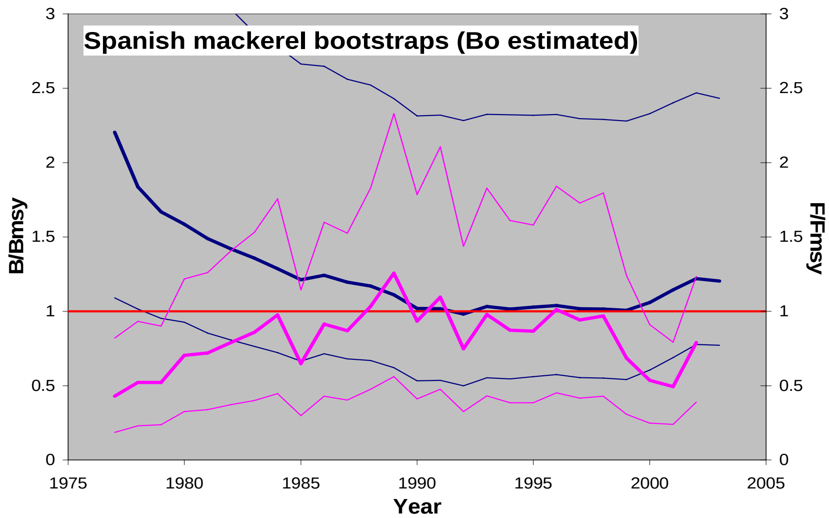


Figure 7. Median of Bootstrap Runs with B_{1977} Estimated in the Model. Blue lines show biomass histories, pink ones show fishing mortality rate histories, and the red line indicates MSY levels. Among the biomass and fishing mortality rate lines, the heavier line shows median values while the lighter lines show 80% confidence intervals.

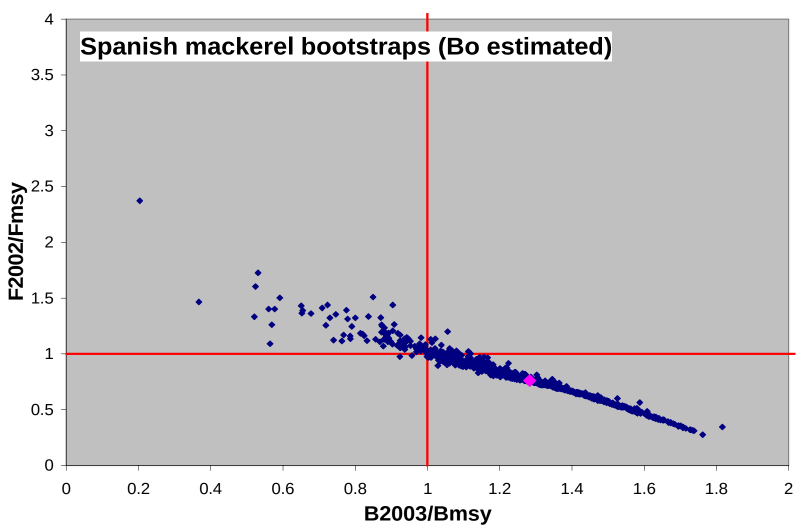


Figure 8. Variation in Present Status among Bootstrap Runs with B_{1977} Estimated in the Model. Each blue point represents a different bootstrap run, while the pink point represents the median values from all 1000 runs.

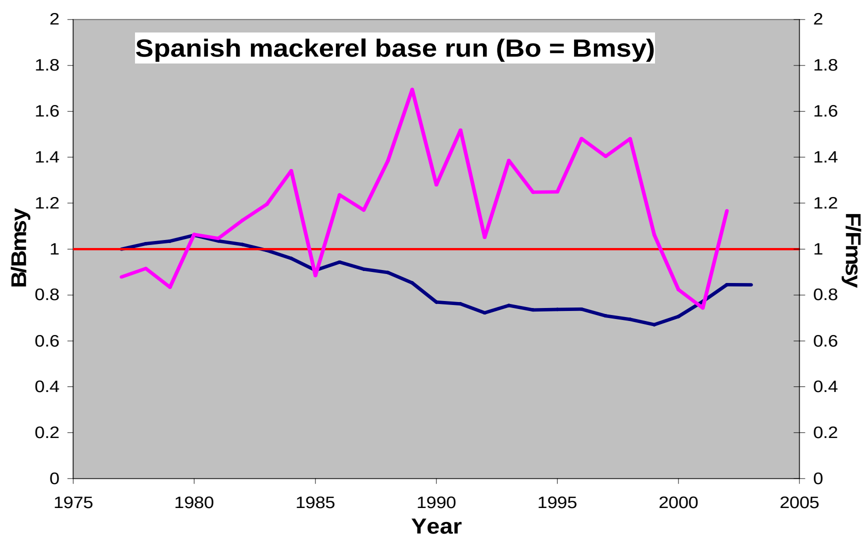


Figure 9. Base Run with B_{1977} Fixed at B_{MSY} in the Model. The blue line shows the biomass history, the pink line shows the fishing mortality rate history, and the red line indicates MSY levels.

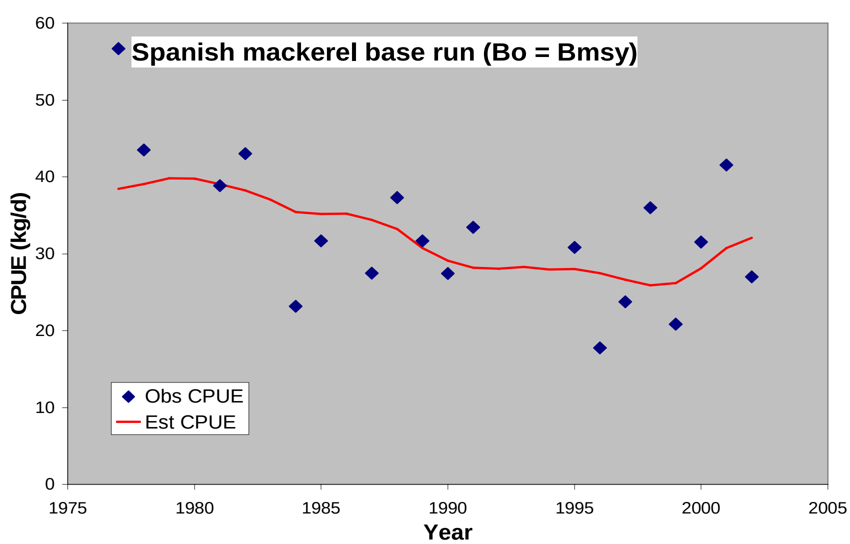


Figure 10. Fit of Base Run with B_{1977} Fixed to Trinidad gillnet CPUE Index. Blue points show observed values while the red line shows the values achieved in the fitted model.

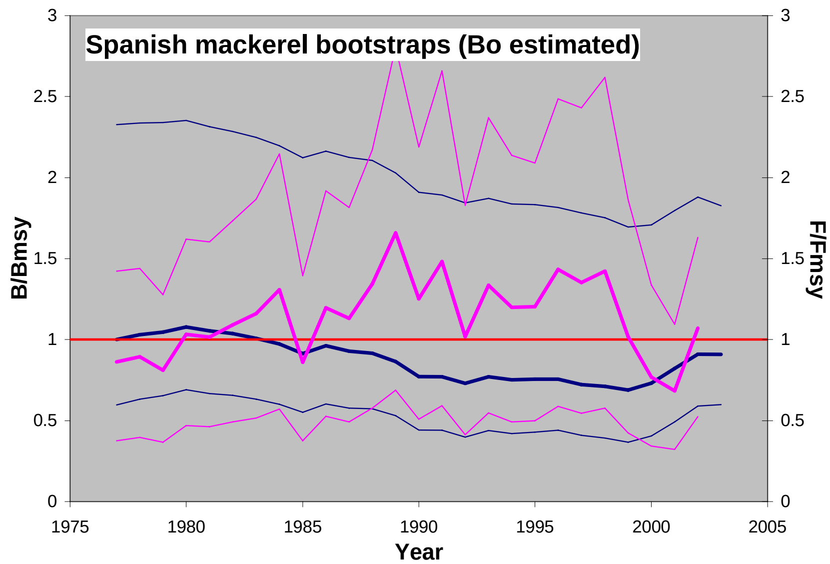


Figure 11. Median of Bootstrap Runs with B_{1977} Fixed at B_{MSY} in the Model. Blue lines show biomass histories, pink ones show fishing mortality rate histories, and the red line indicates MSY levels. Among the biomass and fishing mortality rate lines, the heavier line shows median values while the lighter lines show 80% confidence intervals.

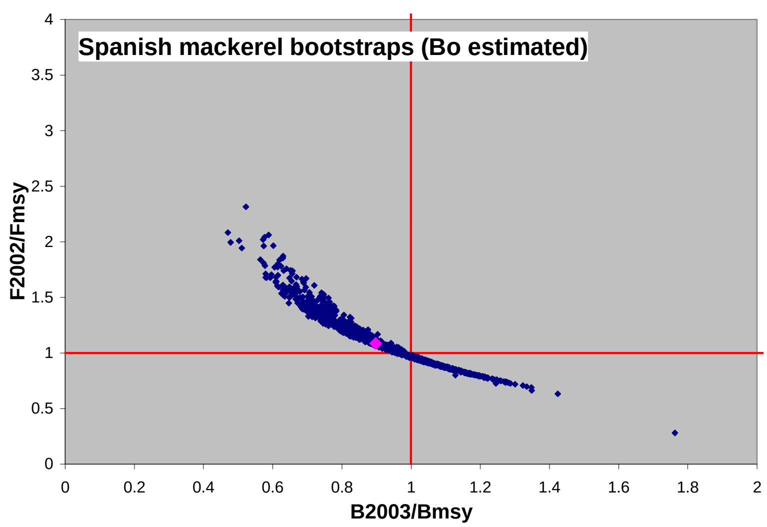


Figure 12. Variation in Present Status among Bootstrap Runs with B_{1977} Fixed at B_{MSY}. Each blue point represents a different bootstrap run, while the pink point represents the median values from all 1000 runs.

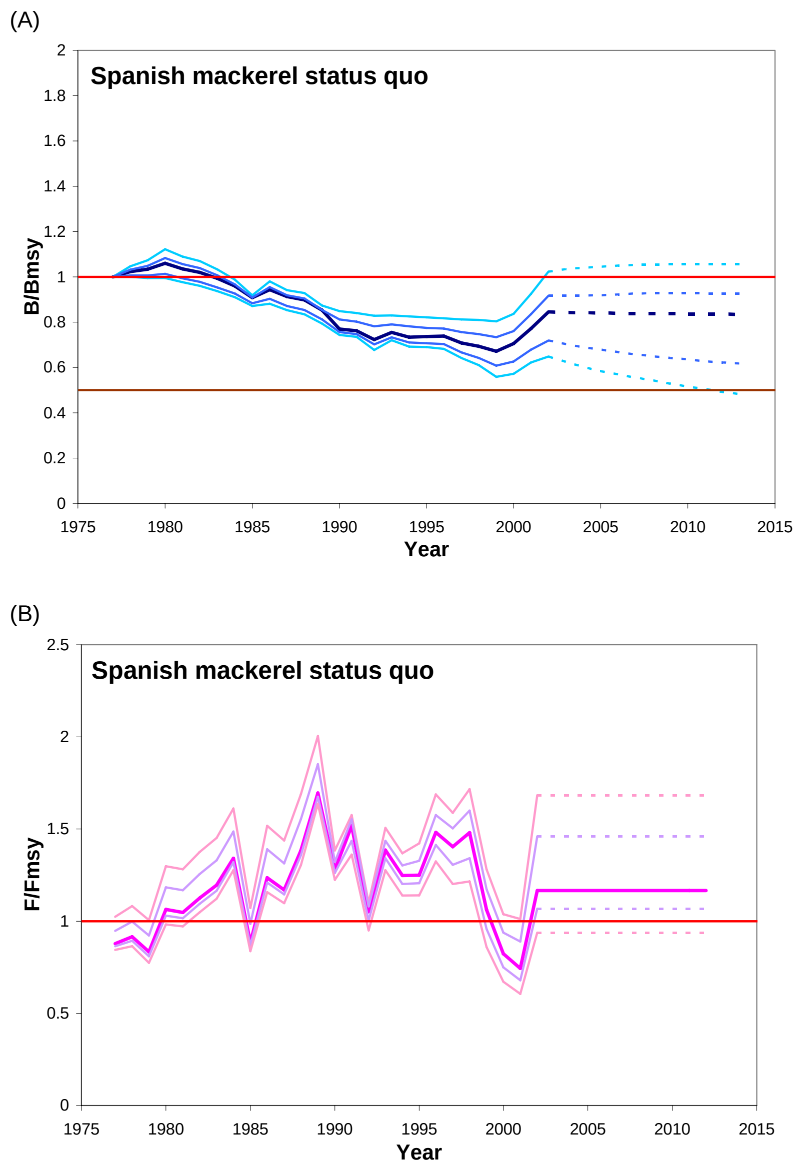


Figure 13. Projections under Status Quo. (A) Biomass relative to B_{MSY}. (B) Fishing mortality rate relative to F_{MSY}. Solid lines are estimates, while dotted lines are projections into the future. The thick middle line represents the median estimate, while paired lines above and below show confidence intervals. The inner pair of lines show 50% confidence intervals, meaning that 25% of all runs fell above the upper line and 25% below the lower line. The outer pair of lines show 80% confidence intervals, meaning that 10% of all runs fell above the top line and 10% below the lower line.

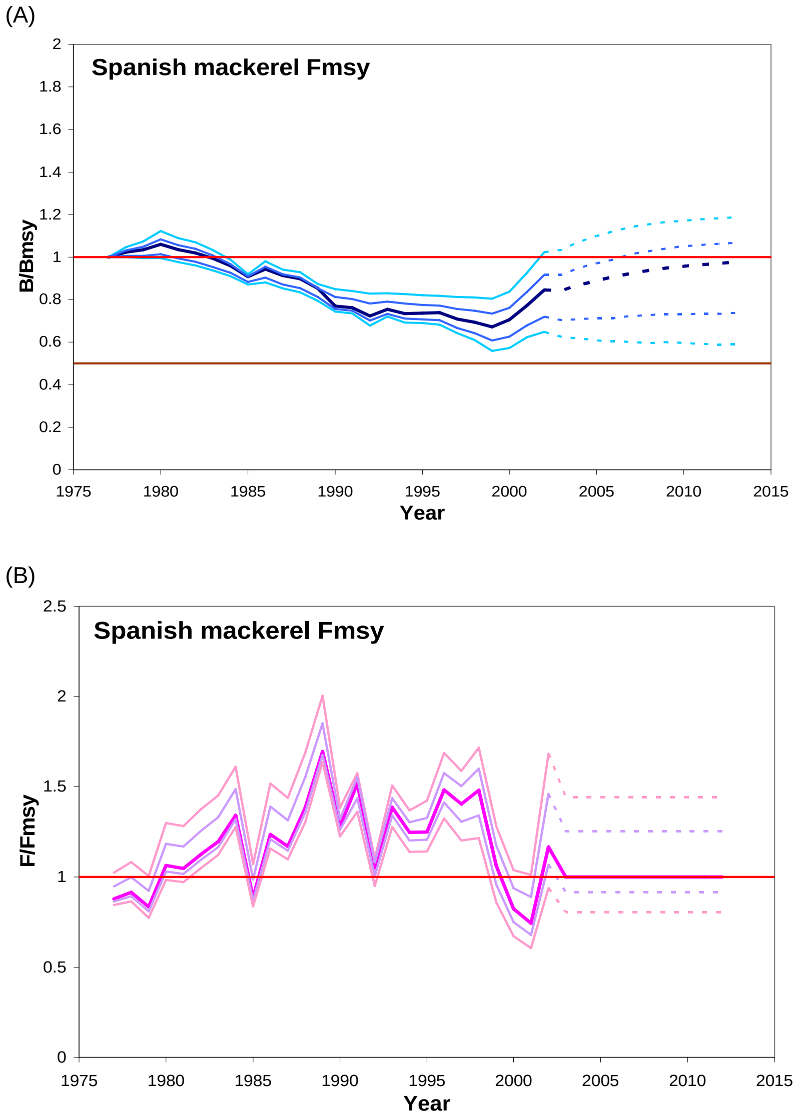
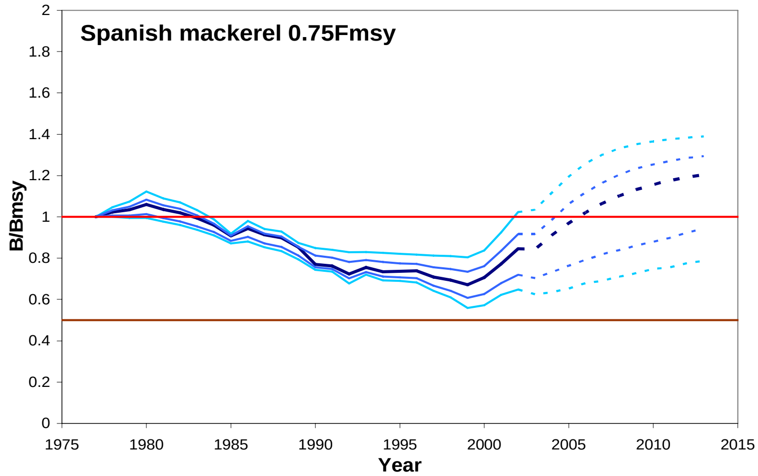


Figure 14. Projections under F_{MSY}. (A) Biomass relative to B_{MSY}. (B) Fishing mortality rate relative to F_{MSY}. Solid lines are estimates, while dotted lines are projections into the future. The thick middle line represents the median estimate, while paired lines above and below show confidence intervals. The inner pair of lines show 50% confidence intervals, meaning that 25% of all runs fell above the upper line and 25% below the lower line. The outer pair of lines show 80% confidence intervals, meaning that 10% of all runs fell above the top line and 10% below the lower line.

(A)



(B)

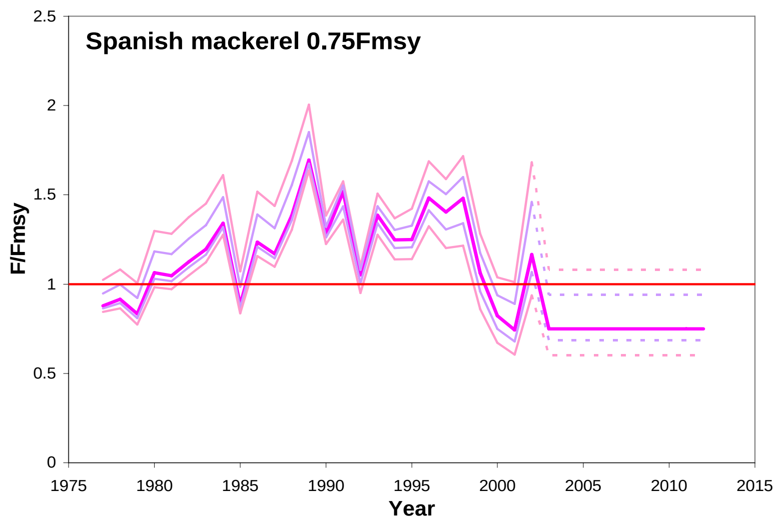


Figure 15. Projections under $0.75F_{MSY}$. (A) Biomass relative to B_{MSY}. (B) Fishing mortality rate relative to F_{MSY}. Solid lines are estimates, while dotted lines are projections into the future. The thick middle line represents the median estimate, while paired lines above and below show confidence intervals. The inner pair of lines show 50% confidence intervals, meaning that 25% of all runs fell above the upper line and 25% below the lower line. The outer pair of lines show 80% confidence intervals, meaning that 10% of all runs fell above the top line and 10% below the lower line.

2. Wahoo (*Acanthocybium solandri*) fishery - Eastern Caribbean

Rapporteurs: Christopher Parker, Dan Hoggarth, and Elizabeth Mohammed

2.1 MANAGEMENT SUMMARY

2.1.1 Policy and objectives

Several member countries of the Caribbean Regional Fisheries Mechanism are interested in expanding their large pelagic fisheries (FAO, 2003), including wahoo (*Acanthocybium solandri*) where possible. For most countries, the management objectives for wahoo specifically, were not available to the authors at the time of writing. As a result, the CRFM Large Pelagics Working Group requests guidelines from the CRFM Fisheries Forum on the individual country management objectives for the wahoo to direct future stock assessments and further refine management recommendations for the species.

2.2 STATUS OF STOCKS

Total wahoo catches in the western tropical Atlantic has raised gradually since 1960, from about 100 t, to a recent peak of 1400-1600 t in the late 1990s. Catch rates (standardised catch per trip) of wahoo in the eastern Caribbean have fluctuated between about 13 and 27 kg/trip, without a clear trend, over the period 1995 to 2003. Current biomass could not be accurately estimated using the data available, but recent catches are assumed to be sustainable since catch rates have not declined at these levels of harvest.

2.3 MANAGEMENT ADVICE

Using standardised catch/trip as an index of abundance, the wahoo stock appears not to have declined over recent years. However due to the limited data available, the assessments cannot be considered robust enough to predict the long-term sustainability of the fishery at current or increased levels of exploitation. Therefore, a precautionary approach should be adopted in managing this fishery whereby no large increases above present fishing pressure are recommended until stock dynamics are better understood.

For this wide-ranging species, effective control of exploitation levels will require the cooperation of all entities harvesting wahoo within the stock's presumed geographic range (from north east Brazil to Rhode Island, USA). No national or regional regulations are currently in place for the commercial exploitation of wahoo in any part of its range. Although ICCAT provides regional coordination for Atlantic tunas, no specific regulations are set for wahoo, which, on a wider-regional scale, is one of the less important stocks. Barbados, and Trinidad and Tobago are contracting parties to ICCAT and are thus bound by any country quotas or minimum sizes set for other species. Given the importance of wahoo to the Eastern Caribbean CRFM countries, and the assumption of a widely distributed and shared stock, it is proposed that CRFM assume responsibility for coordination of regional assessment and management of wahoo, in collaboration with other Caribbean states and ICCAT. Once the mechanisms for collaboration in management are in place, appropriate management measures which consider the trade-offs between meeting individual country needs and stock conservation can be agreed upon for implementation.

Data collection systems, specifically for catch and effort statistics, must be improved or implemented to refine future stock assessments. Given the importance of historical information in assessing the present stock status individual countries must be encouraged to "mine" existing information, to extend the historical time series of catch rate data. It is recommended that the CRFM continue to monitor catch trends at a regional level and coordinate more intensive stock assessments. However, individual countries must also be encouraged to track the catch trends of their own fishery to allow early detection of any changes that may signal stock decline. In the event that catches or catch rates decline, the CRFM should encourage collaboration among countries to achieve consensus on the appropriate management strategies to be adopted.

2.4 STOCK ASSESSMENT SUMMARY

Contrary to the previous assessment of George et al (2001), the available wahoo length frequency data was interpreted as having limited value for stock assessment. Some samples in Dominica and St Lucia showed the capture of 30-70cm fish in the 3rd and 4th quarters of the year, assumed to be the entry of new-year classes. The samples taken in the 1st and 2nd quarters comprised mostly medium-sized wahoo of around 70-100cm. Fish above 100cm were uncommon in the eastern Caribbean, but were reported in rod and reel samples provided by ICCAT for the Gulf of Mexico and northern Caribbean / eastern US waters. The relative absence of large fish in the eastern Caribbean length frequency data was interpreted as due to emigration from the sub-region rather than the very high mortality rates assumed by George *et al* (2001).

Assuming that the length frequency data would not provide reliable mortality rate estimates, the stock was assessed using a non-equilibrium surplus production model. This attempted to estimate the maximum sustainable yield (MSY) for the western Atlantic fishery based on the estimated average catch rates from vessels in eastern Caribbean CRFM countries since 1994, and the FAO statistics of total catches taken by all countries in the western tropical Atlantic since 1960. To correct for differences in months sampled and vessel characteristics in the five countries (Dominica, St Lucia, St Vincent, Grenada and Barbados) catch rates were standardised to an annual regional average. . Due to the short time series of catch rates available, the analysis proved unable to accurately predict the model parameters (*K: carrying capacity, r: population intrinsic growth rate* and *q: catchability coefficient*). As a result, the MSY could only be estimated approximately as the peak catches taken in 1997-1999 (i.e. 1400-1600 t). Total regional catches in 2000-2002 have fallen slightly below this level, largely due to reported reductions in catches taken by Venezuela.

2.5 STATISTICS AND RESEARCH RECOMMENDATIONS

The working group examined approximately 17 000 length frequency measurements and 24 500 fish catch records, as sampled by the CRFM countries between 1995 and 2003. Following are a number of recommendations (not prioritized) to be addressed by the CRFM and individual countries for improvement of the quality of future assessments:

Recommendations for the Caribbean Regional Fisheries Management

1. Encourage participation and collaboration of non-CRFM territories e.g., Venezuela, USA, Netherland Antilles in stock assessments. The current assessment could be improved significantly if historical information on catch per unit of effort or effort were available for some of these countries e.g., Venezuela and the USA. Contradictions between Venezuelan

wahoo landings in the ICCAT and FAO databases introduced additional uncertainty in the assessment. As well, wahoo catches from Martinique and Guadeloupe could not be incorporated in the analysis as the data were reported, along with catches of other species, in an aggregate "unidentified fish" category. Collaboration among all countries harvesting wahoo would serve to clarify discrepancies, improve data quality and ultimately improve upon future analyses and associated management recommendations.

2. Coordinate systems (e.g., logbook and/or observer) for recording more refined estimates of fishing effort among countries (e.g., linking catches to gear type; identifying when there is a switch in target species), estimation of total catches from recorded data, and validation of data before submission for consideration in assessments.
3. Monitor trends in regional catches and catch rates to identify signs of stock decline and promote regional collaboration on appropriate management strategies to be implemented.
4. Provide continued support to the IMA for validation of presumed annual growth rings to facilitate otolith based ageing of wahoo aimed at providing information on the age structure of catches and refined estimates of growth parameters for future assessments.
5. Prioritise, based on commercial importance and collaboration with harvesting countries, the species to be assessed and the frequency of assessments e.g., unless otherwise indicated stock assessments should be repeated on bi-annual basis and given the close association between the dolphinfish and wahoo fisheries, it is suggested that similar assessments on dolphinfish be alternated with wahoo.
6. Encourage and assist countries with development of a regional database on historical catches and fishing effort, extending prior to the commencement of the CARICOM Fisheries Resource Assessment and Management Programme in the early 1990s. This exercise will involve intensive data mining from scientific, historical and administrative documents (published and grey literature) designed to expand the time series of available data, improve the contrast in the data set and contribute to improved parameter fitting in assessment models.

Individual countries

1. Monitor trends in national catches and catch rates to identify signs of stock decline and promote regional collaboration on appropriate management strategies to be implemented.
2. Provide data on total catches of wahoo (estimated from landings data), in the format and level of detail required by the CRFM for incorporation in stock assessments.
3. Provide more detailed information on fishing effort associated with each catch record e.g., in addition to "number of trips" data on the boat specifications (type, size, etc.), type and number of gear as well as number of hours fishing or the number of hooks used can facilitate improved estimates of catch per unit of effort and fish abundance. Estimates of effort can be further refined by consideration of trips with zero catches. Future analyses should take into account 'zero' catch trips to improve estimates of total fishing effort. Where necessary, revisions to sampling strategies should be considered to improve estimates of fishing effort and fish abundance.
4. Conduct extensive review of historical data (data mining) aimed at providing information on historical catch rates and catches to improve fitting of model parameters in future assessments.
5. Adjust biological sampling programmes (length frequency and aging), in collaboration with the CRFM, so that all size/age ranges in the catches are sampled without bias to any specific gear. In countries where only large-medium sized wahoo are caught giving unimodal frequencies, unless of particular value to the country, length frequency sampling of wahoo should be discontinued, as these samples are not useful for either growth or Z estimation. If and when otolith ageing techniques are validated, countries should send more samples for aging, e.g. every 2-3 years, based on standardised (minimum selectivity) sampling methods, to be used to estimate mortality rates. Such estimations should take account of presumed

wahoo migration patterns and should include samples from areas inhabited by larger wahoo. Length frequency data from fishing tournaments should also be examined to determine possible biases in analysed samples from the commercial fleets.

6. Submit current fleet information to CRFM outlining on-going and historical developments to allow elucidation of the effects of changes in the fleet and fishing methods on catches.

2.6 SPECIAL COMMENTS

None.

2.7 POLICY SUMMARY

2.7.1 Fishing activity

A description of the fishery in the eastern Caribbean is taken from George *et al,* 2001. The fishery for wahoo (*Acanthocybium solandri*) in the eastern Caribbean, and particularly off the Windward Islands and Barbados, is primarily small-scale. Eastern Caribbean fisheries operate mainly along the eastern side of the Windward Islands, to the south and west of Barbados and off the north and northeastern coasts of Trinidad and Tobago. In most countries it appears that the majority of catches in the commercial fishery are incidental rather than directed. Additionally, the species is captured in the recreational fisheries of several eastern Caribbean islands and is a target in some fishing tournaments. Oxenford *et al* (2003) provide additional information on fisheries throughout the distribution range of the species within the Atlantic.

In the eastern Caribbean, fishing vessels range from small open boats and fibreglass pirogues, with outboard engines, to the larger inboard diesel-powered day launches in Barbados and pelagic iceboats of both Barbados and Tobago. Since the mid-1980s, several islands of the eastern Caribbean have expanded their offshore fisheries for large pelagic species utilizing longlines. Larger pirogues and decked vessels using mechanized mid-water and surface-set longlines with 3 to 10 miles of line and 100 to 500 hooks are employed (George *et al.*, 2001). Wahoo is captured as by-catch in this fishery, which mainly targets large tunas.

The primary gear is hook and line, deployed using either trolling or handlining techniques (George *et al*., 2001). Between one and three lines (36 to 55m, 54.5 to 72.73 kg tested monofilament line) are used simultaneously on a single trolling trip. Although each line may carry one to three hooks, most often only one hook is used. Handlines may have several hooks to each line and a variety of hook types and sizes are used throughout the islands. Hooks are baited with either fresh bait (dead) and/or artificial lures. The fishery is seasonal, occurring mainly between November and July.

Fishers often use seabird congregations and drifting objects to find aggregations of large migratory pelagics, including wahoo. George (2001) states that an average trip length of pirogues and dayboats is about 8 to 12 hours, inclusive of travel and search time. Average trip lengths for iceboats range between 4 days (Tobago) and 7 days (Barbados), while longliners may stay out at sea for several days.

2.7.2 Biology

Wahoo (*Acanthocybium solandri*) is a large, migratory pelagic species, distributed in both tropical and circum-tropical waters of the Atlantic. It is a relatively fast-growing species, particularly in the first year of life. Longevity is estimated at between five and six years, but may be as much as ten years according to Kishore and Chin (2001). Estimates of asymptotic length range between 1410mm TL to 2210mm FL and length at maturity ranges between 934mm FL and 1020mm FL, for the species in the Gulf of Mexico, North Carolina and Bermuda. Maturity is reached within the first year of life. The species exhibits an extended spawning season, between May and October. It is piscivorous, feeding mainly on scombrids, exocoetids, clupeids, cephalopods, and to a lesser extent species associated with floating material. Oxenford *et al*. (2003) give a detailed account of the biology of the species.

2.7.3 Distribution, Migration and Stock Structure

The following information on distribution, migration and stock structure of wahoo has been summarised from a synopsis on the biology of the species by Oxenford et al (2003). In the context of a stock assessment the distribution, migration and stock structure of a species define the geographical limits of the management unit. Specifically in the Western Central Atlantic (WCA) the distribution of the species ranges from as far south as the northeast coast of Brazil, to as far north as Rhode Island in the USA.

Although little is known about the movements or migration patterns of wahoo in the WCA, it is believed that in the northern part of the WCA the species migrates through the Florida Straits along the Gulf Stream during the early spring, with peak migration in late July and early August. Based on analyses of landings data in the WCA, it is presumed that wahoo move seasonally, extending into cooler waters in warmer months, and are migratory within and beyond the Exclusive Economic Zones of countries within the WCA region (Oxenford *et al*, 2003). It is also possible that the species utilizes the Bermuda seamount as a seasonal feeding area, as presumed for both yellowfin tuna and blackfin tuna. There are opposing views regarding migration of the species within the eastern Caribbean. Neilsen *et al.* (1999) suggested year-round recruitment to the fishing ground with highly migratory behaviour and the possibility of a similar pattern of movement as dolphinfish (*Coryphaena hippurus*). However, George *et al* (2001) suggested migration of older fish beyond the southeastern Caribean region at the end of the peak fishing season. Their observation of a steady decrease in mean length of wahoo caught northwards over five islands in the southeastern Caribbean is also inconsistent with that observed for dolphinfish.

Generally, due to the limited data available, the stock structure of wahoo is uncertain. However, several authors (Hunte, 1987; Mahon, 1990 and 1996; Neilson et al., 1999 as cited in Oxenford *et al.*, 2003) consider the likelihood of a shared stock within the Western Central Atlantic (WCA), either straddling or migrating between the EEZs of two or more countries, as a reasonable assumption. Genetic studies support the single unit stock hypothesis and further suggest that the stock boundary extends beyond the WCA (Constantine, 2002 as cited in Oxenford *et al*., 2003).

In this assessment the Western Tropical Atlantic region, as specified by the International Commission for the Conservation of Atlantic Tunas (ICCAT), was taken as the geographical range for management of the species associated with the fishery in the eastern Caribbean.

2.7.4 Fishery Management

There are no active management regulations specifically for wahoo in any of the southeastern Caribbean countries. Statistics on wahoo are reported to and collated by ICCAT, but no stock assessments have been carried out or any specific international regulations proposed.

In the US, the South Atlantic Fishery Management Council in cooperation with the Mid-Atlantic and New England Fishery Management Councils developed a comprehensive fishery management plan for both dolphin and wahoo in the Atlantic. The Dolphin/Wahoo Fishery

Management Plan was approved in December 2003 and the final rule implementing the regulations for Federal waters became effective on May 27, 2004. The suite of regulations was implemented in three tranches in July, September and November 2004. Under these regulations, by December 2004, the US wahoo fishery is subject to: Gear restrictions (only hook and line and spearfishing gear may be used; longline gear may not be used to take the animals in areas where use of that gear is prohibited for highly migratory species); regulated access (owners, dealers and operators of charter boats, headboats and commercial vessels must have permits and may be required to submit reports on their activities); compliance with sea turtle protection measures; catch regulation (catches are limited to 500lbs of wahoo per trip and 200lbs of dolphin and wahoo combined for commercial vessels fishing North of 390^{o} N latitude without a Federal commercial vessel permit).

2.8 SCIENTIFIC ASSESSMENTS

2.8.1 Summary of previous stock assessment work

The 2000 wahoo assessment (George *et al,* 2001) used mainly a length-based approach, which included the following methodologies:

- Growth rates estimated from Modal Progression Analysis followed by Linking of Means in 'FiSAT' (L_{inf} = 203.5cm, K = 0.47 year^{-1}).
- Total mortality rates (Z) estimated from length-converted catch curves for 1996 (5.41 year^{-1}) and 1997 (4.58 year^{-1}).
- Natural mortality rate (M) estimated using Pauly equation (0.63 year^{-1}).
- Length at first capture (selectivity) from the catch curve method (L_c = 90.4cm).
- MSY = 2 137 t and F_{MSY} = 0.34 year^{-1} estimated from the Thompson and Bell predictive length based model.
- Target harvesting rates estimated from length based Thomson and Bell YPR model (F_{max} = 1.09 year^{-1} and $F_{0.1}$ = 0.37 year^{-1}; $F_{30\%SPR}$ = 0.68 year^{-1} and $F_{40\%SPR}$ = 0.47 year^{-1}).

Based on the fishing mortality rates estimated tentatively as F = Z-M = 3.98 year^{-1}, George *et al* (2001) concluded that the fishery was overexploited and that existing levels of fishing effort (and resulting fishing mortality) were not sustainable.

2.8.2 Length frequency data analysis

2.8.2.1 Objective

Length frequency data were examined to determine their potential value to the wahoo stock assessment and to search for evidence of migration patterns around the Caribbean region.

Based partly on the same data, George et al (2001) reported smaller fish between August to December in the two most northerly islands of the data set, Dominica and St Lucia.. These observations were based on a GLM analysis, with mean sizes presented, but not the 'raw' length data.

2.8.2.2 Data used

Wahoo length frequency data were examined from TIP-entered data sets for five Eastern Caribbean countries (Barbados, Dominica, Grenada, St Lucia, St Vincent and the Grenadines) (Table 1). No data were available for Trinidad or Tobago. Length frequencies were taken from three gear types: handlines; troll lines and bottom longlines (palangue). Most data were available for 'hand lines' (Barbados and Dominica) and troll lines (Grenada, St Lucia and St Vincent). In most cases, it is believed that samples recorded from 'hand lines' could include 'trolling' catches, and vice versa since both gear types may be used on the same fishing trip, with no distinction in the associated trip records. Very small samples were also taken from bottom long lines (n=22). Since the lengths of fish taken by demersal longlines were similar to those from the other main trolling/handline gears (Table 2), data for all gears were combined for analysis.

Sample sizes were unevenly distributed over time and were highest for most countries from 1996 to 1998. After 1998, significant datasets were only available for St Vincent (Table 3). The largest monthly sample sizes were 455 and 509 in St Lucia and St Vincent respectively; most were much smaller than this.

Fish were measured as fork lengths in cm, and were grouped into 5cm length classes for plotting. Average sample sizes per month (for those months in which samples were taken) were 110, 34, 47, 173, and 102 for Barbados, Dominica, Grenada, St Lucia and St Vincent and the Grenadines respectively. Given the sample sizes and time series of available length data, samples were grouped in quarterly time periods for plotting. Due to the uneven sample sizes in different months and years, and time constraints during the meeting, length frequency data were not raised to the total numbers caught in each period (i.e., e.g. weighted by the TIP catch rate data). To view the growth of fish over time, the length frequencies were plotted against the time of sampling using the 'LFDA' software (published by MRAG Ltd and downloadable from the DFID Fisheries Science Management Programme website - http://www.fmsp.org.uk/).

Length frequencies were also examined from Martinique (submitted by L. Reynal, IFREMER), for three different types of trolling line (wire coastal lines - 'traine', wire sub-surface lines – 'traine fond' and monofilament surface lines – 'traine surface').

Data from the ICCAT 'Task I' database were also analysed. These included samples for the following countries recorded as landing wahoo in the Western Tropical Atlantic Region (WTRO): Bermuda; Cape Verde; USA and Venezuela. The annual data coverage varied among countries, gear types and fishing area. Fishing areas were specified according to those outlined by ICCAT for billfish i.e., BIL91; BIL92; BIL93; BIL94 and BIL96 (Figure 12). Fishing areas for Cape Verde, Bermuda and Venezuela were not specified. Attention was therefore given to length and weight frequency data available from US vessels utilizing longlines and rod and reel gear in areas BIL91 and BIL92. The associated data accounted for 78% of the 54,469 fish sampled between 1986 and 1999 for the four countries and six gear types (longlines, rod and reel, handlines, gillnets, mid-water trawls and trawls). Weight frequency data from longliners were available for 1987 to 1999 and length frequency data from vessels using rod and reel gear were available for 1986 to 1999. Of the combined 42,730 fish measured between 1986 and 1999, 82.6% were from longliners fishing in area BIL91, 9.4% from longliners fishing in area BIL92, 1.1% were from vessels using rod and reel gear in area BIL91 and 6.9% were from vessels using rod and reel gear in area BIL92. Given the time constraints for the analysis only the smaller rod and reel samples were used, however, future analyses may incorporate weight frequency data converted to the corresponding lengths using length weight conversion factors derived for the species in the region. Fish lengths in this ICCAT database were measured as 'curved' fork lengths, and no adjustment was made to standard lengths.

2.8.2.3 Results and discussion

The length frequency data for the CRFM countries showed both seasonal variations and differences between countries. The largest length frequency samples were available for the first and second quarters of each year, particularly in Barbados, Grenada and St Vincent (see Figures 1, 3, 5 and 6). Due to the seasonality of the fishery few fish were sampled in the third and fourth quarters. The length frequencies for these countries were mainly unimodal, with a mean size at around 90cm.

Smaller fish, less than about 70cm, were only present in significant numbers in the length frequencies for Dominica and St Lucia – the two countries reported by George et al (2001) as having smaller mean fish sizes. The Dominica length frequencies (Figure 2) showed these small wahoo, particularly in 1997 (year '1' as coded for the sample timing). Increasing mean sizes over the quarterly samples were observed each year in the St Lucia data set (Figure 4). These patterns may be interpreted as the growth progressions of cohorts of fish, probably spawned early in the same year in which they were sampled, or at the end of the previous year. Oxenford et al (2003) reported that wahoo appears to have an extended summer (May-October) spawning season. However, no studies of spawning behaviour have been reported from the eastern Caribbean and the breeding grounds are largely unknown. Illustrations of the possible growth patterns of wahoo are shown in Figures 7 and 8, based on the Dominica length frequencies, and in Figures 9 and 10 for St Lucia. In each case, the first plot shows the highest scoring fit to the length frequency data of a non-seasonal von Bertalanffy curve based on the 'SLCA' algorithm (see LFDA software help files for details of alternative fitting methods). The second plots (Figures 8 and 10 respectively) show curves fitted by eye through the largest modes in the data sets. Both fits provide reasonable interpretations of the limited available data, as do many other combinations of K and L_{inf}. Due to the lack of seasonal progressions growth curves were not fitted to data from the other countries.

If these interpretations of the growth patterns are correct, the single modes commonly seen in the length frequencies in the main fishing seasons in the first two quarters of the year represent mainly the age 0+ wahoo spawned the previous year. The relative absence of any fish above about 120cm may have at least three possible explanations. Firstly, larger wahoo may immigrate from the eastern Caribbean fishery to other parts of their range. Secondly, growth may not follow the von Bertalanffy pattern, but may instead slow down greatly after the fish reach maturity at around one year old (various authors in Oxenford *et al*, 2003). Thirdly, mortality rates (fishing and/or natural) may be so high in the eastern Caribbean that very few fish survive beyond one year old. Since observed catches were relatively low, the first two explanations seem more likely than the third.

The presence of small wahoo in samples from Dominica and St Lucia, and absence in samples from the three more southerly islands could be due to migration of young wahoo, in a north-south direction, as they grow in size. Differences may also be due to different fishing practices in the islands, though all of them are believed to take most fish by trolling. The data from Martinique (north of the five-island group) also showed small sizes in the catch (Figure 11), however, sample dates were not available. The length frequency samples for wahoo from the Gulf of Mexico (Figure 13) and Atlantic waters of the US and the northern Caribbean (Figure 14), captured by rod and reel gears show larger fish with average sizes over 100cm. It is assumed that the US rod and reel fishery has a similar size selectivity to the eastern Caribbean trolling fishery, and that the differences in fish sizes observed indicate real age differences in the portion of the stock distributed in the respective areas. .

If these interpretations of the length frequencies are correct, it is concluded that the length frequency data for the eastern Caribbean are unlikely to give reliable estimates of mortality parameters, e.g. using the length converted catch curve methods used with some caution by George *et al* (2001).

2.8.3 Total catches

2.8.3.1 Objective

Information on total catches was examined to determine the historical pattern of exploitation of the stock by different countries, and their relative importance in the fishery. Total catches may be used as a rough indicator of the likely fishing pressure on the stocks, bearing in mind that the variations in total catches over time may be due to changes in fishing effort, catchability (the efficiency of the fishing fleet) or stock sizes. Increasing total catches may thus reflect either good recruitment into the fishery, or increasing fishing pressure. Over short time periods, recruitment variability may be the main determinant of catch rate changes, while over a long time period, fishing pressure and catchability may be the main effects measured. Catch per unit effort data were also examined as indices of fish abundance (see following section).

2.8.3.2 Data used

Estimates of total catches from both the ICCAT and FAO databases (available on-line) were examined. Both sources showed broadly similar patterns, though with some important differences, as described below.

The ICCAT data show fish catches by country and fishing area from 1968. Catches are reported separately for the eastern and western tropical Atlantic, and for the northwest Atlantic and the Gulf of Mexico, corresponding to the stock distribution ranges of large tunas and billfishes assessed by ICCAT. Fishing areas were not explicitly defined by ICCAT for the wahoo (Papa Kebe, pers. com., ICCAT Head of Statistics Department). However, approximate boundaries can nevertheless be determined based on the spatial distibution of landings reported by the respective countries.

Wahoo catch data were also downloaded from the FAO FishStat+ database for 1960 to 2002. FAO catches are recorded separately for the main FAO reporting areas. For most of the time period, the FAO west central Atlantic appeared to contain equivalent data to the ICCAT 'WTRO' series.

2.8.3.3 Results and discussion

Total catches for the Atlantic are recorded by ICCAT as having increased from under 500 t in 1970 to a peak of over 3000 t in 1997 (Figure 15). High catches in the eastern tropical waters between 1991 and 1994 were nearly all taken by Cap Verde. In the western tropical waters, total catches peaked at just over 1500 t also in 1997, and are recorded as having declined since then.

Total catches in the western tropics are taken both by the countries in the eastern Caribbean (Figure 16) and in the southern Caribbean – Aruba, Netherlands Antilles and Venezuela (Figure 17). In the east, Barbados had the highest recorded landings throughout most of the 1980s, while St Lucia has dominated in more recent times. In the south, Venezuela catches increased up to 1200 t in the 1990s (Figure 17), but declined to almost zero in 2000. Catch data for Aruba and the Netherlands Antilles are lacking in variability and assumed to be reported only every few years.

The FAO catch data show a similar overall pattern of catches, with some important differences, summarised in Figure 18. Data are presented from 1960 to 2003 (the period of overlap in the FAO and ICCAT databases). However, the FAO catch time series extends further back, to 1950, for the southern Caribbean countries. In the 1979 to 1988 period, Barbados catches were recorded as 116-332 t per year by ICCAT but given as zero by FAO. Barbados catches were also zero in ICCAT records for 2001 and 2002, but given as 24 and 41 t by FAO. In 1988-1993, Grenada catches were 20-60 t per year higher in the ICCAT records than in FAO. In 2001, a 255 t catch in St Vincent in the FAO database was recorded as 'ATL' instead of WTRO by ICCAT, possibly representing 'foreign flagged' vessels fishing outside national waters. From 1990 to 2002 FAO give 1-78 t catches per year taken by US vessels, not incorporated in ICCAT records. Of most importance to the assessment, the 463 t crash in Venezuelan catches between 1999 and 2000 is only partly recorded in the FAO data set. While ICCAT records give Venezuelan catches from 2000 to 2002 as 4, 17 and 13 t respectively, the FAO database shows catches of 150, 297 and 275 t. As the major cause of the decline from the 'peak' catches in 1997, this uncertainty is potentially critical to any wahoo stock assessment.

Neither the FAO nor the ICCAT databases record wahoo from Martinique, though it is known that catches are taken. Catches reported by some countries are incomplete as they cover only a part of the likely history of the fishery, e.g. since 1990 for St Lucia. Although the accuracy of these catch data is open to debate, the general picture of increasing catches from low levels in the 1960s to 1000-1600 t in the 1990s is assumed to be broadly correct. Accurate time series should be sought directly from national sources for future analyses.

2.8.4 Catch rates (abundance indices)

2.8.4.1 Objective

Catch rate data (CPUE) from the fisheries were examined to provide an index of the abundance of the fish stocks. Data on fish abundance and total catches are used in 'biomass dynamic' or 'surplus production' modelling (see below) to estimate current stock sizes and maximum sustainable yield. CPUE data is only likely to provide a good index of abundance if fishing practices and locations have remained relatively constant over time, such that the catchability of the gear is also constant.

2.8.4.2 Data used and methodologies

Data were available from 24,500 'trip interview' records of vessel landings (which included wahoo in the catch) from 5 islands: Barbados, Dominica, Grenada, St. Lucia and St. Vincent. Although the combined data set covered a 10-year period between 1994 and 2003 there were differences in the time periods reported by the respective countries. However, the reporting time periods differed among reporting countries (Table 4). The records were screened and those records lacking crucial information such as the date of the landings, catch weights etc were first removed along with obviously incorrect records. The data set included landings reported as gutted weight in pounds (Grenada, St. Vincent and St. Lucia), gutted weight in kilograms (Barbados) and whole weight in pounds (Dominica). Length-weight relationships for both gutted and whole weights for wahoo provided by IFREMER to the CRFM were used to estimate the gutted and whole weights, respectively, for animals within the size range commonly taken in the Eastern Caribbean (based on the size dataset provided by the reporting countries). Based on this it was estimated that gutted weight represents on average 93% of whole weight for wahoo of the most common size classes. This conversion factor was used to raise all the reported weights to a standard whole weight in kilograms.

Landings were reported for a number of gear types including a selection of highly unlikely gears for this species (e.g. fish pots, speargun, gillnet). The highest numbers of landing records were reported for hand lines, troll lines and long lines. These three gear types were therefore considered the most important for the wahoo fishery and all other records of landings by other gears were excluded from the dataset. Longline catches were either listed under the codes for surface longlines (SLIN), bottom longline (BLIN) or simply longlines (LLIN) and were grouped together under the simple group of "longlines" for the purpose of catch per unit effort analysis. Although catches were reported separately for troll and handlines, because of difficulties in estimating the relative proportions taken by the respective gear types due to the multi-gear nature of the fishery explained in Section 4.2.2, data from the two gear types were combined for the analyses.

Only Barbados provided the necessary data to allow catch records to be traced to vessel type. It was also possible to trace the catches taken by Grenadian longliners on the basis of reported gear type used. However, Grenada's reporting of landings by longline vessels was very sporadic for most years, a maximum of 7 per annum, except for 2001 when 519 landings were reported. The 2001 landings by Grenadian longliners, although a good sample size, were excluded from the analysis due to the lack of data for other years needed to estimate changes over time. In the absence of any other vessel information, it was assumed that all the other catches reported by the other islands were taken by pirogues. Having excluded the above records, the data set comprised 23,462 landings. Wahoo captured by pirogues, dayboats and Barbadian iceboats were all taken on hand/troll lines. Catches taken by longliners were all recorded as having been taken on longlines but may include a few catches taken by hand line while fishers wait to haul in the long lines. A breakdown of the final data set by country, time period and vessel type is presented in Table .

In the vast majority of cases, precise effort information such as the number of gears used, soak times and days fished were not provided by the reporting countries. Therefore, it was necessary to focus only on catch per trip as a crude index of catch per unit effort. Differences in the catches per trip between such vessels thus include any differences due to the trip lengths usually taken by each vessel category (usually one day for pirogues and dayboats, and multiple days for ice boats and long liners). Based on general knowledge of the fisheries, it was assumed that the Barbadian moses and the pirogues, both being small vessels constrained to similarly narrow fishing ranges, could be treated as a single group to reduce the number of vessel groups in the analyses. However, given the more appreciable differences between vessel sizes, fishing ranges and gear used, the other vessel types, i.e. iceboats and longliners were analysed separately.

To determine the average trends in catch rate for the whole region over time, it was necessary to remove the effects of the different fishing powers of the vessel types, and to make adjustments for unbalanced sampling of data between years, months, countries and vessel types. The General Linear Model procedure in the SPSS statistical package was used to standardize the catch rate data, using natural log transformed catch weights. Alternative models of the four key variables (vessel type, country, month and year) were tested to determine the significance of main effects and interaction terms.

Catch rate data from Martinique were also analysed. Records for 1998 to 2003 were submitted, but these were already aggregated into monthly averages (i.e. not available as individual trip records).

Trip interview data were also examined from Trinidad's artisanal pelagic database. However, between 1996 and 2003, only 82 records were available in which wahoo was landed. The data were spread across five gear types (multifilament and monofilament gill nets; troll lines, a la vive (livebait) and 'banking'), leaving too few records per gear – year combination for a reliable analysis. Wahoo is only caught occassionally in the Trinidad artisanal fishery, which targets mainly the Serra Spanish Mackerel (*Scomberomorus brasiliensis*), which is more important commercially than wahoo in this country.

Catch rate data are also available from the ICCAT observer database for 1992 to 2002, as used for the Serra Spanish mackerel assessment in this Scientific Meeting. However, time constraints at the Meeting precluded the analyses of these data for wahoo. It is recommended that future wahoo assessments explore the usefulness of these data.

2.8.4.3 Results and discussion

Non-standardized mean annual catch per trip data for each vessel type are presented in Figure 19. The graphs indicate that Barbadian longliners and iceboats recorded the highest catch per trip of wahoo in the region. This is not surprising given the longer fishing trips and greater fishing ranges of these vessels. However, the great variation in catch rates observed for the longline vessels is very striking. Two possible *a priori* explanations may be offered for this. Firstly, longliners, unlike other vessels examined, track tunas and other large pelagics specifically. Hence wahoo will only be caught in areas where the stock distribution overlaps with that of the target species. Secondly, longliners may shift their focus to other species, such as dolphin and wahoo, when catches of the larger pelagics are poor. A closer examination of the longline catch records would be needed to properly explain this observation.

Barbados dayboats exhibited the most consistent pattern for catch rates observed over the time period, while St. Vincent exhibited the highest variability among the day-trip vessels (Figure 19). What is also noteworthy here is that the dayboat catch rates fell within the order of magnitude observed for the Barbados moses boats and the pirogues from the other islands.

Each of the four main effects – vessel type, country, month and year – were highly significant as expected. The inclusion of the second order interaction term for country by month added little to the R^2 of the model and was excluded. This suggested that the seasonality of catch rates differed little between countries. The observed monthly trend in catch rates agreed well with the well-known trend for pelagics in the region, with larger catch rates in the first half of the year and lower catch rates in the latter half (Figure 20). Mean standardised differences in catch rates between countries and fleet types are shown in Figure 21 and 22.

The interaction between country and year, contributed significantly to the model (increasing R^2) indicating that the trends over time were different between the countries (Figure 23). Such differences could not be interpreted ecologically, however, so the GLM model was used to estimate a single regional catch rate index across all the countries (Figure 24).

Based on the standardized values obtained from the GLM analysis, it was found that catch per trip ranged between 24.3 kg (St Vincent) and 10.6 kg (Dominica). Catch rates of 23.4 kg/trip, 21.4 kg/trip and 16.6 kg/trip were derived for St Lucia, Barbados and Grenada respectively (Figure 21).

Figure 22 also shows that overall the longliners took the largest mean catch rates (27.6 kg) but also exhibited the greatest variability (denoted by the wide confidence interval) of all the vessel types assessed. The mean catch rate by Barbadian dayboats (12.9 kg/trip) was slightly less than that of the pirogues (including the Barbadian moses) (15.8 kg/trip) suggesting that the fishing power of the Barbadian dayboat relating to wahoo is close to the average for pirogues in the region. The trends in GLM-corrected catch rates over the study period differed among countries (Figure 23). The very sporadic catch records preclude much comment on the trend for Dominica. However, catch rates showed a comparatively level pattern over the period for both Barbados and Grenada. St. Lucia exhibited a slight increase in catch rates over the period while the St. Vincent data varied considerably. The standardised overall curve (Figure 24) was level for the most part (1997 to 2002) with notable relative low values in 1994 and 1995 and comparative high values in 1996 and 2003. Very little adjunct information is available with the dataset to assist in explaining these anomalously high and low values. However, what is of more immediate concern is that catch rates have not apparently declined over the ten-year study period.

Catch rates for Martinique are given in Figure 25, but were not analysed within this assessment due to time limitations.

One shortcoming of the analysis of the ‘TIP’ database as carried out this year, recognised previously by George et al. 2001, is that fishing trips in which trolling and longline gear capable of catching wahoo were deployed but either caught nothing or caught only other pelagic species, were not included in the data set. Future analyses should take into account such ‘zero’ catch trips as they count towards estimates of total fishing effort. Revisions to sampling strategies should also be considered to improve estimates of fishing effort and ultimately catch per unit of effort that was used as an index of fish abundance in the analyses.

At the data analysis stage, the presence of any large pelagic species (even if wahoo are not included) could be used as a criterion to identify large pelagic fishing trips, which should be counted when estimating catch per unit effort. However, identification of truly unsuccessful trips i.e. where a vessel returns with nothing, can only be captured if such trips are recorded at the landing site in the first place. Fisheries Departments in the southeast Caribbean are unlikely to presently have the capacity to collect such data on an on-going basis and the need to intensify existing monitoring programmes to this degree will have to be carefully assessed. For example, since only comparative trends over time are being monitored here what is most important is the pattern, if any, of the frequency of zero catches over time. If the proportion of trips that are unsuccessful does not vary temporally then the temporal trends in landings described by the recorded successful trips are adequate and only the real values of catch per unit effort need be adjusted by applying a correction factor based on the proportion of unsuccessful trips. However if the proportion of unsuccessful trips varies over time, either randomly or following a different pattern than that described by the data for the recorded successful trips, then it becomes more important to devote the necessary resources to monitoring and recording these unsuccessful trips on a real-time basis.

It may be possible to roughly estimate the frequency and thus elucidate the existence of any temporal patterns for wholly unsuccessful trips with a minimum increase in sampling effort. For example by fisher interviews and more intensive monitoring of the landing sites on a periodic (e.g. even as low as 1 day every month) rather than continuous basis. It is noted that such a sampling strategy may already be in place in some territories, if so then such data should be included in the data set and flagged as such for the next stock assessment exercise.

2.8.5 Biomass dynamics (production) modelling

2.8.5.1 Objectives

Biomass dynamic (surplus production) modelling was attempted to estimate the maximum sustainable yield (MSY) reference point for the fishery, and to investigate the relationships between the annual catch rates, the total catches removed from the fishery and the likely changes in stock sizes over time.

2.8.5.2 Data used and methodology

For the production modelling, several combinations of total catch and abundance time series were examined. Some combinations proved impossible to achieve any good fits for any biomass dynamics model, due to incompatible combinations of catches and abundance (e.g. with both

CPUE and catches rising at the same time; see below). The baseline results presented below are for the FAO total catch series for the Western Central Atlantic. Running from 1960 to 2002, this was the longer of the two catch time series (see Figure 18). It also showed the lesser decline in Venezuelan catches since 1999, which is assumed more likely (since no other countries show any signs of stock collapse). Local advice and expert interpretation was requested from Venezuela but not received within the duration of the workshop. For the abundance index, the GLM-standardised catch rates, combined across the five eastern Caribbean countries were used (Figure 24) for the years 1996 to 2002. The low 1994 data point was excluded from the analysis, as the sample size was very small and unbalanced for that year (see Table). The also low 1995 data point was based on a larger sample size, but only fits implying enormous carrying capacities (K) and MSY could be obtained with this point included. Attempts were made to test the sensitivity of using the ICCAT catch data set instead of the FAO one, but these data combinations also gave unreasonable high-K fits due to incompatible data trends.

Attempts were made to fit non-equilibrium, observation-error versions of biomass dynamic models both using the CEDA software produced by MRAG (see http://www.fmsp.org.uk/) and using spreadsheet models based on the Excel solver routine (e.g. Punt and Hilborn, 1996; Haddon, 2001). Equilibrium fitting of production models (e.g. by plotting catch per unit effort against effort) is well known to overestimate MSY when catches have been increasing over time, as in this case. Models were fitted assuming that the biomass at the start of the total catch time series (1960) was equal to the estimated carrying capacity, *K*.

2.8.5.3 Results and discussion

The difficulty of fitting the biomass dynamics models is illustrated in Figure 26. This shows contours of the scores achieved at different combinations of *K* and *r* (the intrinsic growth rate of the production model), as plotted by the CEDA software. High scores are achieved for a range of pairs of values of *K* and *r*, as is usually found with biomass dynamic models. Along the bottom left of the response surface, feasible model fits may be achieved at values of *r* between 0.2 and 0.8, corresponding to values of *K* between 4,000 and over 10,000 t. Unfortunately, neither CEDA nor the spreadsheet models proved able to find stable solutions within this feasible area, but instead converged towards 'chaotic' solutions corresponding to *r* -values close to 3 (see Haddon, 2001, page 33). To avoid these outcomes, *r* was set to a range of feasible values (0.2 to 0.8) and the best fitting *K* found in each case. From the available data it is quite hard to distinguish between fits with low *K* and high *r* (e.g. Figure 27) and fits with high *K* and low *r* (Figure 28). In the first illustration, the model predicts that the fishing has reduced biomass from the estimated *K* of 9 448 t down to 6 354 t. In the second illustration, biomass has started from a *K* constrained to 20 000 t, and fallen by a similar proportion.

Given the difficulty of fitting the model parameters with automated search routines, no confidence intervals were estimated for the model parameters. Uncertainty in the true values of *r* and *K* and the current biomass is clearly fairly high. However, due to the negative correlation between *r* and *K* within the area of reasonable parameter space (the bottom left of Figure 26), the estimated MSY (= $rK/4$ for the Schaefer model form) is relatively unaffected by the uncertainties in the model parameters. Estimated MSYs and other model parameters for the Schaefer and Fox production models, fitted with least squares and log-transformed error models are given in Table 4. With the limited available data, residuals were well distributed for all models (after excluding the 1994 and 1995 points). The highest scoring fits (measured as R^2 in the CEDA software) were found for mid-range values of r (0.4-0.6) corresponding to *K*s of 7-14 000 t (Table 4).

As commonly found with low-contrast data (see Hilborn and Walters, 1992), MSY is estimated close to the maximum catches so far taken from the fishery (around 1400 to 1600 t). Since catch rates have not declined significantly with the catches taken at this level, the analysis predicts that they are sustainable.

Improvements in the fitting of the model would require abundance data going back to the 1960s and 1970s, when catches were lower, thereby improving the contrast in the data set. Total annual catches have increased significantly from the 1960s to the 1990s, but catch rate data are only available for the 1990s, for most of which, both catches and catch rates have apparently been fairly stable. None of the other studies reported by Oxenford et al (2003) showed any evidence of a decline in wahoo catch rates, although it is possible that real declines in catch rates are masked in the CPUE data by simultaneous increases in fishing power (catchability). Any future analyses should attempt to find improved abundance indicators, both by considering more detailed effort measures where available and by extending back in time as far as possible.

2.9 REFERENCES

Constantine, S.L. 2002. RAPD analysis of genetic variation in wahoo, Acanthocybium solandri, in the western central Atlantic. M.Sc. Research Peper, University of the West Indies, Cave Hill Camps, Barbados.101p.

FAO. 2003 Preparation for expansion of domestic fisheries for large pelagic species by CARICOM countries. Report of the Second Workshop. Caribbee Hotel, Barbados, 18th February 2003. FI:TCP/RLA/0070 Field Document No. 3, 22pp.

George, S., Singh-Renton, S. and Lauckner, B. 2001. Assessment of Wahoo (*Acanthocybium solandri)* Fishery using Eastern Caribbean Data. Pp 25 – 40 In: CFRAMP. 2001. Report of the 2000 Caribbean Pelagic and Reef Fisheries Assessment and Management Workshop. CARICOM Fishery Report No. 9. 139p.

Haddon, M. 2001. Modelling and quantitative methods in fisheries. Chapman & Hall / CRC. 406pp.

Hilborn, R. and C.J. Walters 1992. Quantitative fisheries stock assessment: choice, dynamics and uncertainty. Kluwer Academic Publishers.

Neilson, J.D., Murray, P.A., Finlay, J.A. and Rennie, J. 1999. Wahoo landings in the lesser Antilles: Biased samples cause problems for stock assessment. Proceedings of the Gulf and Caribbean Fisheries Institute. 46:346-359.

Oxenford, H.A., Murray, P.A. and Luckhurst, B. E. 2003. The biology of wahoo (*Acanthocybium solandri*) in the Western Central Atlantic. Gulf and Caribbean Fisheries Research. 15: 33-49.

Punt, A.E. & Hilborn, R. 1996. BIODYN - Biomass dynamic models. User's manual. FAO Computerized Information Series (Fisheries) - No.10. Rome, FAO. 62pp.

Table 1. Length frequency sample sizes by country, year and gear type.

GEARCODE	Year	Barbados	Dominica	Grenada	St Lucia	St Vincent	Grand Total
Hand lines (HLIN)	1995				12		12
	1996	801	119		5		925
	1997	900	109		10	67	1086
	1998	1092	293				1385
	1999	184	160			4	348
	2001		9				9
	2003					3	3
HLIN Total		2977	690		27	74	3768
Palangue / Bottom longlines (PALN/BLIN)	1996					9	9
	1997					3	3
	1998					1	1
	1999					3	3
	2002					3	3
	2003					3	3
PALN Total						22	22
Trolling (TROL)	1995			51	462		513
	1996		193	713	2451	535	3892
	1997		337		1739	904	2980
	1998			30	1031	334	1395
	1999					2045	2045
	2000					1011	1011
	2001					149	149
	2002					92	92
	2003					1045	1045
TROL Total			530	794	5683	6115	13122
Grand Total		2977	1220	794	5710	6211	16912

Note: Records for Bottom longline gear (BLIN) have been combined with those of Palangue gear (PALN) since the gear types are assumed to be the same

Table 2. Length frequency sample sizes by gear types (see Table 1 for gear codes).

Length	HLIN	PALN / BLIN	TROL	Grand Total
0			53	53
5	1			1
10			3	3
15	2		2	4
20	2			2
25	1		2	3
30	5		2	7
35	1		10	11
40			33	33
45	4		74	78
50	4		134	138
55	15		155	170
60	15		243	258
65	31	1	423	455
70	63		648	711
75	168	2	938	1108
80	232	1	1207	1440
85	531		1543	2074
90	521	3	1645	2169
95	722	3	2002	2727
100	601	3	1664	2268
105	389	2	1099	1490
110	231	1	707	939
115	115	1	321	437
120	43	2	112	157
125	21		45	66
130	19	1	31	51
135	14	1	5	20
140	7		6	13
145	7		5	12
150	1	1	5	7
160	2		1	3
165			2	2
170			2	2
Grand Total	3768	22	13122	16912

Table 3. Numbers of catch/effort (TIP) records in the final CRFM countries data set, by country, month and vessel type.

Country		Barbados				Dominica	Grenada	St. Lucia	St. Vincent	
Year	Month	Dayboat	Iceboat	Longliner	Moses	Pirogue	Pirogue	Pirogue	Pirogue	Total
1994	January					27			1	28
	February					18			2	20
	March					7			1	8
	April								2	2
	May					3			2	5
	June					2			3	5
	July					2			3	5
	August					3			1	4
	September					2			1	3
	October					1				1
	November					1			4	5
	December					1			1	2
1995	January	95	23		17	17		190	2	344
	February	73	33		5	17		320		448
	March	194	65	2	13	27		260	4	565
	April	83	27	3	7	41		206	1	368
	May	137	52	3	7	29		152	5	385
	June	81	30	3	1	4		81		200
	July	35	9	5	3	6			1	59
	August	10	6	5	1	13				35
	September	11	6	7	1	2				27
	October	26	9		1	5				41
	November	47	24	5	1	12				89
	December	96	26	4	8	4			1	139
1996	January	107	34	5	8		60	153	2	369
	February	109	39	1	7		177	259	11	603
	March	120	19		12		153	291	23	618
	April	113	35	1	4		150	221	1	525
	May	94	33		5		81	268	14	495
	June	51	10		4		1	106	1	173
	July	11	6	4	5		1	74	2	103
	August	8	3	4	3		2	23	1	44
	September	14	10	4	4		10	37	3	82
	October	5	14	4	1		4	15	1	44
	November	42	29	2			2	135	2	212
	December	46	30	4	3		5	109		197
1997	January	54	32	2	3	43		165	7	306
	February	27	30	3	2	38		261	15	376
	March	55	88	12	2	56		276	5	494
	April	49	75	13	3	25		241	28	434
	May	58	51	5	2	40	82	153	18	409
	June	22	25	5	3	12	44	51	11	173
	July	11	8	3	3	3	15	30	2	75
	August	5	2	5	2	14	21	30	2	81
	September	9	7	3	3	16		60	2	100
	October	5	6	5	4	19		89		128
	November	26	34	6	3	19		112	1	201
	December	48	25	7	2	22		129	3	236
1998	January	48	43	2	5	23	153	164		438

	February	55	55	5	8	6		210	6	345
	March	50	45	2		22	2	258	5	384
	April	52	48	1	7	26		8	16	158
	May	61	49	1	7	35	28		6	187
	June	28	21	3	1	14	70		12	149
	July	10	10	2	1	39	127		4	193
	August	4	15	2	3	24	150		1	199
	September	8	34	4	10	5	97		1	159
	October	6	27	6	15	3	88		2	147
	November	12	53	3	29	12	44		2	155
	December	20	38	3	15	5	16		1	98
1999	January	25	23	2	10	11	262	176	38	547
	February	33	56	12	11	15	299	271	41	738
	March	35	59	8	8	86	298	337	43	874
	April	33	57	6	3	57	150	282	28	616
	May	33	45	4	3	32	104	191	20	432
	June	37	19	4	5	21	88	111	6	291
	July	8	14	6	4	13		89	4	138
	August		1	5	9	3	38	24		80
	September	2	5	5	3	2	15	19	2	53
	October	2	8	4	2	2	5	17	1	41
	November	10	5	1	8	7	14	2	1	48
	December	13	22	4	5	7	37		13	101
2000	January	15	17		1		53	111	11	208
	February	17	36	4	3		191	145	27	423
	March	29	50	8	3		140	109	13	352
	April	31	47	9	4		48	133	33	305
	May	30	65	3	3		58	172	21	352
	June	18	13		3		22	69	17	142
	July	3	3	6	2		26	33	6	79
	August	1	1	3	5		12	7		29
	September	3	4	5	5		46	18	4	85
	October	8	2	5	5		23	21		64
	November	13	9	6	15		27	37	1	108
	December	20	6	3	10		32	48	7	126
2001	January	21	23	1	3	3	117	130	1	299
	February	21	32	3	2	1	23	235	5	322
	March	26	32	2	5	2	158	346	6	577
	April	14	30	6	3	1	163	201	3	421
	May	16	20	4	2	19	23	115	2	201
	June	10	4	5	5	4	60	80	2	170
	July	2	1	5	2	10	53	39	3	115
	August	1		1	1	6	12	34		55
	September	3	3		4	7	16	45		78
	October	2	6	7	13	14				42
	November	2	2	2	14	16	2			38
	December	10	19	3	6	17	4		11	70
2002	January					23		161	1	185
	February					78		230	2	310
	March					92		279	34	405
	April					35		209	1	245
	May					27		120	1	148
	June					30		84	8	122
	July					14		38	2	54
	August					13		68	2	83
	September					7		10		17

	October					6		14		20
	November					15		43	5	63
	December					26		70		96
2003	January							114	18	132
	February							180	37	217
	March							175	28	203
	April							148	22	170
	May							67	2	69
	June							75	2	77
	July							61		61
	August							10	11	21
	September							46	4	50
	October							19	6	25
	November							34	3	37
	December							95	11	106
Total		2878	2132	321	444	1487	4250	11134	816	23462

Table 4. Biomass dynamic model fits to the FAO catch time series (1960-2002) and the CRFM regional abundance estimates (CPUE, 1996-2002).

Schaefer model (least squares error model)						
R	K	q	MSY	Rsq	Final B	FB/K
0.2	25591	109	1279	0.177	17775	69%
0.4	10065	297	1413	0.199	6766	67%
0.6	9448	318	1417	0.199	6354	67%
0.8	7252	416	1450	0.191	4975	69%
Schaefer model (log transformed error model)						
R	K	q	MSY	Rsq	Final B	FB/K
0.2	27536	97	1377	0.153	19894	72%
0.4	14308	199	1431	0.165	9891	69%
0.6	9787	298	1468	0.166	6783	69%
0.8	7681	375	1536	0.158	5522	72%
Fox model (least squares error model)						
R	K	q	MSY	Rsq	Final B	FB/K
0.2	21296	137	1567	0.186	14202	67%
0.4	10831	291	1593	0.206	6919	64%
0.6	7391	432	1631	0.199	4810	65%
0.8	6320	467	1860	0.194	4537	72%
Fox model (log transformed error model)						
R	K	q	MSY	Rsq	Final B	FB/K
0.2	22472	126	1653	0.159	15452	69%
0.4	10831	291	1594	0.206	6919	64%
0.6	7391	432	1631	0.199	4810	65%
0.8	6320	467	1860	0.194	4538	72%

Notes: r = intrinsic growth rate, K = carrying capacity (or unexploited biomass), q = catchability ($*10^{-5}$), Rsq = goodness of fit indicator, Final B = estimated 2002 biomass, FB/K = 2002 biomass / K.

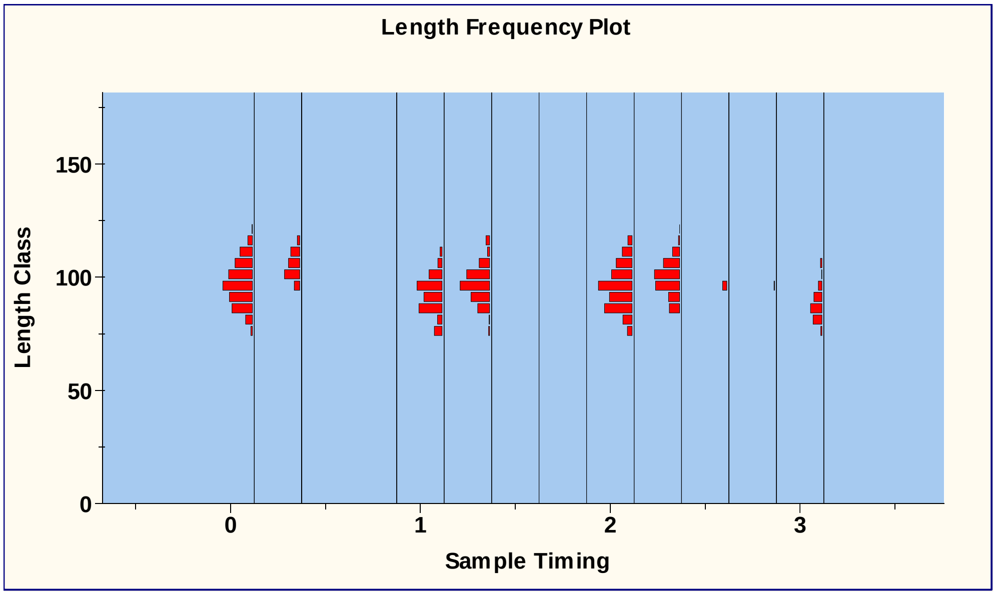


Figure 1. **Quarterly length frequency data for <u>Barbados</u> (0 = start of 1996 in all plots; 1 = start of 1997 etc, length classes in cm).**

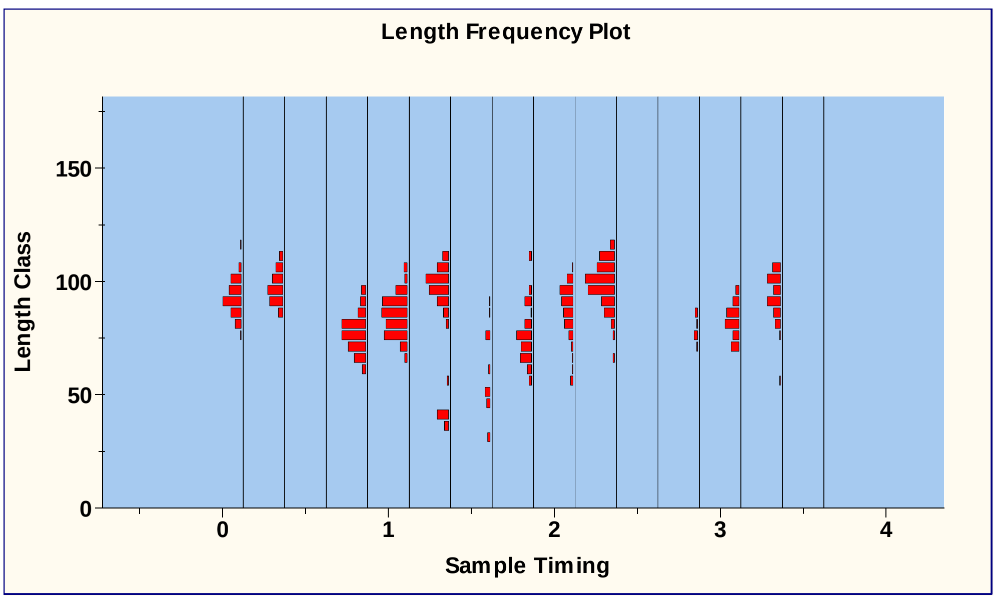


Figure 2. **Quarterly length frequency data for <u>Dominica</u> (excluding 9 fish sampled in 2001, length classes in cm).**

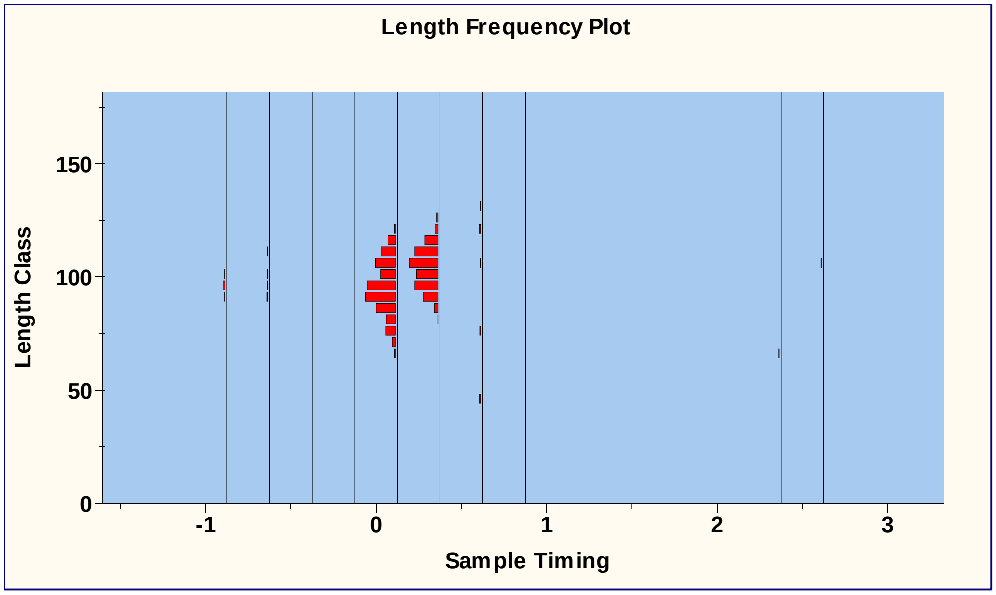


Figure 3. **Quarterly length frequency data for Grenada.**

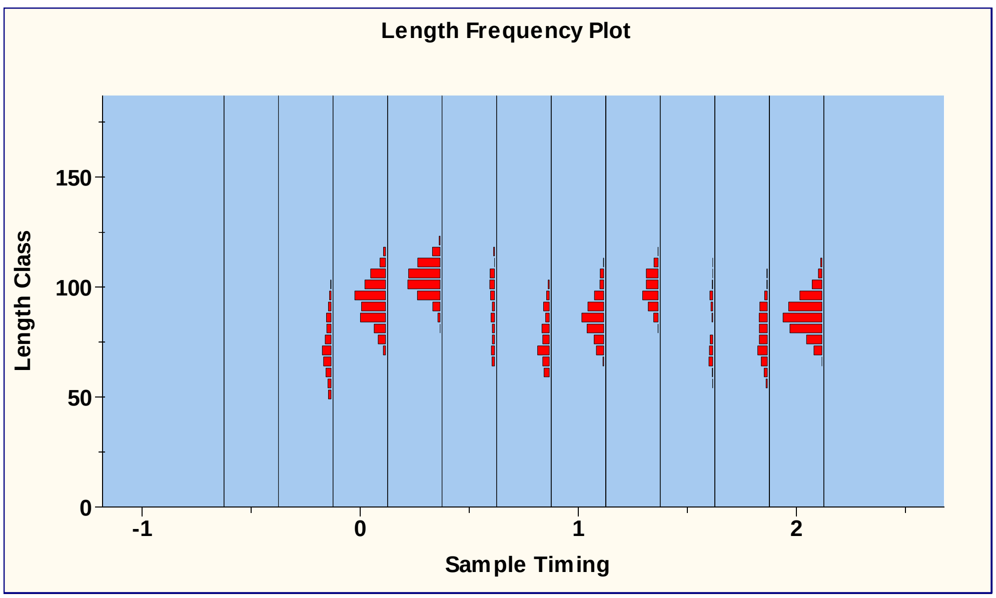


Figure 4. **Quarterly length frequency data for St Lucia.**

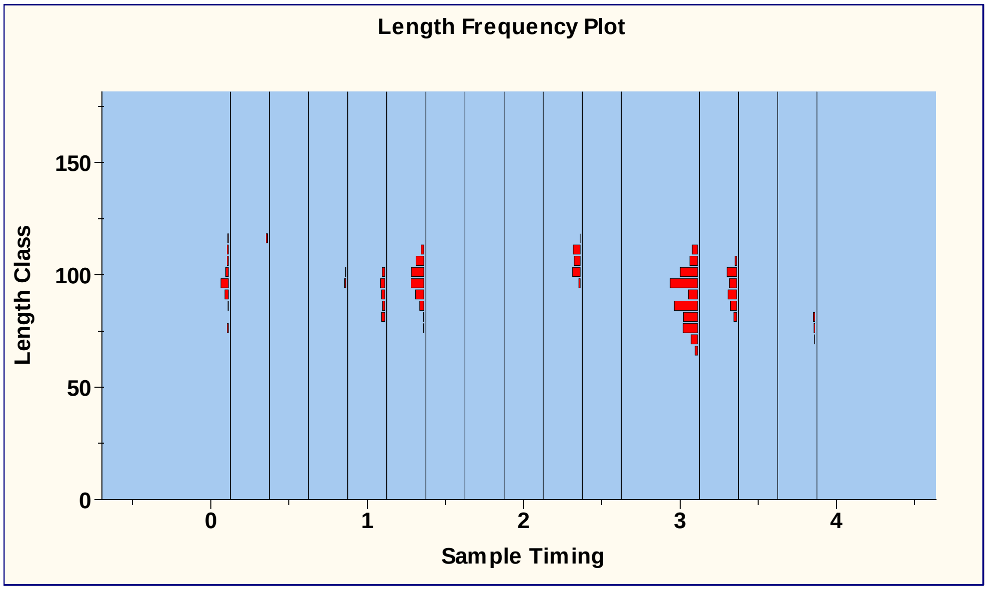


Figure 5. **Quarterly length frequency data for St Vincent for years 1996 to 1999.**

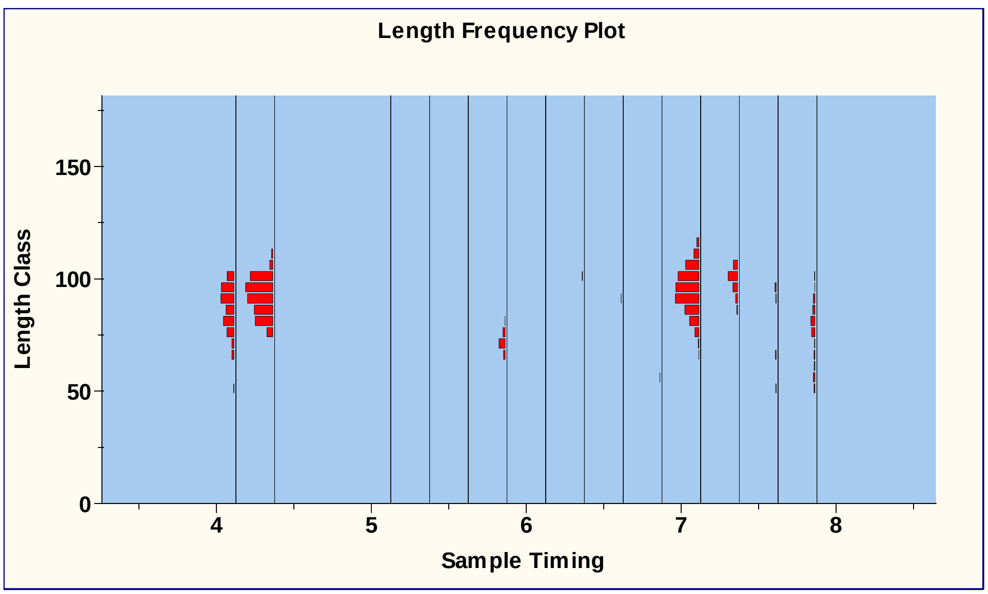


Figure 6. **Quarterly length frequency data for St Vincent for years 2000 to 2003.**

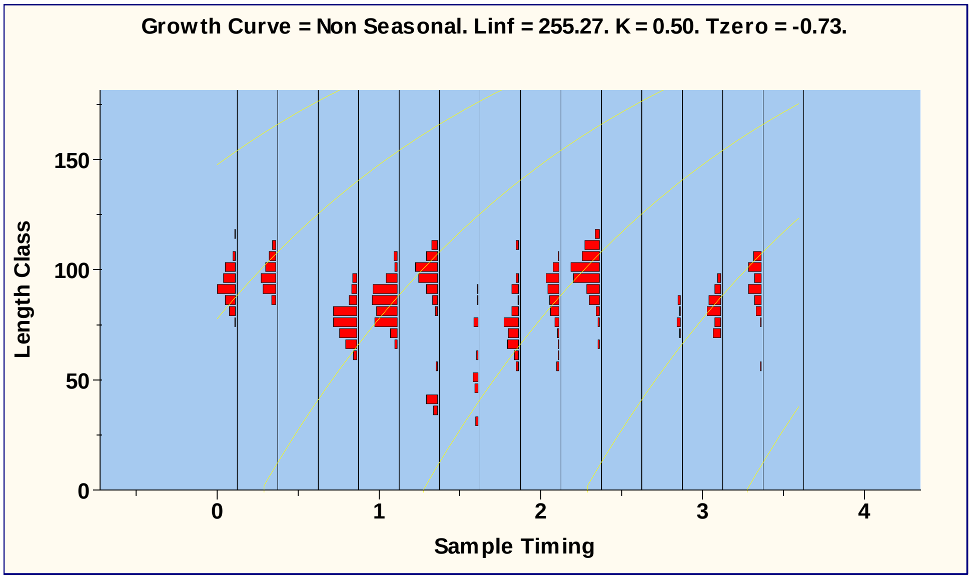


Figure 7. Non-seasonal von Bertalanffy growth curve fitted to the <u>Dominica</u> length frequency data for 1996 to 1999 (maximum scoring fit for SLCA method).

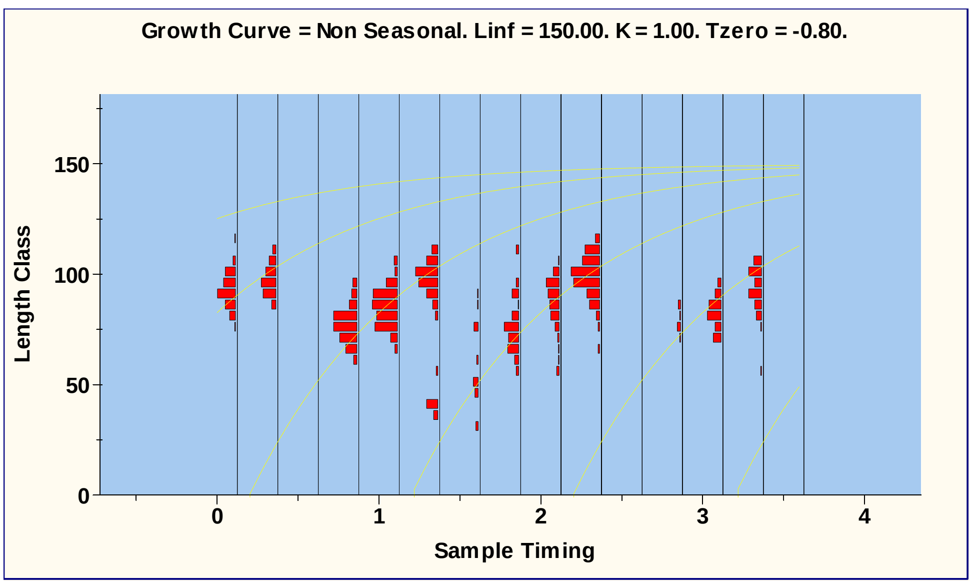


Figure 8. Non-seasonal von Bertalanffy growth curve fitted 'by eye' through the <u>Dominica</u> length frequency data, illustrating assumed cohorts.

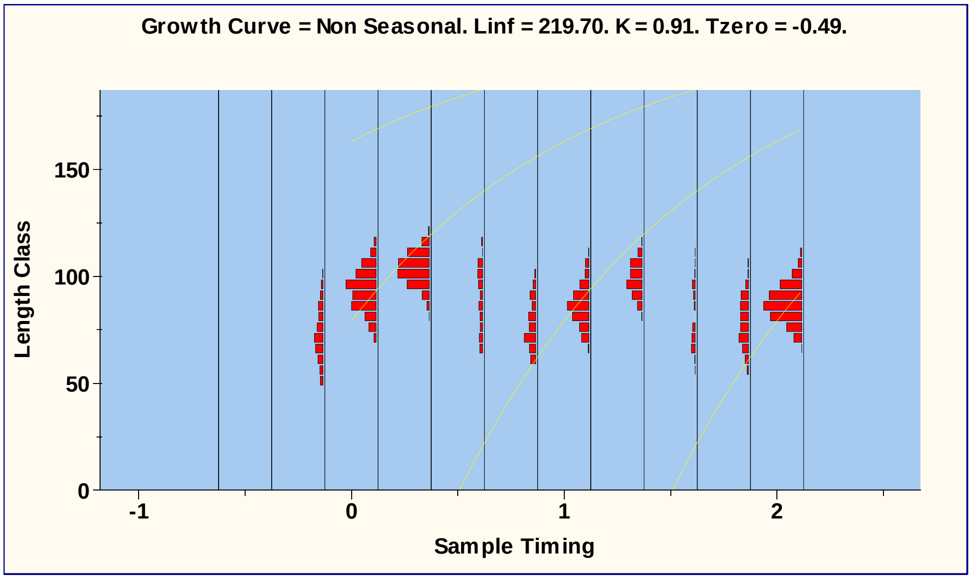


Figure 9. **Non-seasonal von Bertalanffy growth curve fitted to the St Lucia length frequency data for 1996 to 1999 (maximum scoring fit for SLCA method).**

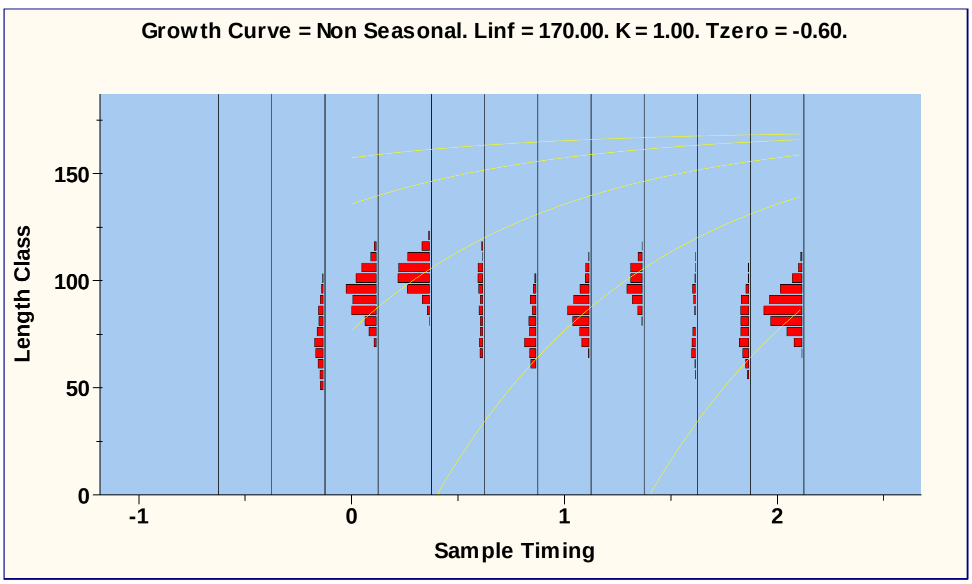


Figure 10. **Non-seasonal von Bertalanffy growth curve fitted 'by eye' through the St Lucia length frequency data, illustrating assumed cohorts.**

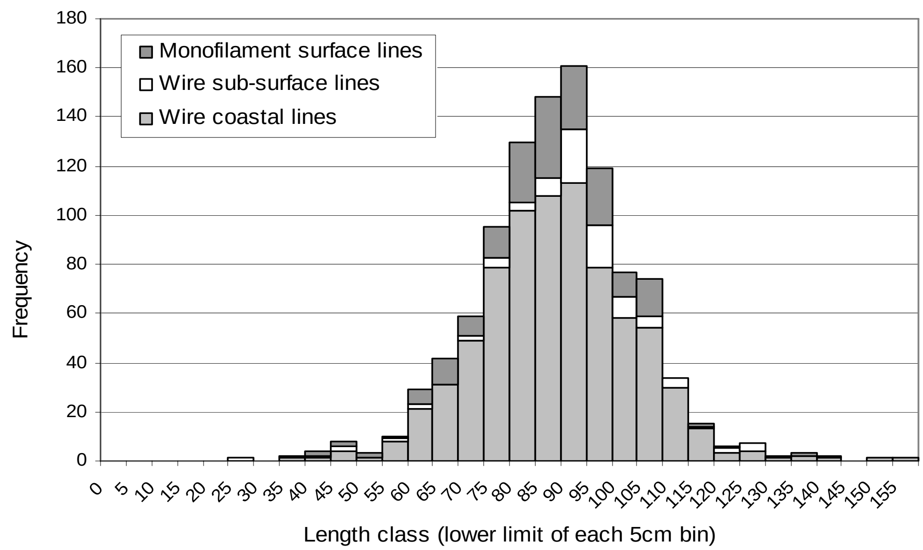


Figure 11. **Length frequency data submitted by Martinique (IFREMER).**

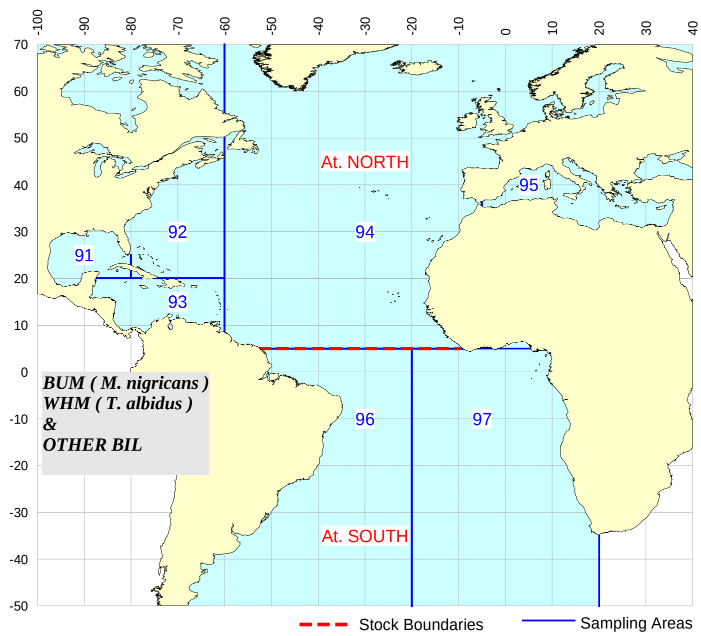


Figure 12. **ICCAT zones used for observer data.**

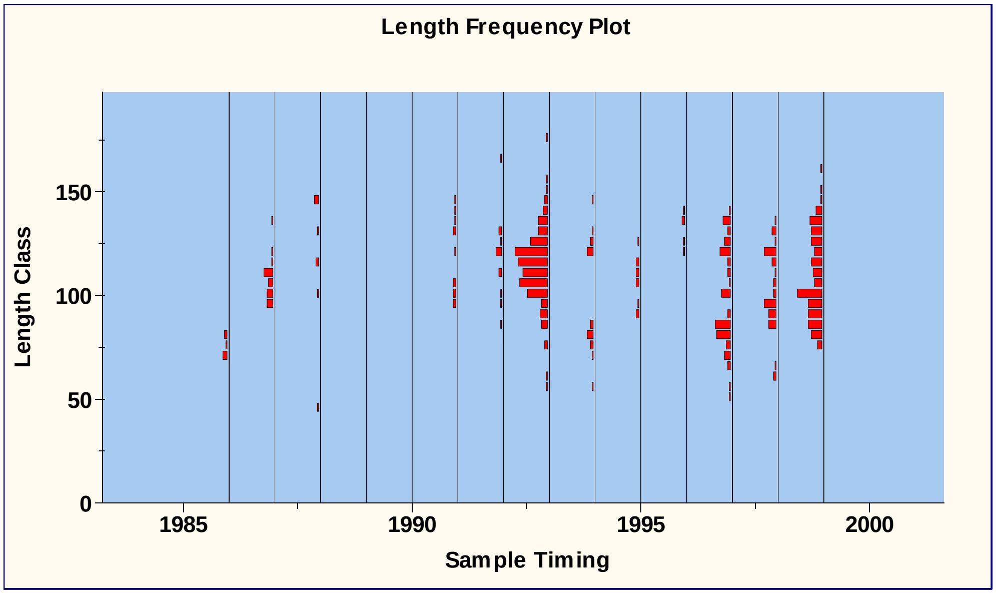


Figure 13. **Length frequencies of wahoo from ICCAT Area 91 (Gulf of Mexico).**

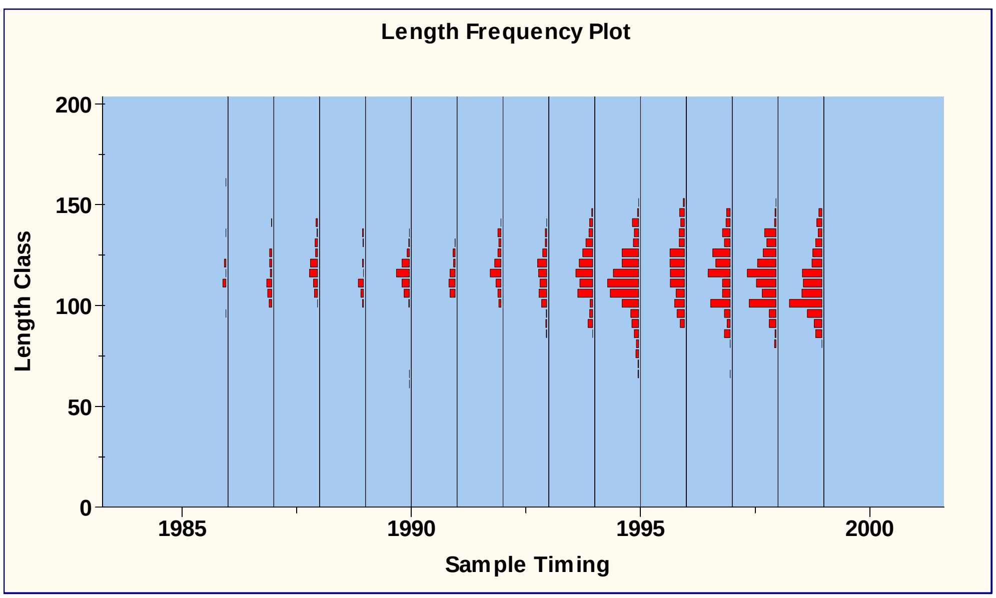


Figure 14. **Length frequencies of wahoo from ICCAT Area 92 (US east coast and northern Caribbean).**

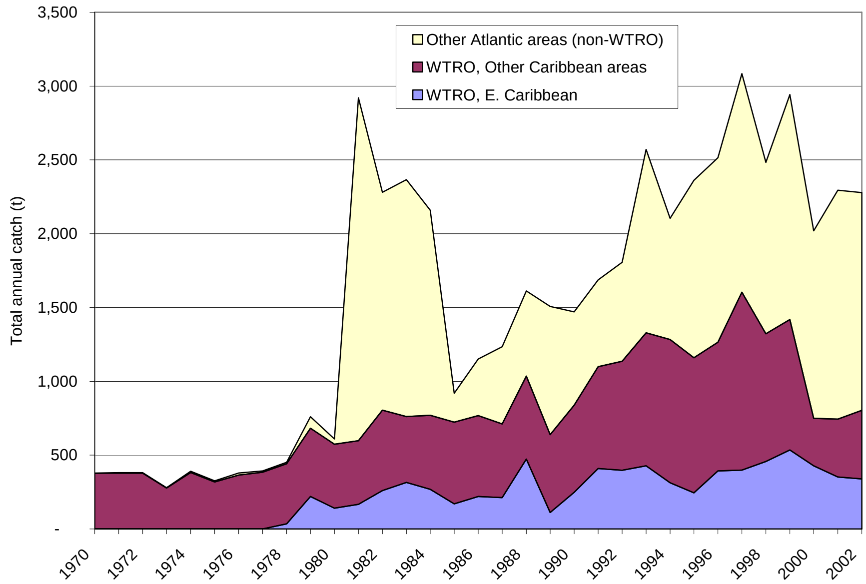


Figure 15. Total catches of wahoo by year, as reported by ICCAT for western tropical Atlantic waters (WTRO) in the eastern Caribbean and other countries, and for other non-WTRO areas (eastern USA and mid / east Atlantic). See following figures for further area breakdowns by countries.

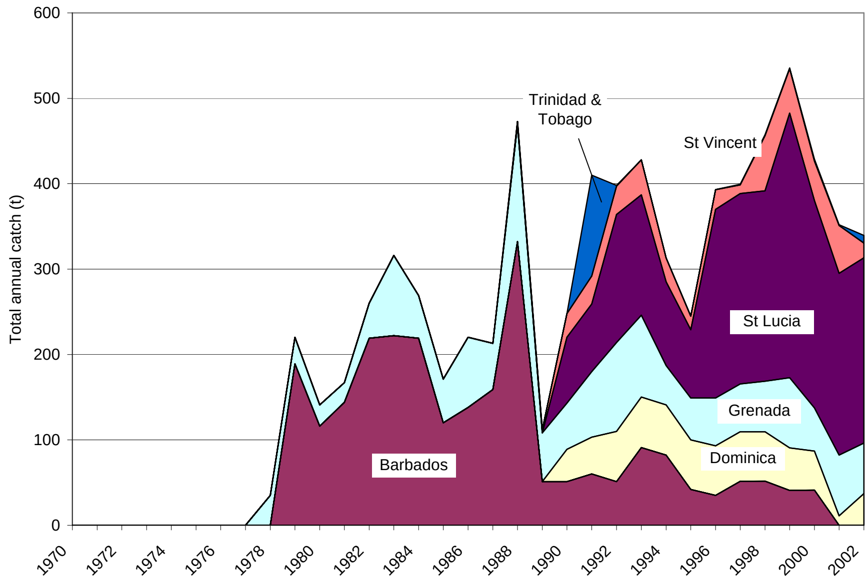


Figure 16. **Total wahoo catches per year (ICCAT data) for the eastern Caribbean countries.**

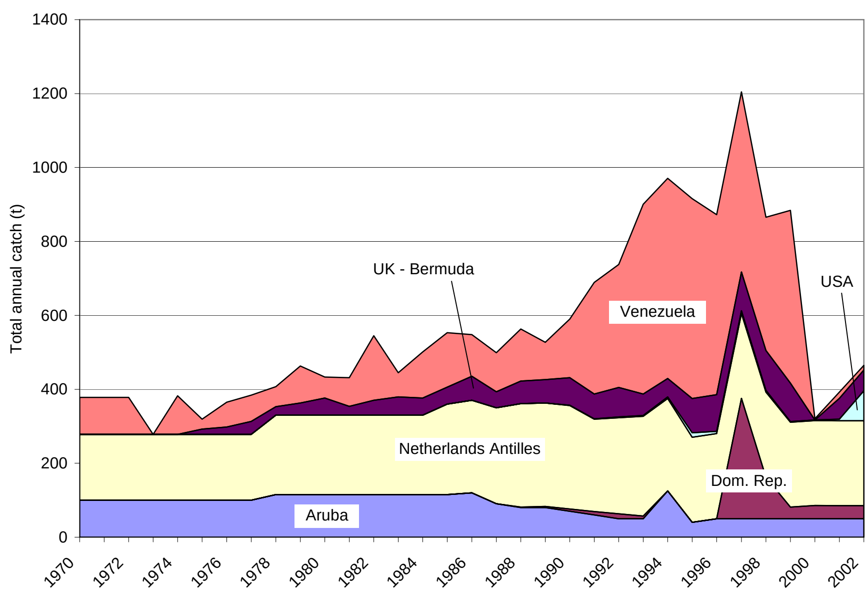


Figure 17. **Total wahoo catches per year (ICCAT data) for other countries in Western Tropical (WTRO) area.**

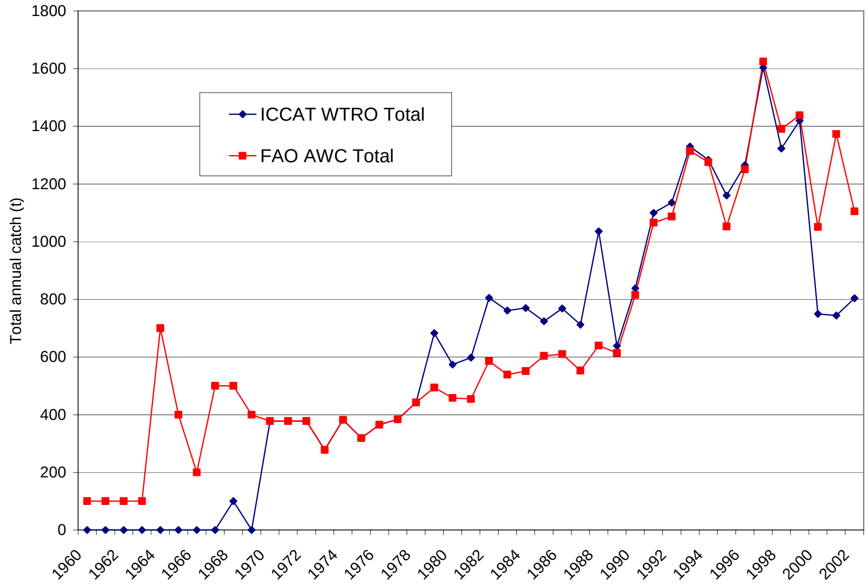


Figure 18. **Comparison of total annual wahoo catches, as reported by ICCAT and FAO.**

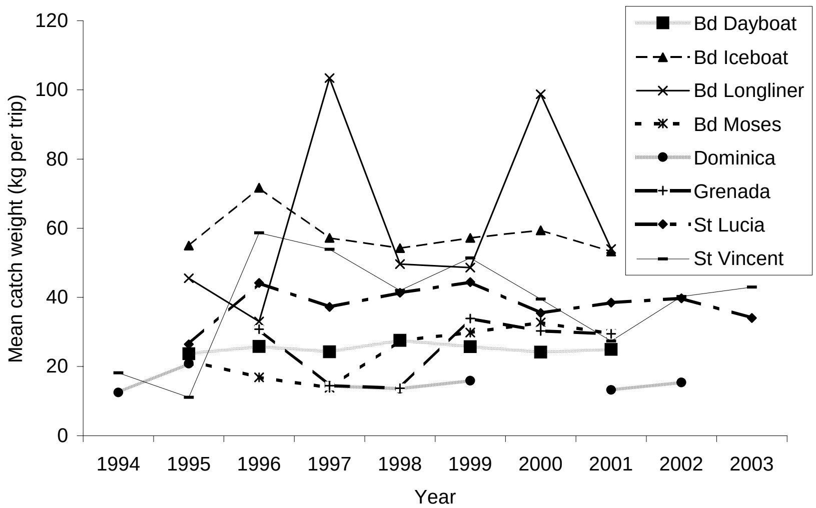


Figure 19. **Unadjusted mean wahoo catch rates (kg/trip) by vessel type (Barbados) and country (source TIP data).**

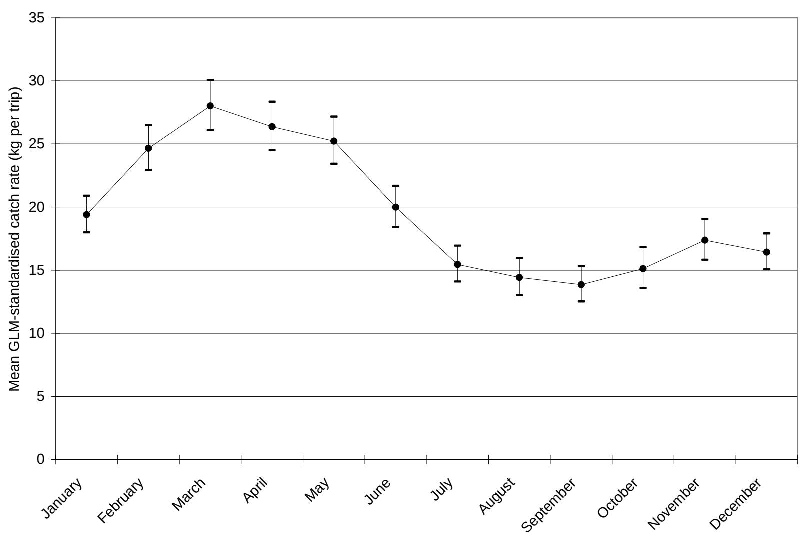


Figure 20. **GLM-standardised mean monthly wahoo catch rates for the Eastern Caribbean for years 1994 to 2003.**

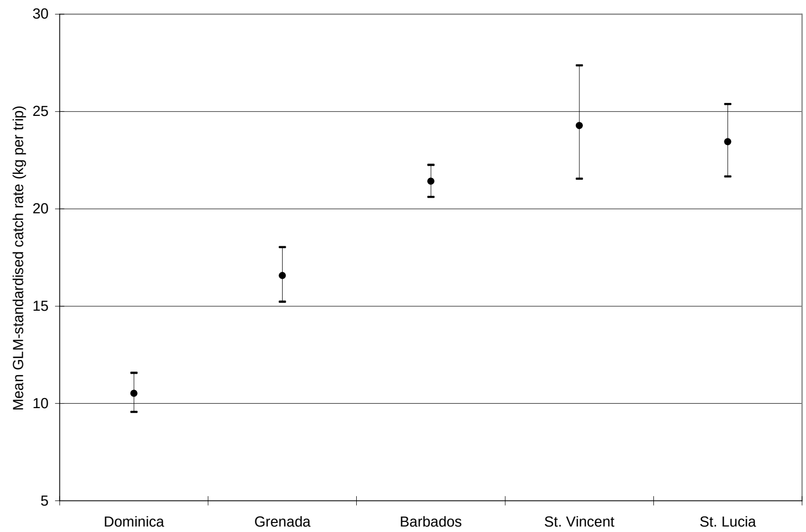


Figure 21. Mean GLM-standardised catch rates by country.

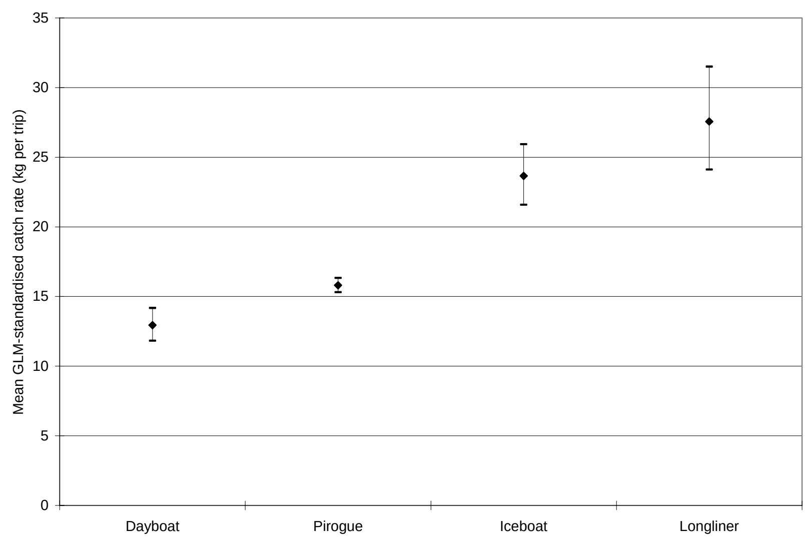


Figure 22. Mean GLM-standardised catch rates by boat type.

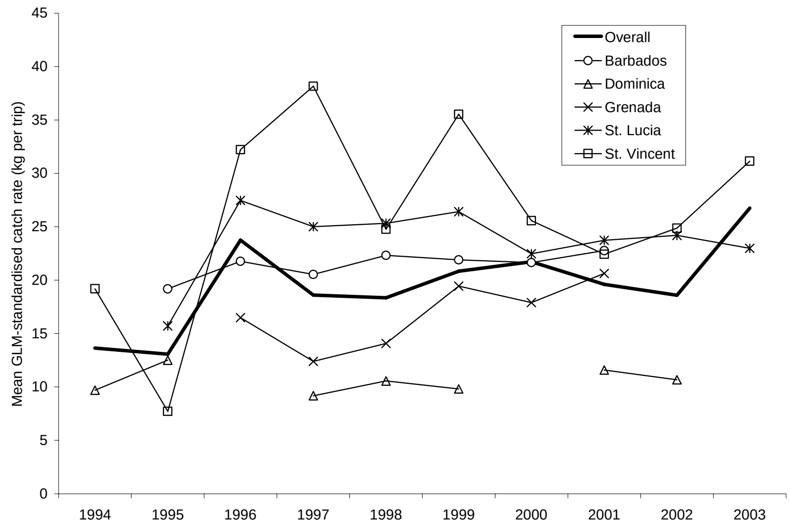


Figure 23. **GLM-standardised catch rates by year and country.**

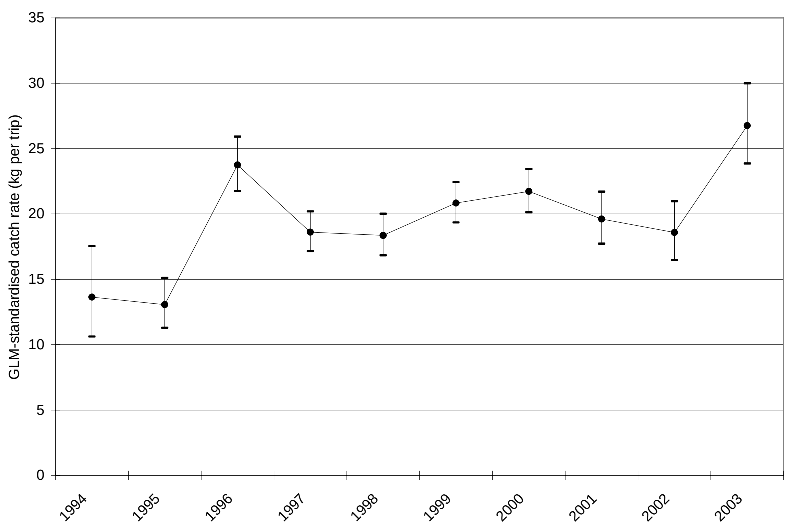


Figure 24. **Mean GLM-standardised catch rates for the E. Caribbean countries.**

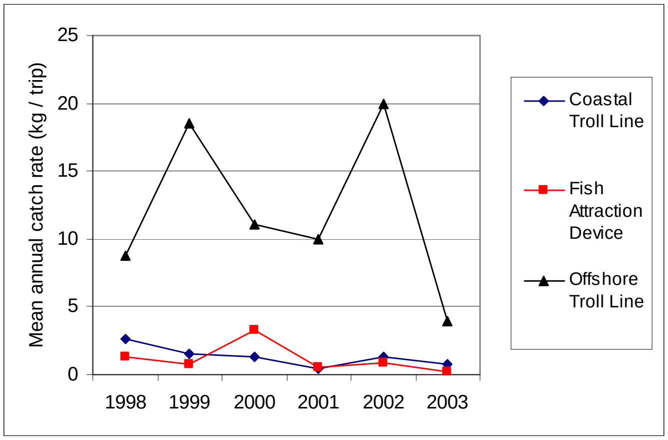


Figure 25. **Catch rates (kg / trip) by gear type reported by Martinique (IFREMER).**

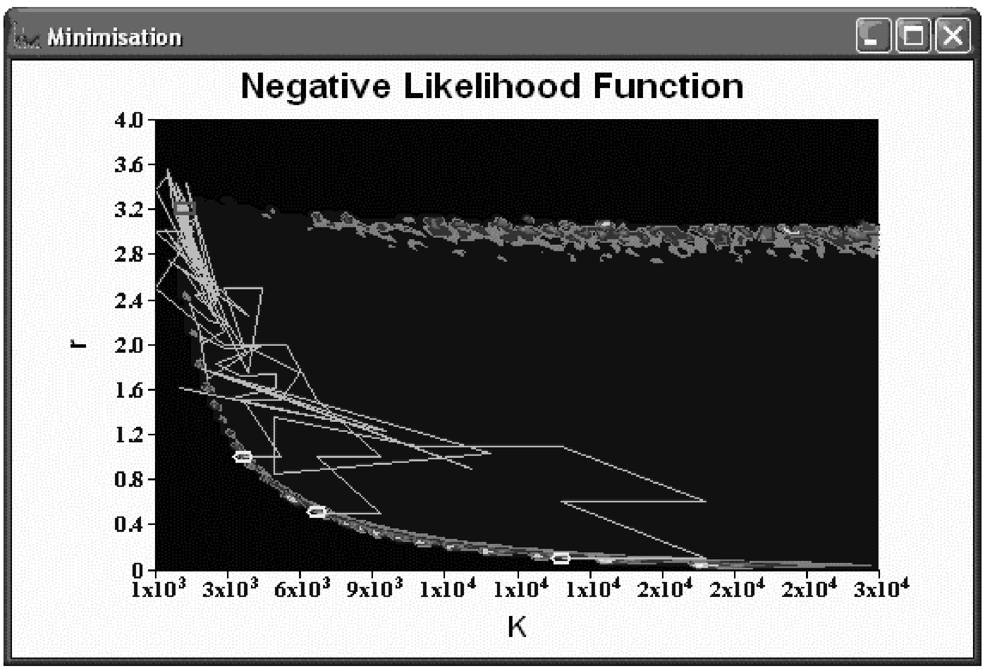


Figure 26. **Illustration of CEDA maximisation search for Schaefer model fitting.**

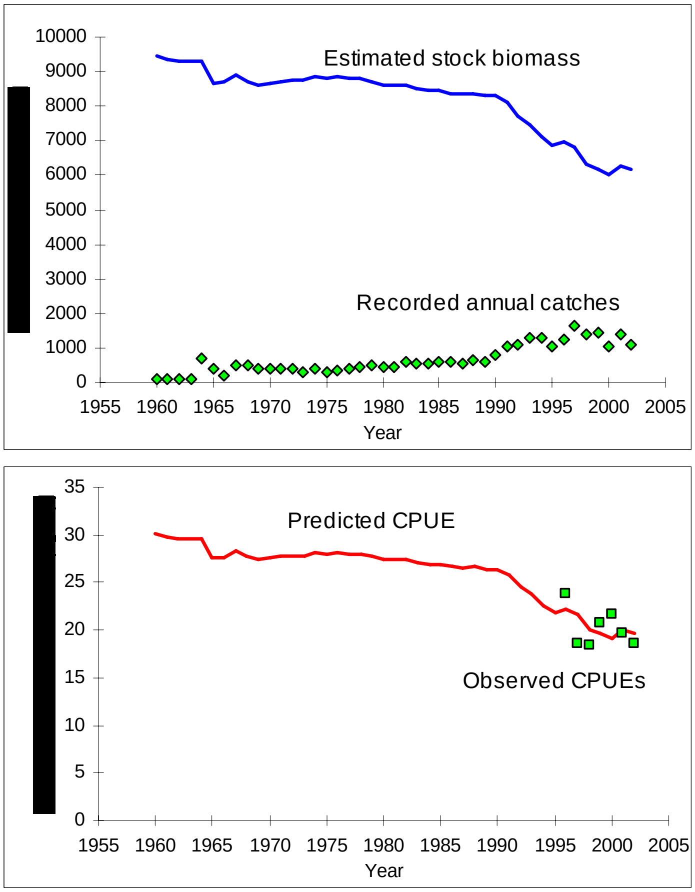


Figure 27. **Illustration of Schaefer production model fit for K=9448t and r=0.6**

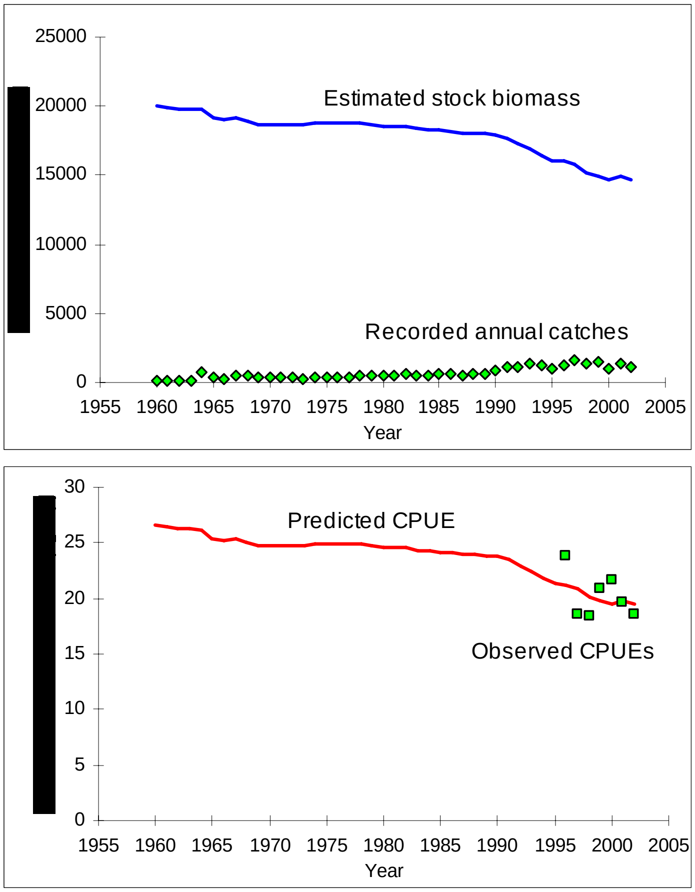


Figure 28. **Illustration of Schaefer production model fit for K=20000 and r=0.32**

PART III – NATIONAL REPORTS SUBMITTED

NATIONAL REPORT - THE BAHAMAS

Prepared by:

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Ministry of Agriculture, Fisheries and Local Government
Nassau, Bahamas

1.0 Introduction

The Bahamas covers an area greater than 343,450 km^2. Of this, 154,553 km^2 comprise shallow waters (up to 200 m depth). The length of the shallow water shelf has been estimated to be 4,633 km. The shallow water banks have an average depth around 9 m but water depth can plummet to between 370 m and 3 700 m along the edge. Just west of the Tongue of the Ocean is the world's third longest barrier reef, running along the east coast of Andros, the largest island in The Bahamas.
In terms of export earnings the most valuable fishery resources obtained from the Bahamian Exclusive Fishery Zone include spiny lobster (*Panulirus argus*), sponge (various species), queen conch (*Strombus gigas*), stone crab (*Menippe mercenaria*) and scalefish (*Epinephelus spp, Mycteroperca spp, Lutjanus spp, Haemulon spp, Caranx spp, Selar spp*). Most of the catch is landed in the islands of New Providence, Abaco and Eleuthera. However, Grand Bahama, Long Island and Andros have lesser but still significant landings of fishery resources. This report will focus on two of these species, the queen conch and the spiny lobster.

2.0 Description of the Fisheries and Fleets

The commercial fishing industry of The Bahamas is based primarily on its shallow water banks, principally the Little Bahama Bank and the Great Bahama Bank. Other shallow water bank areas are also found adjacent to several of the southeastern islands.

Vessels used for fishing in the Bahamas range in size from 11 ft to 100 ft according to The Department's records. A fisheries census conducted in 1995 showed that there were approximately 9,300 fulltime fishers. There were also over 4,000 small boats and vessels.

2.1 Conch Fishery and Fleet

Approximately 95% of fishers are believed to target spiny lobster. It is unknown how many fishers or vessels fish for conch, however, many fishers switch to conch during the seasonal closure of the lobster fishery. Evidence of this is seen in the seasonal fluctuations observed in conch landings. Up to 70% of annual conch landings take place during the 4 months that the lobster fishery is closed. Fishing effort for conch is believed to be high compared to the early 1990s. This conclusion is arrived at because prior to 1992 the commercial export of conch was prohibited except for limited quantities that were exported for personal use. As a result of the lifting of the export ban, there was an increase in fishing effort for conch as evidenced by large increases in landings during 1993 and 1994. During 1993, approximately 217.7 t of conch meat was allowed to be exported, while during the following year, approximately 356.1 t of conch meat was exported. Since 1995 an export quota has been in place, however fishing effort is still believed to be higher.

Queen conch is exploited on shallow banks but primarily near densely populated islands and at depths accessible by free diving and hookah gear. The dinghy is the main type of vessel used in the conch fishery. In many instances these small vessels (< 20 ft long) work in conjunction with a larger motorized “mothership” that acts as a base for operations.

The Queen Conch is primarily collected by hand while diving (hookah and free diving). In few parts of the country the conch staff is used. The conch staff is a pole up to 9 m long. It normally has two prongs at one of the ends and is used to hook the conch and bring it to the surface. Conch is usually landed in the shell and then cleaned dockside. Some larger boats remove the conch from the shell at sea and freeze the meat.

2.2 Lobster Fishery and Fleet

Approximately 95% of fishers are believed to take part in the spiny lobster fishery. Many small vessels that take part in the commercial fishery and they work in conjunction with a large vessel that acts as an operations base. Up to eight vessels may work in conjunction with this “mothership” and may stay at sea for up to four weeks. Virtually all landings are lobster tails. Therefore $^{2}/_{3}$ (the head and legs) of the resource is wasted.

Fishing gears that are utilized include spears, the lobster hook, compressors, lobster traps and casitas. Of these, a license is required for compressors and lobster traps. The maximum number of traps that can be used is indicated on the permit. The traps must also be of specific dimensions (91.4 cm x 61 cm x 61 cm with slats no less than 2.54 cm apart) unless there is authorization to do otherwise.

The casita is locally referred to as a “condominium” and consists of a sheet of zinc placed on concrete blocks or wood. Condominiums are unregulated and very effective at aggregating lobsters. This has resulted in the use of condominiums becoming increasingly popular since the early 1990s. There is a possibility that the condominiums enhance the fishery by providing additional dwelling places for lobsters. Conflicts also exist due to the use of casitas. Fishers who do not use casitas complain that the casitas attract lobsters that would otherwise be found on the reef, thus making the lobsters less available to them. Fishers also complain that use of casitas is so popular that there is little space for them to operate without coming into contact with them. This has resulted in fishers who do not set casitas still harvesting lobsters from any casitas they find. Also, because of the close proximity and great number of unmarked casitas, owners have difficulties in determining which casita is actually theirs. This has lead to further ownership conflicts.

3.0 Data Collection and Handling

Landings data for conch and lobster are collected by interviewing fishers and inspecting their catch. Two data collectors do this. This data is somewhat limited due to the constraints associated with having only two data collectors and multiple landing sites on multiple islands. This data is supplemented by other sources of data and can be seen in Sections 3.1 and 3.2.

Other data that is recorded include the number of duty free allowances, the number of compressor permits and the number of registered commercial fishing boats by size. Records pertaining to compressor permits do not reflect the actual number of compressors used. The registry of commercial fishing vessels also does not reflect the actual number of boats engaged in commercial fishing.

Data that is currently collected is stored as Microsoft Access files. It is entered by a data entry clerk, then organized and checked for errors by the data manager. The data manager also summarizes the information in Microsoft Excel format and makes it available to other staff. The Bahamas is seeking to store, manipulate, retrieve and analyze its data in a much more efficient manner. Improvements in these areas are expected within the next year due to the planned introduction of CARIFIS.

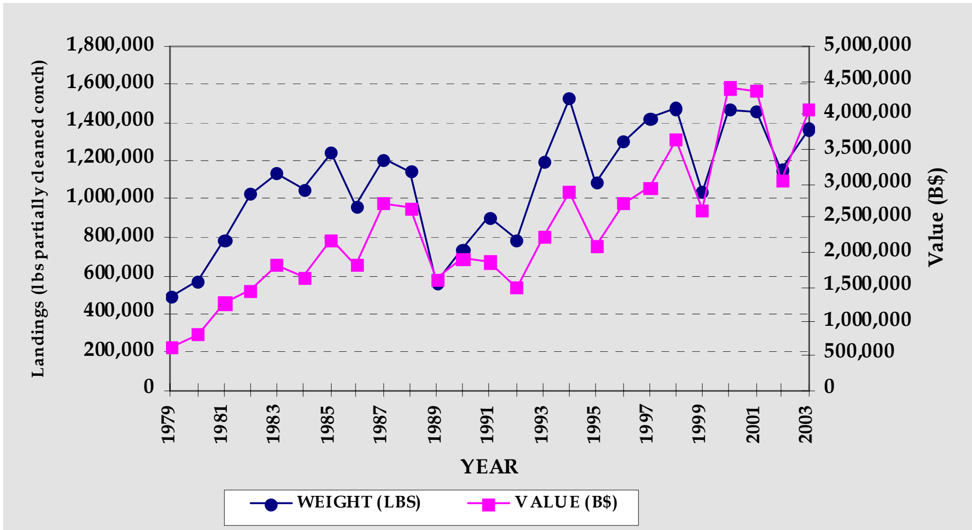
3.1 Conch Data Collection and Handling

The landings data collected by the data collectors does not capture total conch landings since major conch landings also occur on islands where no data collector is present. Fortunately, most islands with major fishing communities also have processing plants that purchase a large portion of the fishery products landed in those communities. Purchase reports and export records are sent to The Department of Fisheries by the processing plants. Thus the Department has estimates of the total weight of conch landed, the total weight exported, the local value of landings, the value of exports, landings by major-island and exports by island. The conch landings data collected refers to partially cleaned conch. In partially cleaned conch, approximately 44% of the wet tissue weight has been removed.

However, the data is still limited in that it does not reflect much of the conch that is sold or consumed locally. Nevertheless, the year-to-year differences in recorded landings are still considered reflective of actual trends in landings. Recorded conch landings had no obvious declining or increasing trend over the last 10 years however; the value has gradually risen (Figure 1). Effort data is also collected. Over 20% of the total recorded landings for conch have the effort data associated with it. However, the percentage of the total effort is unknown.

The Department of Fisheries initiated a conch stock assessment project during 1996 to determine the effect of the current level of harvests on the sustainability of the local stocks. The data required for the project and collected during the project included fishing effort and meat weight frequency by area. In addition to individual measurements of shell length, shell weight, lip thickness, meat weight, and tissue weight were collected for the project. Since the completion of the stock assessment project in 1999, attempts have been made to continue to collect weight frequency and catch per unit effort with the hope of updating this assessment.

Figure 1: Recorded Conch Landings and Value (1983-2003)

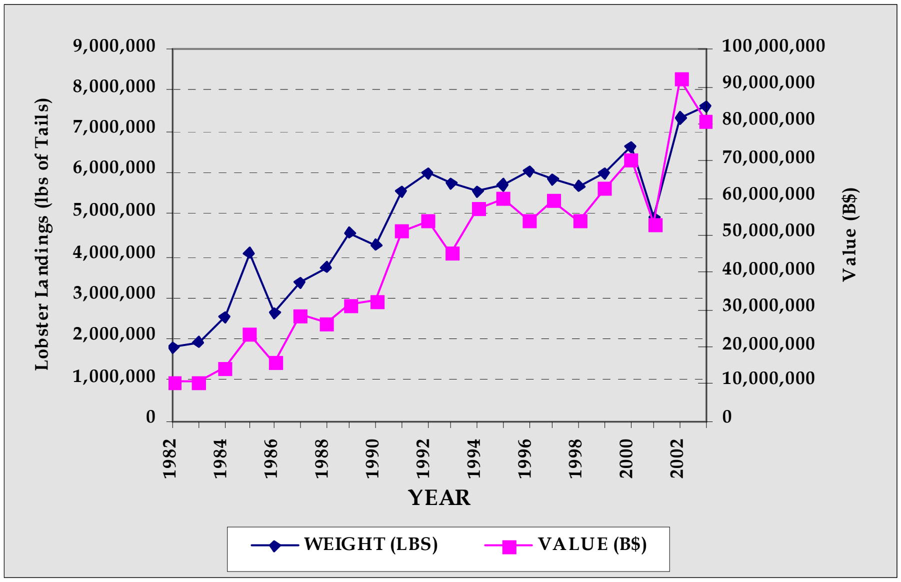


3.2 Lobster Data Collection and Handling

Lobster landings data is supplemented by export records reported by processing plants and consists of total exports per year per commercial size category per processing plant. The processing plants also supply purchase records of what was purchased from fishers. A significant amount of landings are exported. Therefore, exports are believed to be somewhat reflective of total landings. Landings primarily represent tail weights and have gradually risen since the early 1990s (Figure 2). Landings value has also gradually risen.

Approximately 15% of the total recorded landings for lobster have effort data associated with it. The percentage of the total effort is unknown. The export records pertaining to size categories are used as a source of biological data. These export records have been converted to size frequency data. This size-frequency data is valuable but not ideal since analysis currently cannot be applied to time periods smaller than a year in addition to some of the weight categories being too broad (e.g. 16-20 oz category).

Figure 2: Recorded Spiny Lobster Landings and Value (1982-2003)



4.0 Policies and Regulatory Framework

The overall management goal for Bahamian fisheries is to ensure that Bahamian fisheries resources are utilized to the maximum benefit of Bahamians. Only Bahamian citizens can take part in commercial fishing unless the individual is in possession of a spousal permit or a work permit that specifically allows fishing.

Enforcement is the responsibility of the Department of Fisheries, The Royal Bahamas Defence Force, The Royal Bahamas Police Force and The Customs Department. Infractions are usually detected by The Department of Fisheries except poaching by foreign nationals.

Some of the regulations that apply to all Bahamian fisheries are seen below: -

1. SCUBA diving for any fisheries resource is prohibited.
2. Compressors can be used for commercial fishing, but only during the lobster season (August 1 to March 31). In order to use a compressor the fisherman must have a permit from the Department of Fisheries, which is issued only to trained divers.
3. Compressors can only be used in waters between 30 ft and 60 ft.

Approval has also been given for five areas to be designated as marine protected areas. These marine protected areas are expected to positively impact a number of fisheries resources. The Department is in the final stages of determining the boundaries of these areas and formulating management plans. The Bahamas and CRFM are also in the process of developing a fisheries management plan.

In addition to general regulations there are regulations specific to each fishery. Regulations that are specific to the conch and lobster fishery are seen in Sections 4.1 and 4.2.

4.1 Lobster Policy and Regulations

The primary management objective for the spiny lobster fishery is to ensure that spiny lobsters are harvested for maximum economic benefit that this is done in a sustainable manner. A number of regulations are in place for the spiny lobster fishery. These regulations include: -

1. It is illegal to capture, possess or sell egg-bearing spiny lobster
2. It is illegal to remove the eggs from a spiny lobster
3. It is illegal to possess a spiny lobster that has had the swimmerettes removed
4. A license is required to trap spiny lobster. The dimensions must be 91.4 cm x 61 cm x 61 cm with slats no less than 2.54 cm apart) unless there is authorization to do otherwise.
5. There is a closed season during the period April 1st through July 31st.
6. The minimum harvestable size for a spiny lobster is 82.55 mm carapace length or 139.7 mm tail length. The tail length regulation is only enforced when the carapace is absent.

4.2 Conch Policy and Regulations

The management objective for the conch fishery is to ensure that conch is harvested in a sustainable manner while attempting to meet local demand firstly and foreign demand secondly.
In 1995, the government, knowing that it did not have all relevant information necessary to ensure the sustainability of the fishery, adopted a precautionary approach and established a quota system to limit the export of the resource. It was intended that the amount exported would gradually be diminished however the quota has fluctuated since its inception.

A number of regulations are currently in place for the queen conch fishery. These regulations include: -

1. It is illegal to capture, possess or sell conch without a well-formed lip.
2. The commercial exportation of conch or conch by-product is only allowed with a license issued by the minister responsible and inspection by the Department of Fisheries
3. Non-commercial exports are limited to 4.5 kg (10 lbs) for any person, and should be in your personal baggage as you leave the country.
4. Sport fishing regulations allow the harvest of 10 conchs per person for foreign vessels, while in possession of a sport-fishing permit.
5. Compressors can be used for commercial fishing, but only during the lobster season (August 1 to March 31). In order to use a compressor the fisherman must have a permit from the Department of Fisheries, which is issued only to trained divers.

5.0 Conclusion

Bahamian fisheries have historically been difficult to manage. This is partly due to the vastness of Bahamian fishing grounds and the interspersed nature of the Bahamas' over 700 islands and cays. While beneficial in terms of fisheries production, this situation has been a great impediment to providing the resources needed to collect the data, provide the enforcement, and conduct the research necessary to manage Bahamian fisheries at the highest level possible. Nevertheless, the Bahamas has made significant strides in attempting to manage its fisheries sustainably. However, amidst the growing local and global demand for food and economic well being, the Bahamas and support organizations such as the CRFM must continue to improve the level of management afforded to Bahamian fisheries.

6.0 References

Cochrane, K.L.(ed) A fishery manager's guidebook. Management measures and their application. FAO Fisheries Technical Paper. No. 424.Rome, FAO. 2002. 231p

Deleveaux, Edison V. 1999. The Status of the Conch Fishery of the Bahamas. Department of Fisheries. 8 pp.

Deleveaux, V. K. 1999. Report for the *Strombus gigas* Stock Assessement Workshop. Belize City Belize. 6 pp.

Gittens, L. and M. Braynen.2002. Report For The Second Workshop On Management Of The Caribbean Spiny Lobster Fisheries In The WECAFC Area.9p.

NATIONAL REPORT - BELIZE

Prepared by:

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Belize Fisheries Department
Ministry of Agriculture and Fisheries
June 2004

1.0 INTRODUCTION

Prior to 1946 the Caribbean spiny lobster (*Panulirus argus*) was seldom fished as a lucrative commodity (Gordon, 1986). The Lobster fishery is the largest of the capture fisheries utilizing some 62,000 traps and over 2,000 shades. Most of the licensed fishermen in Belize target the lobster commodity utilizing methods such as free diving using hook-sticks, traps and many times shades " casitas". Divers using hook-sticks mostly catch lobster within the extensive inshore reef habitats along the coast of Belize, while others use wooden traps and "casitas". Over the past decades the industry grew as more fishermen ventured in with good returns. In 1949 and 1976 the export tails in pounds was 72,875 and 443,274 respectively. In 1999 the export lobster tails was 656,000 pounds. Lobster production by the Fishermen Co-operatives has maintained fairly stable over the last five years ranging between 400,000 and 600,000 pounds.

Presently the success and importance of the lobster fishery can still be attributed to the high demand on international markets awarding a lucrative price of $ 15.00 US per pound of tails.

2.0 BIOLOGY

The biology of spiny lobsters in Belize the information requires updating, as it is older than 40 years old. Allsopp (1968) completed a study to introduce a data collection system capturing fisheries statistics and provide information on *spawning seasons as indicated by the occurrence of 'berried' females*. His work also outlined the effects of factors such as socioeconomic and environmental conditions on catch; and sought to document other stock parameters, such as on fecundity (see Table 1.1).

Table 1.1 Fecundity of 'berried' females at different carapace lengths

Size of Female (Carapace Length in cm)	**Egg Count**
6.9	260 000
8.4	410 000
9.6	530 000
11.9	870 000

Adapted from Allsop (1968)

Recruitment, and natural mortality were discussed in descriptive details as they relate to migration and shortening of the actual fishing season for the former, and cannibalistic predation and discarding of lobster waste (removed heads etc.) for the latter. Weber (1968) conducted a tagging study to estimate growth and movement. This study also included information on morphometrics. Unfortunately the original data is not available and the report does not contain equations for length/weight or length/length relationships. These reports provided substantive basis for the formulation of the Fisheries regulations regarding the spiny lobster fishery. Wade, Auil and Fanning (1992 in press) also conducted research on the morphometric relationships for spiny lobster for use in verifying and updating the then Fisheries Regulations. The table below summarizes those relationships.

Table 1.2 Direct and indirect morphometric relationships

Sample Location	Type of Relationship	Variables	Equation
Caye Caulker	**Direct**	CL:TW	$CL = 16.31 \times TW^{0.311}$ $TW = 0.0012 \times CL^{2.689}$
National Cooperative. (Belize City)	**Indirect**	CL:TL TL:TW	$CL = 11.13 + 13.418 \times TW^{0.333}$ TW $0.00013 \times (32.08 + 1.375 \times CL)^{2.808}$

Adapted from Wade *et al.* (1992)

Recommendations from the last mentioned report were used to make an amendment to the Fisheries Regulations in the same year.

3.0 DESCRIPTION OF THE FISHERY

Lobster is harvested from traps inside the barrier reef in shallow water and by free diving with hook sticks on rocky bottom and also in deeper waters (60 ft–70 ft) (Figure 1).

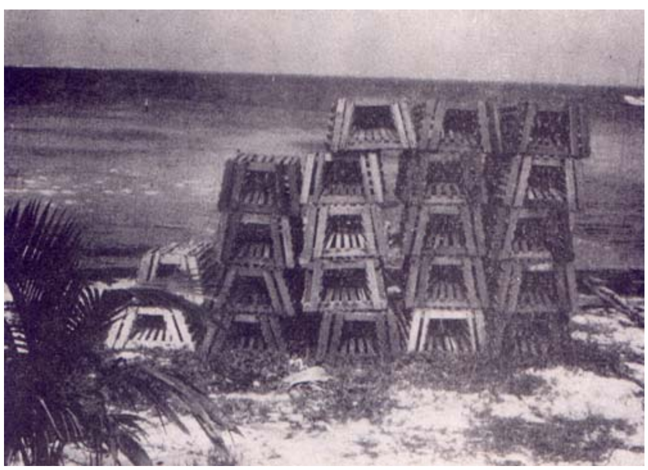

Figure 1.

The fishing fleet is comprised mostly of wooden or fiberglass skiffs with average lengths between 12-28 feet and usually propelled with outboard engines (Figure 2).

Figure 2.

In addition there are the wooden sails boats, which are equipped with sails and auxiliary engines. These boats would carry up to 8 small canoes and 10 divers (Figure 3).

Figure 3.

However, there is a lobster season in Belize that is open from June 14th- February 15th of each year whereby fishermen are allowed to harvest lobster from the main fishing ground. In addition there are other regulations that govern the sustainable existence of the lobster fishery. The fisheries regulation stipulates that it is illegal to be in possession of lobsters as follows:

LOBSTER: (*Panulirus argus*)

1: Minimum carapace length is 3 inches.
2: Minimum tail weight is 4 ounces.
3: **Closed season** is February 15th-June 14th
4: No person shall take berried females or molting individuals.

The Belize marine fisheries sector has grown from approximately 790 registered fishermen and 566 boats in 1973 to approximately 3,200 registered fishermen and 790 registered boats in 2003.

The fishing areas in Belize are divided six fishing grounds where the central and southern part if the coastlines are the areas for fishing lobster in Belize (Figure 4).

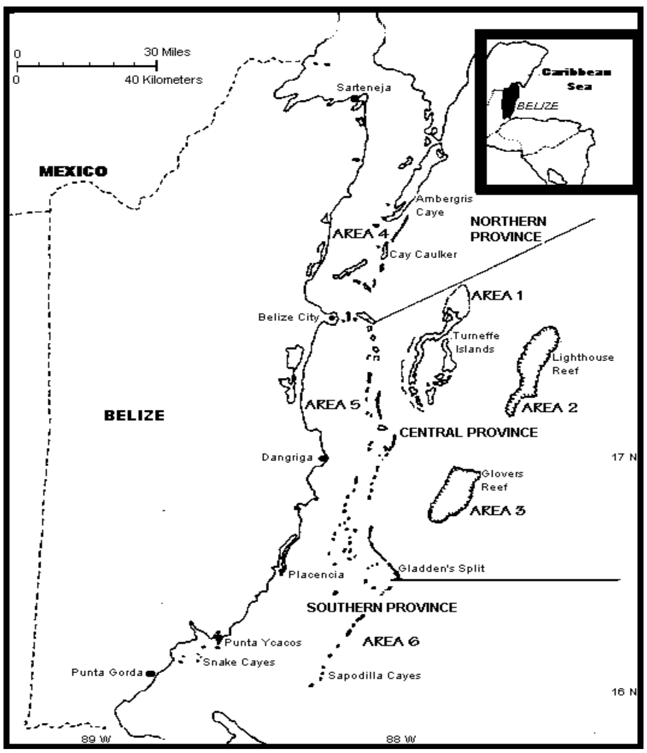

Figure 4.

4.0 STATUS OF THE STOCK

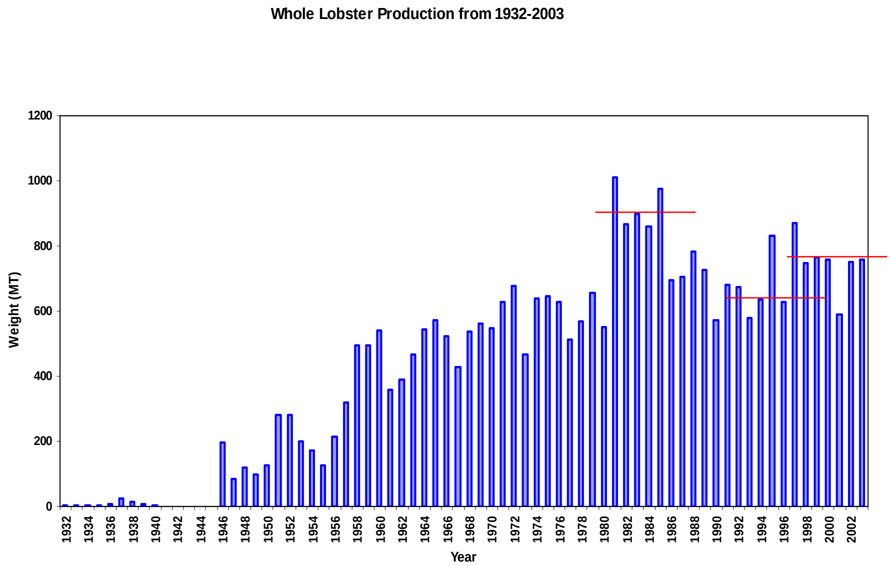

Figure 5.

Lobster landings from Belize are available of the fishery, from 1932 – 2003 (Figure 1). As early from the 1950's landings increased over time with a peak in the 1980's. However, landings decreased in the 1990's due to increase fishing effort (the number of boats, fishers and fishing gears). During the late 1990's and the early 2000's the lobster industry suffered severe impacts caused by hurricanes leading to decrease landings.

Lobster production by the Fishermen Co-operatives has maintained fairly stable over the last five years ranging between 400,000 and 600,000 pounds. A study was conducted in 2000 where the available data in the Department was analyzed, which resulted in the lobster fishery being fully exploited characterized by catch rates fairly stable despite increases in effort and catch fluctuates according to recruitment and environment conditions.

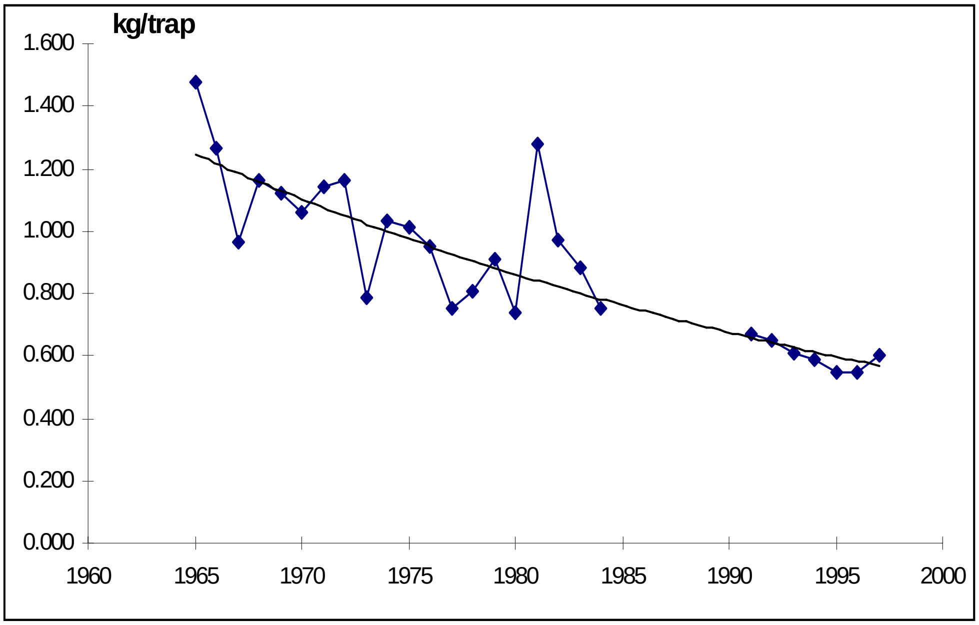

Figure 6.

The health of the fishery is running the risk of being overexploited and if nothing is done presently it might lead to depletion. A simple application of a production model, under the present conditions, shows a Maximum Sustainable Yield of 700 M.T. (whole weight) moving in an interval between 550 and 825 M.T. according to the behavior of yearly recruitment (Del Leon, 2000) (Figure 6).

5.0 RESEARCH

Some basic research has been conducted within three marines reserves, where the abundance of lobster in the marine reserves was monitored and compared to fishing areas outside the marine reserves from 2000- 2003. One of the conclusions was that spill over was occurring in the marine reserves and the abundance of lobster population at Glover's Reef Marine Reserve increased by three fold.

The Fisheries Department has prepared a project proposal document, which has been submitted to a grant agency for funding. It is anticipated that the project will be funded which would allow basic investigation on the lobster population in Belize. The project consists of lobster tagging, underwater surveys, post larva settlement monitoring and the development of a management plan.

NATIONAL REPORT – BRITISH VIRGIN ISLANDS

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Introduction

The British Virgin Islands (BVI) is located to the east south east of Puerto Rico. The territory has a population of approximately 22,000 people and is 182 square kilometers in area.

Although it is generally accepted in the BVI that the fishing industry is important, many residents are probably unaware of its valuable social and economic contribution and its potential to generate more benefits than are currently realized.

The fishing industry unfortunately, has a legacy of being considered the poor man's trade. Fishing gear and craft are thought of as traditional and unsophisticated, seemingly requiring no special skills to operate them and the benefits from fishing either subsistence or on a small scale commercially. At the macro economic level the estimated contribution of fishing to the Gross Domestic Product (GDP) is relatively low being about 1.35 in 1999 and ranging between 3.3 (1981) and 1.12 (1994). At the policy level this suggests that the fishing industry is relatively unimportant and ranked close to the bottom of the government's agenda. It is however, generally believed that the fisheries contribution is grossly underestimated as a consequence of inaccurate reporting and inconsistent data collection activities, which excludes many of the relevant components of the fishing industry from national accounting estimates.

Furthermore, it is often forgotten that these poor subsistence or small-scale fisherman help to provide a valuable source of protein, making an important contribution to food security. From a nutrition perspective fish is an easily digestible food, and an excellent source of essential nutrients especially to children. Ordinary citizens, who enjoy fish as food, do not go out to sea with fisherman and are therefore unaware of the remarkable skill employed by the fisherman at sea.

Modern fishing has radically changed, requiring a fisherman to operate larger vessels and use modern equipment, maps, and modern fishing gear. It is also now necessary to learn modern techniques of handling and marketing fish and business management strategies.

Geography

The BVI exist on the same geological shelf as Puerto Rico and the US Virgin Islands with the exception of St Croix. The total shelf area is approximately 3,026 square nautical miles (10,393km^2) of which about 3130km^2 (30%) is under the jurisdiction of the BVI. Approximately 90% of the BVI portion of the shelf is comprised of coral reef and rocks. There are several banks which rise above the general shelf floor but the most notable ones associated with fishing are the Barracuda Bank which is located in the south east of Virgin Gorda, the Barracuda Bank in the north west of Jost Van Dyke, the Kingfish Bank, Turtle Head and Whale Bank to the north of Jost

Van Dyke. The shelf edge is generally considered to be at the 100-fathom (180m) Isobaths beyond which the ocean floor rapidly plunges to depths in excess of 1000m.

The pelagic area beyond the shallow shelf belonging to the BVI is vast; it is approximately 830000 square nautical miles (274813 km^2)

The Fisheries

The fisheries of the BVI have been categorized into two main types namely the commercial (artisanal) fisheries and the recreational fisheries. There is a third emerging fishery namely the offshore longline pelagic fishery.

Artisanal Commercial Fisheries
The commercial fisheries are in fact artisanal fisheries, which employ small boats and traditional methods. Studies show that there are about 300 commercial fishermen operating in the BVI waters. Fifty percent (50%) of the fishermen own fishing vessels and gear and the other 50% act as helpers or employees of the vessel and gear owners. The age of the fishermen ranges between approximately 20 and 80yrs. Fishers are either full time or part-time. Pomeroy (1999) in a survey of the population of commercial artisanal fishers found that 55% of them were full-time and 45% were part-time.

Fishing Vessels and Gear
There is a wide range of vessels comprising the commercial artisanal sector. Vessels range in size and type from 11ft dinghys to 60 ft vessels of various types. The ranges of vessel sizes are presented in Table 1 below.

Table 1 Vessel sizes and numbers per category.

Vessel Size	Number of vessels
Up to 12’	1
12’ to 20’	46
21’to 30’	44
31’ to 40’	11
41’ to 66’	10
67’ and more	0

(Pomeroy 1999)

Pomeroy (1999) reported that 68% of the vessels use outboard engines, 36% use inboard engines and one vessel use an inboard\outboard engine. The horsepower of the engines used is presented Table.2 after Pomeroy (1999).

Table 2 Engine horse power and numbers of different types

Horsepower	**Outboard engines**	**Inboard engines**	**Inboard/outboard**
Up to 15hp	7	-	-
15hp to 30hp	9	-	-
31hp to 50hp	9	-	-
51hp to 100hp	26	2	-
101hp to 150hp	12	12	-
151hp to 300hp	10	14	1

301hp and more	1	8	-

(Pomeroy, 1999)

The most popular fishing gear is the fish trap, even fishers who use another gear type as the primary gear will use them, in some cases as a secondary or tertiary gear. Most fishers tend to use a combination of fishing gears to target different species seasonally. The fishing gears and gear combination used by commercial fishers is presented below in Table 3.

Table 3 Gear type combination and number of users

Gear type combination	Number of users
Fish trap	50
Fish trap/handline	47
Handline	13
Seine net /fish trap/handline	7
Seine net /fish trap	7
Seine net	7
Fishing rod/handline	4
Dive	4
Fish trap/fishing rod	4
Fish net/seine net/handline	4
Fish trap/gillnet	3
Fishing rod	3
Fish trap/fishing rod/handline	3
Longline/fishtrap	2
Handline/gillnet	2
Seine net/handline	2
Dive/fish trap/ handline	2
Dive/handline/fishing rod	2
Fish trap/handline/longline	2
Fish trap/handline/gillnet	1
Horizontal longline	1
Handline/dive	1
Handline/fishing rod/ fish trap/ gillnet	1
Fishtrap/longline/handline/fishing rod	1
Fish trap/gillnet/fishing rod	1
Longline/fishing rod	1

(Pomeroy 1999)

About 40% of the catch landed annually by commercial artisanal fisherman is from fish traps. The catch comprise mainly reef and slope fish such as *Acanthurus coeruleus* (blue tang), *Acanthurus chirurgus* (doctor fish), scaridae (parrotfish), haemulidae (grunts), balistidae (triggers) etc. Lobsters are the most lucrative component of the fish trap catch. Traps are either rectangular box traps, arrowhead traps or Antillean Z shaped traps. They are made of chicken wire walls and wooden frames as shown below.

Rectangular box traps at Red Bay Landing Site

Mesh size is about 11/2” to 2”. The construction of the walls of fish traps with plastic coated, square wire mesh walls is an emerging trend which is being discouraged, in addition a programme is to be implemented to promote the use of biodegradeable panels in fish traps. Traps are set either individually or in strings of 4,5, 6, 7, or 8 traps, between 50 – 60 ft apart. Traps are set in depths of 80 to 120 to 150 ft. They are cleared about twice per week. Once traps are set the fisher will go out on day trips to clear the traps with a crew of 2-3. Trips per week average 1.7 and time on a fishing trip averages 7.5 hours. Some fishers go out overnight clearing the traps over two days before returning to port. A few, (it is believed, four) combination fishers go out for 3 to 5 days and will clear the traps twice during that time.

Rectangular box traps at Red Bay Landing Site

The hook and line fishery presently contributes a small amount approximately 10% to the total fish caught by commercial artisanal fishermen. About 70% of the catch is composed of snapper and groupers. Most of the hook and line fishing is conducted in the deep water slopes and banks using vertical lines. Lines used are typically 40, 50 and 60 pound test line. Number 8 or 9 hooks are commonly used. Off shore pelagic longlines may comprise up to 1,200 hooks at a time. Trips may be 5 to 7 days.

The net fishery is characterized by the use of gill net and beach seine nets. The fishery contributes approximately more than 35% to the total annual catch landed by artisanal fishermen. It is generally known that bonito (*sarda sarda)* and some species of carangids (mostly blue runner and carevalle jack) form the bulk of the net catches.

Fishing Seasons

Fish traps are normally used all year round but generally used on an average of 40 weeks per year. The same time frame has been determined for handlines and rods and diving. Horizontal longlines are generally used from October to May. It was estimated that they are used on an average of 22 weeks per year. Seine nets are used largely from November to March for jacks and from March to August for S*arda sarda* (bonito), *Caranx crysos* (hardnose) and *Ocyurus chrysurus (*yellowtail). Seine nets were reported to be used an average of 30 weeks per year (Pomeroy, 1999)

Fishing activities

Pomeroy (1999) found that generally artisanal (commercial) fishers fish an average of 2.5(SD:0. 89) trips per week. The average total time of a fishing trip (from leaving the landing site to returning to it) was found to be 10.4 (SD: 19.88) hours. The minimum amount of time of a fishing trip was two hours, while the maximum was 216 hours. Full time fishers, fished and average of 2.7 (SD:0: 82). For 1998 the average number of fishing trips per week and the average total time of a fishing trip for seven major fishing gears/combinations were determined as shown in Table 4 below (commercial longline are excluded)

Table 4 Average fishing per week and total time or a fishing trip for seven major fishing gears/combinations

Gear type	Trips per week	Total time of a fishing trip
Fish Traps	1.7 (0.7)	7.5 (8.89)
Fish Traps /Handline	1.7 (.81)	10.4 (9.12)
Seine Net Trap Hand line	2.6(1.71)	6.9 (3.5)
Seine Net	2 (0.71)	5.4 (3.97)
Dive	2.3 (0.54)	5.1 (2.16)
Seine Net/fish Trap	1.6 (0.41)	5.4 (3.1)
Fishing Rod/ Handline	4.6 (1.86)	10.8 (9.3)

(Standard deviation in parentheses)

Pomeroy (1999) further reported that 91% of all the fishers using fish traps explained that they would haul all of their traps during a fishing trip. Fishers who use hand line and fishing rods report that they usually keep an average of one hand line per person in the water and two fishing rods per person in the water. The number of sets and hauls of a gillnet and seine net will depend upon the catch and the “action’. The fishers report that they will set and haul the net an average of two times per trip depending on the catch. However, they will terminate their activities if there is a large catch after one haul or if there is no catch. Divers reported making an average of three dives per fishing trip.

Landings

The total landings by the commercial/artisanal sector is approximately 820,000 kg. The 1998 economic study conducted by Pomeroy (1999) provided estimates of catch, excluding oceanic pelagics, per sq kilometer shelf area in the BVI per year of 570 lbs (259kg.) and trips per sq. km. of 2.94 trips.

Data Collection

Systematic data collection systems remain to be developed. Currently limited landings data are collected at the BVI Fishing Complex. The legally mandated management system for the Fishing Complex directed that all fishers sell 80% of their catch to the Fishing Complex. One of the objectives of this was to facilitate among other things the continual recording of fish landings by vessel/diver and to derive estimates of total landings for the Territory. Infrastructure was also developed for the outer islands, to facilitate this system. However, the ease of delivering catch directly to waterfront hotels and restaurants, the higher prices received for this as well as for direct sales off trucks or from homes have militated against the success of this system. Only a few fishers sell their fish to the Fishing Complex and these are primarily from one location. There are a limited number of divers and about half of them sell their catch regularly to the Fishing Complex. Using data collected through the economic survey by Pomeroy 1999 and data collected by the Fishing Complex estimates of total production were derived (quoted above) as well as estimates for two of the most important commercial species namely lobster and conch. The estimated landings of lobster and conch are presented in Figures 1 and 2 respectively.

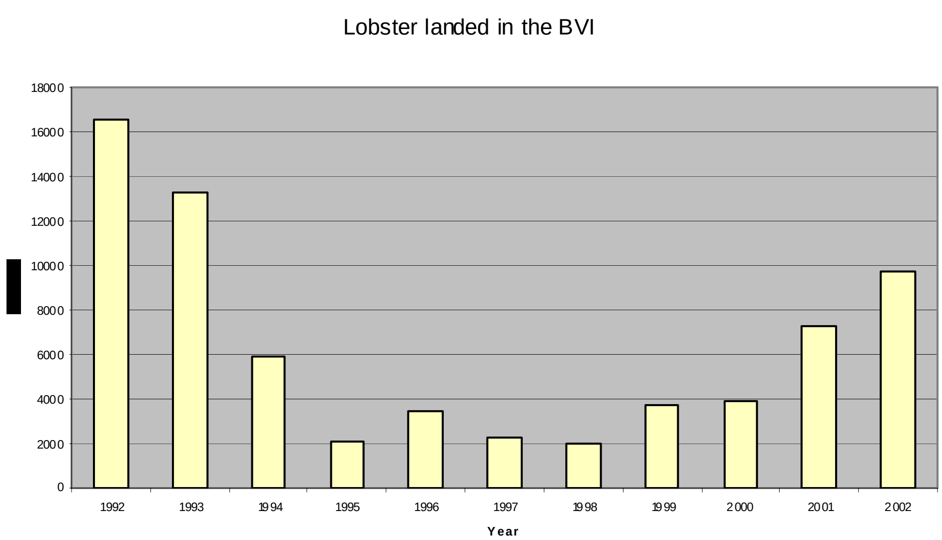


Figure 1. Estimated landings of Lobster landed in the BVI.

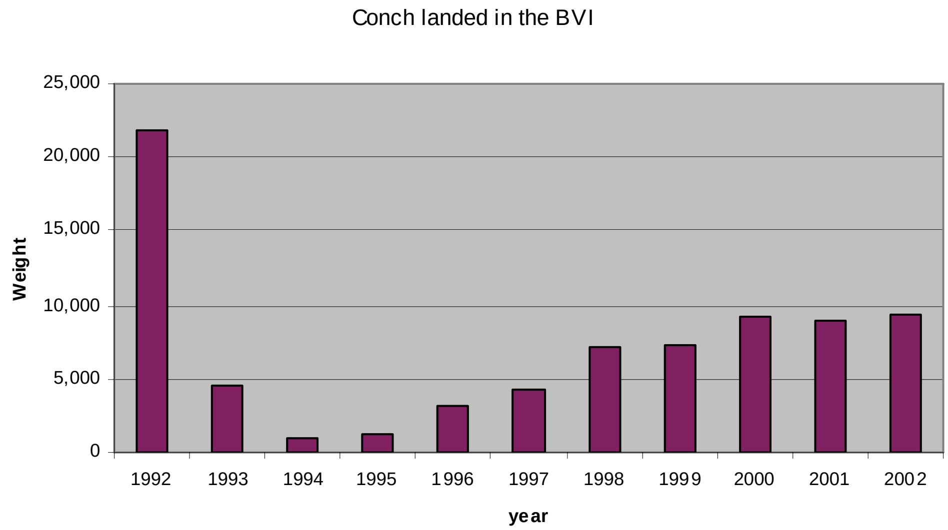


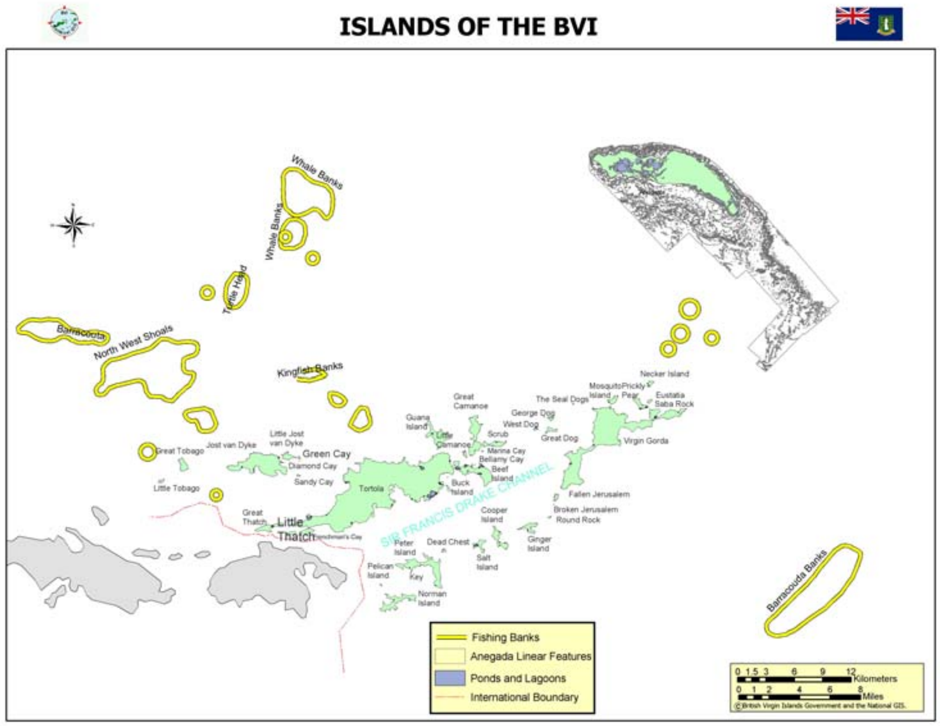
Figure 2. Estimated landings of Conch landed in the BVI

Currently biological data are collected at the Fishing Complex for a number of species including the red hind (*Ephinephalus guttatus*) which is one of the most important food fish species. These data are primarily length and weight data as well as details on fishing location, fisherman, gear used and total weight of catch. Data collection systems are currently being reviewed and a logbook system is to be implemented. Completion of the logbook is a legal requirement under the 1997 Fisheries Act. This will be linked to the licensing and registration system. The completion and submission of logbooks will be a criterion for evaluating applications for fishing licenses. This will also address the problem of disposing of catch before arriving at the landing site as well as the difficulty of enforcing the mandatory sale of 80% of the catch to the Fishing Complex. The logbook system is expected to be supported by an observer programme.

In terms of relative importance of species in the landings by volume, some indication of this was obtained from a percentage composition of landings of the sample taken at the Fishing Complex for biological data collection. The yellow tail snapper (*Ocyurus chrysurus)* and the queen triggerfish (*Balistes vetula*) were most important by volume. In terms of value however, the most important species are the queen conch, spiny lobster and red hind.

Fishing Areas
The BVI is comprised of over 40 islands including various cays and rocks providing diverse habitats for marine fish species. Figure 3 shows the distribution of the island masses and banks exploited by local fishers.

Most artisanal fishing is carried out on the shelf particularly in the areas around Anegada, east and north of Tortola and Jost Van Dyke including the banks. The areas around Virgin Gorda, Peter Island, Cooper Island, Salt Island and to the west of these islands are also fished by a number of fishermen. Hook and line fishing (vertical longlining) is conducted in deep water around the edges of the shelf and at Barracuda Bank on the east side of Virgin Gorda. This is also the area most frequented by the recreational fishermen.



Marketing
Most fishermen market their own catch at various convenient places within the territory. A few sell their fish at or near landing sites. Marketing of fish from the back of a pickup truck is not uncommon. An appreciable number of fishermen sell their catch directly to the hotels and restaurants, as most of these establishments are located on the waterfront. The catch is usually delivered before the fishers return to their homeports. A small number of fishers sell their fish to the BVI fishing company. Some of the fishers from Anegada have established a marketing system whereby their fishing activities are made to conform to the demand by foreign buyers who visit the island regularly.

Recreational Fisheries
Recreational fisheries that operate within the BVI comprise mainly foreign boats and fishermen who visit the BVI for the purpose of fishing for pleasure and sport fishing. The difference between sport fishing and pleasure fishing lies in the sport fishery potential to catch big game fish such as the marlins and sailfish. The sport fishing vessels are adequately equipped to catch such fish while the pleasure fisherman normally use a simple handline or rod and line for amateur angling. Pleasure fishing licenses are either valid for one year or one month. The fishers with annual licenses target pelagics. The boats are either privately owned or are charter boats and fish individually or in organized fishing tournaments. This is a growing industry. In 2003 over 700 pleasure fishing licenses were granted. In 1991, 127 licenses were issued in respect of

recreational fishing boats by the Conservation and Fisheries Department. Of the licenses issued, about 80% were for foreign boats, mostly operating from the neighboring USVI; approximately 54 licenses were issued for sport fishing while the rest were for pleasure fishing. Pleasure fishers are limited to 30 lbs catch per trip. Approximately 39,000lbs. (17,727kg) was landed by charter boat operators in 1998 (Pomeroy, 1999).

Offshore Pelagic Fishery
As previously mentioned this is an emerging fishery. There are currently two boats involved in this fishery. In 2003 there was only one boat in operation targeting swordfish, tunas and other billfish, using pelagic lines. For the 2003 fishing season just over 8,000kg of swordfish and 2,200 kg of tuna were landed.

Policy and Legislation
The Conservation and Fisheries Department has the statutory responsibility for the conservation and management of the living marine resources including the fisheries resources. It's mission articulated in the Fisheries Management Plan (FMP) of the BVI, is to *seek to ensure that the fishery and the resources base on which it depends are managed in a sustainable manner for the greatest possible benefit of the people of the British Virgin Islands.*
The goal of fishery management as stated in the FMP is *to ensure that stocks are maintained at, or are restored to, levels that can maximize sustainable yield given an appropriate, environmentally sound and economically justified effort.*

The FMP further identifies the Objectives of Fishery Management as follows:

- To ensure that the fishery is effectively managed towards sustainable use of the resource base
- To ensure that development objectives are identified, prioritized and management measures implemented towards increasing the sustainable contribution of fisheries to the gross national product, while generating greater foreign exchange earning, increase locally produced marine food supplies and employment opportunities for the British Virgin Island nationals.
- To develop a consensus based framework for integration of marine and coastal resource used, towards rational exploitation of the national resource base.

A comprehensive review of domestic fisheries legislation was undertaken in 1995 with a view to incorporating the relevant provisions as necessary. This review led to a complete revision of the Fisheries Ordinance. Specifically, emphasis was placed on the incorporation of UNCLOS and specific provisions for the inclusion of sections relevant for the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on Law of the Sea relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks and related Instruments.

The Virgin Islands Fisheries Act 1997 provides for the development of Fisheries Management Plans through relevant assessments. The Act promotes the optimum utilization of the living resources of the EEZ for the benefit of the Territory. It provides for the licensing of national as well as foreign fishers and vessels and specifies terms and conditions of harvesting including fees and associated fines and penalties for contraventions of the Act. It also prescribes quotas in respect to some components of the fishery, for example a 30 lb catch limit for pleasure fishing as well as mechanisms to limit the number of participants in all categories if required.

It requires the determination of fishery surplus and prescribes conditions of access by other states or "competent regional organization". In this regard it promotes regional or joint approaches to management and enforcement of fisheries regulations and harmonization of fisheries management frameworks within the region.

There are terms and conditions stipulated for the conduct of marine scientific research. Such stipulations include not only local but also foreign applications to conduct such research. Terms and conditions extend to the data and information collected and access to such data and information.

In addition closed areas with respect to marine protected areas and fishing priority zones are declared. Closed seasons and moratoria are prescribed for specific resources and mechanisms for the continual review of management and conservation measures are included. In addition certain identified fishing practices (use of scuba equipment, spearguns or explosives) are prohibited.

Closed seasons

***Margate* Jan. 1-Mar. 31**

***Red Hind* Jan. 1- March 31**

Nassau grouper
Mar. 1–May 31

***Conch* June 1-Sept. 30**

***Turtle* April 1 to Nov 30**

***Lobster* March 1-June 30**

Minimum size limits are specified with respect to certain species. The minimum size for lobsters is 3.5 inches carapace length and tail weight of not less than 12 ounces. For conch the minimum shell length is 7 inches and minimum meat weight of not less than 8 ounces. The catching of immature whelk is prohibited. An immature whelk is defined as one with a shell smaller than 2.7/16 inches. Limits and restrictions are placed on the harvesting/landing of reproductively active individuals of some species (Lobsters).

The legislation further requires that the relevant authorities maintain a register of vessels of all categories.

It also prescribes the data that should be collected and provides for the systematic reporting of relevant data to appropriate management authorities with respect to certain resources. In this regard the legislation promotes cooperation with neighboring states in the conservation and management of living marine resources.

Provision is also made for protecting the marine environment from pollution from any source. The legislation therefore provides for cooperation with other states and regional organizations for the purposes of "undertaking programmes of scientific research and encouraging the exchange of information and data acquired about pollution of the marine environment", establishing rules and standards, and working towards the reduction, elimination or prevention of marine pollution.

In the Act terms and conditions are also specified for aquaculture and processing establishments. With regard to the latter adherence to conditions stipulated under associated legislation is mandated.

Research

The research capability of the Conservation and Fisheries Department is limited. A number of activities are being developed aimed at enhancing the data collection system for catch and effort data. Current and recently completed research projects are presented below in Table 5.

Table 5 Current and recently completed research projects

STUDY	OBJECTIVE	OUTPUT/STATUS
Lobster Monitoring Programme	Generally to specify peak spawning periods for lobsters in the BVI. -Initiate and continue fisheries monitoring activities for lobsters. -Establish linkages among related institutions for research on lobsters. -Initiate fisheries independent surveys for lobster resources. -Develop an information support network for lobster research.	Involves collection of fishing details, length frequencies, gender, reproductive stage for females numbers of berried females caught (landings not permitted) ongoing
Researching Red Hind spawning and aggregation sites within the BVI (Hind Project)	-To identify possible spawning aggregation sites within the BVI. -Calculate the gonosomatic indices and reproductive stages through the spawning season	Technical Report # 1;On- going
The abundance and distribution of queen conch in the BVI	-To address the concerns regarding the decline of the conch stock in the BVI	Paper and poster presented at the GCFI Conference Nov. 2003; On-going
GIS and fisheries management in the BVI-its uses and practicalities	-To show how GIS application could benefit the fisheries managements. Its advantages and importance of inculcating the use of GIS within the fisheries unit	Paper presented at the GCFI Conference Nov. 2003; Completed *"GIS in Fisheries Management in the British Virgin Islands – issues and practicalities."*

References Source Documents/Literature Cited

British Virgin Islands Government. Virgin Islands Fisheries Act, 1997 arrangement of sections.67p

British Virgin Islands Government (2003). Virgin Islands Fisheries Regulations arrangement of regulation.121 p

Conservation & Fisheries Department, British Virgin Islands. Fisheries Management Plan. 56 p

Pomeroy, Robert S.1999. Economic analysis of the British Virgin Islands commercial fishing industry 26p.

Powers, Robert John L.Munro, Mark Difenthal and Grant Lane. 2003 Preliminary investigation into the feasibility of small scale, commercial aquaculture of Pueruli from the wild 12p.

The Agriculture, fisheries mining & Quarrying Subcommittee January 1998. Productive and Economic sector report Agriculture fisheries Mining & Quarrying Construction.46p

NATIONAL REPORT – GUYANA

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I. ABSTRACT

The Republic of Guyana has a total area of 215,000 km2 (83,000 sq. miles), a coastline of 432 km., a continental shelf area of 48,655 sq. km., and an EEZ of 138,340 sq. km. The fisheries sector is a net foreign exchange earner, contributing 2.4 – 2.7 % of GDP over the last 5 years. The marine fishery is divided into industrial, semi-industrial and artisanal. The inland fishery is at a subsistence level, and aquaculture is in the research and developmental stage.

The fisheries policy has outlined specific policies for various fishery types, but this is not yet implemented. The Coast Guard assists in MCS. Legislation is being updated.

The Penaeid Fishery is experiencing declining landings, while the Seabob Fishery is experiencing increasing effort and landings. The Red Snapper Fishery is relatively new and experiencing increasing effort. The Inshore artisanal Fishery comprises a variety of gear types, which effectively exploit the artisanal fishery. The artisanal fishery continues to experience increased effort, and landings continue to increase.

The vessel data is out of date, and the sampling coverage very low for certain segments of the fishery.

II. BACKGROUND INFROMATION

a. Guyana – Geography, Climate and Population[1]

The Republic of Guyana is located on the northern coast of South America, bordering the Atlantic Ocean and sharing the southern border with Brazil, the eastern border with Suriname and the western border with Venezuela. Its total area of 215,000 km2 (83,000 sq. miles) is divided physically into four broad ecological zones:

(i) A flat coastal clayey belt which is about 4.5 feet below sea level, and in which most of the agriculture activity occurs;

(ii) A sand belt, to the south of the coastal belt, which includes the intermediate savannahs;

(iii) An undulating, central peneplain, which comprises more than half of the country's area, and in which are located tropical forests and mineral deposits. This landform stretches from the sand belt to the country's southern boundary and also encompasses the Rupununi Savannah which borders Brazil;

[1] Chakalall, B. 1991. Aquaculture in Guyana – A preliminary Assessment. FAO Programming and Formulation Mission to Guyana. TCP/GUY/9151

(iv) The highlands, which are found in the mid-western area of the country. This area includes the Pakaraima mountain range.

Administratively, Guyana is divided into 10 Regions (Appendix 3c).

Guyana has an extensive system of rivers and creeks, most of which have their sources in the mountain ranges of the south and west and flow north-easterly to the Atlantic Ocean.

Guyana has been described as having abundant natural resources which include fertile agriculture lands on the coastal plain and in the riverine areas, tropical hard wood forests and associated fauna, fish and shrimping grounds both in the Atlantic Ocean and in the rivers, and minerals such as gold, diamonds, bauxite and manganese.

Guyana has an equatorial climate, its main features being high but variable rainfall, high humidity, and a relatively narrow variation in temperature. The annual temperature range is 21 to 32ºC (average 26ºC). The heat in the coastal areas is tempered throughout the year by cool north easterly trade winds. The daily average sunshine is between 6 to 7 hours and the daylight hours range from 11.5 to 12.5 hours.

Rainfall is high, but variable, with an average of 2,400 mm per year in the coastal plain. The coastal rainfall pattern is fairly well defined with two rainy seasons in May/June and in December/January, the former having the largest amount of rainfall. Rainfall in the forest region averages about 2,600 mm and in the savannah region about 1,500 mm per year. The Rupununi Savannah region has a well-defined dry season from October to April. The country lies south of the hurricane belt and is not affected by the hurricanes that periodically pass over the Caribbean and Central America. Tidal waves are not known to occur in this region.

The most fertile soils are found in the coastal plain but require seas and river defenses to make them cultivable. The coastal plain is composed mainly of recent alluvial deposits of very fine clays and varies in width from 16 to 64 km. The major agricultural products for export (sugar, rice) are grown in this region, which is also the major fishery and livestock production area and where the industrial and commercial centres are located. It is estimated that the coastal plain is less that 5% of the total land area.

Almost the entire coast was covered with mangrove formations. Over the years, there has been a severe depletion of the mangrove vegetation, which is presently estimated to be about 80,000 ha. Some local residents claim that the depletion and expansion of the mangrove vegetation was a cyclical process. Very little documented information is available on the mangroves and the causes of its depletion.

Most of the coastal region generally lies between 0.5 – 1 m below mean high tide level, and extends approximately 8 km or more from the coastline. As a result, the coastal plain is subject to flooding by seawater. Over time, protective concrete sea walls and earthen embankments were built and together with a network of drainage canals and sluices protected the coastal plain from flooding.

The total population of the country was estimated (mid-2000) at 772,000 persons, most (approx. 90%) of whom are concentrated along the narrow coastal strip bordering the Atlantic Ocean. The population density is 3.59 persons/km2 when related to total land area and about 300 persons/km2 when related to agricultural land.

b. Marine Fishing Area[2]

Guyana has a coastline of 432 km and a continental shelf area of 48,665 sq. km. The average width of the continental shelf is 112.6 km. The area of the Exclusive Economic Zone (EEZ) is 138,240 sq. km. Most of Guyana's fishing occurs in the relatively shallow waters of the continental shelf. The marine resources exploited within the EEZ are mainly the demersal fishery resources and, to a much more limited extent, the pelagic fish resources which are to be found both over the continental shelf and toward the continental slope.

c. General Overview of the Fisheries Sector, and Importance of the Marine Fisheries3

The fisheries sector plays a strategic role in the economy of Guyana. Its contribution to the Gross Domestic Product (GDP) has oscillated between 2.4 and 2.7 per cent during the last five years, and top the agricultural GDP, between 7 and 8 per cent during the same period. The sector also contributes to the balance of trade by being a net foreign currency earner. Appendix 3b shows fish production for the period 1991-2001.

Between the period, 1962 and 1972, annual fish imports almost doubled fish exports in live weight terms. Between 1972 and 1992 fish imports figures were almost zero. Any increases in imports after 1992 can be considered insignificant, in comparison to the level of fish exports.

During the last decade, there was a steady growth in fish exports. In 1999, fish exports reached a peak of US$35. million, made mainly of frozen shrimp and fresh and frozen fish products. It is foreseeable that the driving force of international demand for fish and fish products will continue to reinforce these trends. The main export markets for Guyana fish products are the Caribbean (Jamaica, Trinidad and Tobago and Barbados are among the most important destinations) and in North America (USA and Canada). Exports to EU countries are not significant at this stage. It is worthy to note that a good volume of Guyana's fish exports, in particular to CARICOM countries, is composed of small/medium size shipments made by small producers and traders.

Per capita fish consumption in 1999 was about 58.7 kg, one of the highest in the world. The high per capita fish consumption translates into a significant contribution of fish to the total animal protein intake (46%) and to the total protein intake (23%) of the population of Guyana.

The fisheries sector plays a strategic role in its contribution to food security. Since it is a major, and very often, almost the only alternative source of food, income and employment for households in marine, coastal, riparian and rural communities. It is estimated that about 10 600 jobs depend directly from fish harvesting, processing and marketing activities. Many other persons are also benefiting indirectly. The sector thus makes an important contribution to poverty reduction through the provision of opportunities for income generation and enhancement.

[2] National Development Strategy for Guyana (Shared Development through a participatory Economy) Chapter 13 – Fisheries Policy, 1997-2002. Ministry of Finance, Government of Guyana.

[3] Chakalall, B. and A. Gumy. 2002. Programme for the Organisational and Operational Strengthening of the Department of Fisheries of Guyana. FAO Mission report prepared for the Government of Guyana (*Draft*). Georgetown, Guyana, 23 April – 3 May 2002.

The labour-intensive, small-scale (capture fisheries) sub-sector supplies fish primarily to the domestic market. The capital-intensive, industrial sub-sector supplies mainly the export market. The small-scale fisheries sector has shown dynamic growth with a steady increase in landings, which peaked during the 90's. During this period, landing, storage, distribution, and service facilities were improved. However, the main operational conditions, such as scattered landing sites, insufficient landing and distribution infrastructure, weak organization patterns, difficult working and living conditions of fishers and rather low economic returns to fishers' efforts, still prevail, as in most developing countries.

In the recent past, the production from the small-scale fisheries has been increasingly supplying the international market, through numerous shipments of small volume to neighbouring Caribbean countries and to ethnic communities living in the USA and Canada. The industrial fishery supplies to the domestic market with by-catch species have also been growing. In spite of the duality, in terms of structure at the capture level, product flows are gradually converging at the market level, thus highlighting the significant driving force of both domestic and export markets.

It is very important that the implications of these trends in fish demand on the sustainability of the fisheries sector should be evaluated and taken into account, when defining the long-term policy orientations for sustainable fisheries development in Guyana.

The offshore, industrial shrimp trawl fleet has shown increased landings of seabob over the last five years and decreasing landings of the penaeid shrimp. As a result, there is increasing pressure to enter the seabob fishery and to increase fishing effort.

The semi-industrial fishery targets the deep slopes of the continental shelf for groupers and snappers. Some of the major issues facing this fishery include, increasing fishing effort in a poorly regulated fishery and inadequate enforcement, and the need for co-operation between flag states and coastal states in controlling fishing effort.

The artisanal fishery accounts for approximately 90% of the total fish landings in Guyana in more than 90 landing sites. Some of the major issues facing the artisanal fishery include, use of fishing gear that catches large quantities of juveniles of main commercial species, fishing gear interaction and conflicts between artisanal and industrial fisheries.

d. Inland Fisheries[4]

Subsistence freshwater fishing is conducted in rivers, creeks, lakes, reservoirs, canals and in savanna areas where the seasonal increase in rainfall gives rise to large expanses of seasonally flooded lands. This type of fishing is influenced by the down period in agriculture and the unavailability of other economic activities. For example, in the sugar estate areas the intensity of fishing varies adversely with the harvesting of sugar cane and rice. Freshwater fishing is undertaken with small, flat-bottomed, dory type vessels and cast nests, seine or handlines.

[4] National Development Strategy for Guyana (Shared Development through a Participatory Economy), Chapter 13 – Fisheries Policy, 1997-2002. Ministry of Finance, Government of Guyana

The limited data available indicate that most inland fishing is carried out by Amerindians, although non-Amerindians fish in inland waters near the coast and in the vicinity of logging and mining communities situated in the interior of the country. At present, the effort is largely directed at subsistence fishing, although a few fishermen participate in small-scale commercial fisheries based on inland waters.

The country's flowing waters are the "blackwaters" typical of rain forest regions. Many of these waters support a diverse population of fish, which often reach large sizes.

There is also a limited amount of marine and brackish water subsistence fishing, especially of crab, in inter-tidal areas along the coast, without the use of vessels. The main crab species taken are the Blueback or Blue Sheriga, the Bunderi and the Red Sheriga.

There is a small but active trade in ornamental fish. In 1997 over five million of these fish were exported, with a value of G$36 million. Collectors catch ornamental fish mainly in riverine areas, utilizing craft powered by outboard engines, and varying types of fishing gears (dragnets/seines, dip-nets, pin-seines).

e. Aquaculture

Overview[5]: The first reliable accounts of attempts at aquaculture in Guyana can be traced back to the early East Indian inhabitants of the Corentyne coast near the Berbice River estuary. Their present day descendants, and others, practice a system of fishery enhancement similar to aquaculture, but which does not contain all the activities to be properly defined as aquaculture.

This practice involves the legal or illegal opening of the sea defense, and taking advantage of tidal inflows of high tides, juveniles, larvae, eggs, etc. are trapped in the coastal empoldered swamps and in some cases, specially constructed impoundments near the foreshore, where they are allowed to mature to marketable size. Many species are contained in the seawater, some of the targeted ones being Swamp Shrimp, Snook, Cuffum and Mullet.

These brackish water farms operate as extensive polyculture systems. Yields fluctuate widely from year to year, with rainfall being the key to a good yield, to reduce the excessive salinity resulting from evaporation of the brackish water. The practices are extensive, with variable stocking densities, limited pond management and no feeding. However, basic impoundment construction, predator exclusion, water management and harvesting techniques are employed.

Freshwater aquaculture was first started in the late 1940's, with the introduction of Mozambique Tilapia. It was thought that fish culture could be undertaken in association with agricultural practices, such as fish in irrigated rice fields, or flooded sugar cane fields. Also, the hundreds of miles of irrigation canals offered a ready possibility for undertaking freshwater aquaculture.

None of these ideas were carried out at the time, primarily because Government placed emphasis on the development of the potential of the marine capture fisheries.

[5] Geer, T. and Singh, K. 2003. Overview of Aquaculture in Guyana.

Renewed interest in freshwater aquaculture occurred in Guyana in the 1970's with the establishment of three stations by the Department of Fisheries and a joint IDRC/GUYSUCO venture. The Nile Tilapia was introduced, and attempts were made at the culture of alternate indigenous species such as the Hassar. The government stations supplied tilapia for close to 500 private ponds in the country in the 1980s. However, these activities were not successful in the long term.

Preliminary stock assessment, conducted by the Guyana-Brazil WECAFC ad-hoc Working Group in May 1998, has indicated that the Penaeid shrimp resources have probably reached their maximum sustainable yield and that a number of commercial fin fish species thought to be under-exploited are probably being over-exploited.

With the continuing decline in shrimp landings and increased effort in finfish fishery, aquaculture is being promoted as an activity that can attract investors, generate employment and improve incomes and foreign exchange earnings through exports. In this regard, as well as in increased food production and higher nutritional levels for the population as a whole, aquaculture is seen as playing a critical role. It also envisages improving the living standards of the rural farmers in Guyana.

Farmers currently operating in sugar and rice are interested in diversifying their operations and dedicating portions to the culture of freshwater fish and shrimp for sale in the local markets and for exports. The local demand for freshwater fish is high, and there is a culture/tradition of consuming freshwater fish in Guyana, which is reflected in the per capita consumption of fish in Guyana, (58.7 kg per year in 1999).

In 1997, the acreage under aquaculture expanded, as well as the number of species being cultured.

Generally, the policy, legislative and institutional requirements are in place to support the development of aquaculture.

Research[6]: A draft Action Plan for Aquaculture Development, prepared with the support of CIDA (Canadian International Development Agency) in 1994, mainly recommended the establishment of a fresh water fish culture station. Furthermore, in 1997, the FAO/SLAC TCDC aquaculture specialist visited Guyana and, in collaboration with the Fisheries Department, outlined proposals for aquaculture development, one of which included the establishment of a freshwater station.

On July 13th 2001, Phase 1 of the Mon Repos freshwater Aquaculture Demonstration Farm and Training Centre was commissioned. This facility was constructed as a result of a partnership with the Food and Agriculture Organisation of the United Nations (FAO-TCP 8922), the Government of Guyana and the Canadian International Development Agency (CIDA).

[6] Geer, T. and Singh, K. 2004. Report on the Activities of the Mon Repos Aquaculture Station, July 2001 to December 2003.

The four-acre (2 ha) facility has 15 ponds, one laboratory office/facility and one house with a staff of three persons (two technical and one support staff).

The objectives of the Mon Repos facility are: to provide training to farmers so as to enable them to practice scientific, sustainable aquaculture; to provide high quality seedstock and broodstock to farmers, to enable them to attain high yields; to perform adaptive research, and to provide the information to farmers, so as to improve productivity.

Work is presently being carried out with Red Tilapia, Nile Tilapia, Hassar, Giant Malaysian Freshwater Prawn and Freshwater Pacu.

Research has been done on the evaluation of several feeds (local and imported) with the various species, hormonal sex reversal and stocking rate trials with tilapia, and inducement of spawning and production of fingerlings of Hassar.

III. GENERAL OUTLINE OF FISHERY AND FLEET DESCRIPTION

a. Industrial
- i. Penaeid (prawns) Trawl Fishery
- ii. Sea Bob Fishery

b. Semi-Industrial
- i. Red Snapper Fishery
  1. Hook and Line
  2. Pots and Traps

c. Inshore Artisanal
- i. Chinese Seine fishery
- ii. Cadell Line Fishery
- iii. Gillnet Fishery
  1. Gillnet polyethylene, outboard engine
  2. Gillnet polyethylene, inboard engine
  3. Gillnet nylon, outboard engine
  4. Circle seine (modified gillnet nylon, outboard engine)
  5. Tangle seine (modified gillnet nylon, outboard engine)
- iv. Pin Seine Fishery

d. Inland fishery
- i. Subsistence Fishery
- ii. Ornamental Fishery

e. Aquaculture
- i. Freshwater Culture
- ii. Brackish Water Culture

IV. FISHERIES MANAGEMENT

a. **Policy**: The general policy regulating the fisheries of Guyana states that: "The key to the development of any type of fishery is long-term sustainability. Conservation and management measures to control harvesting levels and protect stocks are therefore the highest priorities in the development of a strategy for the sustainable growth of Guyana's fisheries sector"[7]. Guyana's fisheries policy also recognizes the important role of the Department of Fisheries in fisheries policy and the role of the Fishermen's Co-operative Societies. Several specific policy recommendations have been put forward for various fishery types. However, none are in force as yet.

b. **Legislation**: the Fisheries Legislation (Fisheries Act 1957), which presently governs the fishery of Guyana, has undergone several modifications over the years, and is in the process of revision. Recent modifications/updates include Regulations for export to the European Union and the Aquaculture Bill.

c. **MCS**: The Department of Fisheries has implemented an observer programme for the industrial fleet in 2003, but this activity is limited. Compliance with the TED requirements is monitored by Department of Fisheries staff (TED Inspectors). Vessels are also required to submit logbooks (both industrial and artisanal). Registration of all fishing vessels is compulsory, and all vessels are also required to be licensed. The Coast Guard (equipped with two vessels), assists in the enforcement of the fishery legislation and protection of the EEZ.

d. **Research**: No research is presently taking place in the marine fishery of Guyana, other than that linked to the sampling programme.

V. DETAILS OF INDIVIDUAL FISHERY

1. Penaeid (Prawn) Trawl Fishery

a. **Brief Description**: The Penaeid (prawn) Fishery is regarded as an industrial fishery operation, and is mainly export oriented. Prawn fishing in Guyana has been practiced for over 25 years. However, this fishery continues to experience a decline in landings. 88% (35 vessels) of the prawn trawlers are owned and operated by an American company, and have been fishing for over two decades. The remainder (5 vessels) is locally owned.

This fishery is subject to a 6-week Closed Season from the end of August to mid-October.

The use of Turtle Excluder Devices (TEDs) is mandatory on all prawn vessels.

[7] National Development Strategy for Guyana (Shared Development through a Participatory Economy), Chapter 13 – Fisheries Policy, 1997-2002. Ministry of Finance, Government of Guyana.

b. **Policy and Objectives**: The majority of the vessels engaged in this fishery are foreign owned. Any license that becomes vacant due to the withdrawal by a foreign owned vessel will be given to a Guyanese company/individual on a preferential basis.
The general objective for the fishery is to stabilize the landings through sound management. It is generally regarded that this resource is being exploited at its optimum sustainable yield, or above. Therefore, it is hoped that several management measures, including the Closed Season, will assist in the stabilization of landings for this fishery.

c. **Legislation and Regulations**: In keeping with the Fisheries Act and the Maritime Boundaries act, prawn vessels are issued with a license, which takes into account the ownership of the vessel (local or foreign), the length of the vessel, and the base of operation. Fishermen are also licensed.
Trans-shipment at sea of fishery products is illegal.
All prawn trawlers are required to use TEDs when trawling.

d. **Changes Over Time**: Before the implementation of UNCLOS, prawn trawlers fished in more areas that they do today, which resulted in more catch, and a greater proportion of lobster.
The mandatory use of TED's, implemented in 1999, has reduced the amount of finfish previously captured.
Approximately 20 years ago, 120 vessels were fishing for prawns. Today, only 21 vessels are actively fishing prawns.
Previously, nylon nets were used, and needed to be treated with oil, or tar, to preserve them. The newer nets (polythene) do not need treatment, and are lighter, stronger and more durable.

e. **Vessel Characteristics**: The vessels are 62-75 feet (19-23 meters) long and are constructed of metal. They are powered by Cummings or Caterpillar diesel engines, of 335-365 horsepower. The vessels have riggings and are equipped with a fishing table. Trawl nets are towed behind the trawler, to the sides. All the vessels are equipped with on board refrigeration, and have radios and geographic Positioning Systems (GPSs).

f. **Gear:** The mesh size used is 4-5 cm (1.6 to 2 inches) in the wings and 2.5 to 3.5 cm (1-1½ inch) in the cod end. Jib trawl nets, 35 feet (11 meters) long are used, equipped with a TED. Tickle chains are used to improve the quantity of the catch. A try net 8-9 feet (3 meters) long is also used every 23-30 minutes, to give and indication of the abundance of the target species. Each vessel is equipped with 10 nets, four of which are used at any one time, in a double rig (twin trawling), with a sledge.

g. **Number of Vessels**: 40[8]

h. **Time and Areas of Operation**: Fishing is usually done for 12 hours in a 24-hour cycle, with 3-4 hours per drag, 6 drags in total. Fishing can be done in

[8] Department of Fisheries Annual Report 2003.

day or night, and is carried out in 100-250 fathoms (183-458 meters) of water. Fishing is done in both sandy and muddy substrate areas. The Penaeid fishery is carried out in specific fishing zones, and fishing in these zones is rotated within the year.

i. **Species targeted**: Prawns (*Farfantepenaeus* (*Penaeus*) *brasiliensis, F. notialis, F. schmitti* and *F. subtilis*. Other species also caught include squid and lobster.

j. **Units of Effort**: 8,000 to 10,000 gallons (36,000 to 45,000 litres) of fuel per trip are used. The crew comprises 4 persons, and the length of a fishing trip is 30-35 days. Each vessel makes approximately 8 trips per year.

k. **Details of Statistical/Sampling Programme**: 2 vessels were sampled in 2003, representing 5% of the fleet.

2. Seabob Trawl Fishery

a. **Brief Description**: The Seabob Fishery is regarded as an industrial operation, and consists of 92 trawlers, of the standard Gulf of Mexico type, all of which are locally owned. This fishery has seen an improvement in landings over the past five years.
This fishery is subject to a 6-week Closed Season, from the end of August to mid-October.
The use of Turtle Excluder Devices (TEDs) is mandatory on all seabob vessels.

b. **Policy and Objectives**: The seabob fishery is reserved for Guyanese, and the present policy is to facilitate increased production, in a sustainable way.
This fishery has not been intensely studied, and until more data is obtained, this resource should be exploited cautiously.

c. **Legislation and Regulations**: In keeping with the Fisheries Act and the Maritime Boundaries Act, seabob vessels are issued with a license, which takes into account the length of the vessel, and the base of operation. Fishermen are also licensed.
Trans-shipment at sea of fishery products is illegal.
All seabob trawlers are required to use TEDs when trawling.

d. **Changes Over Time**: Over the past 6-10 years, there has been approximately 20% increase in time spent at sea.
10 years ago, two nets per drag were used, with a 4-man crew. Then, about 6 years ago, this changed to four nets per drag (double rig), with the use of a sledge. The crew also increased to 6 persons.
The mandatory use of TEDs has reduced the amount of finfish previously captured.

e. **Vessel Characteristics**: The vessels are 62-75 feet (19-23 meters) long and are constructed of metal. They are powered by Cummings or Caterpillar diesel engines, of 335-365 horsepower. The vessels have riggings and are equipped with a fishing table. The nets are towed behind the trawler, to the sides. All vessels are equipped with radios and GPSs. The vessels are not equipped with on board refrigeration, but use ice instead.

f. **Gear**: The mesh size used is 4-5 cm (1.6 to 2 inches) in the wings and 2.5 to 3.5 cm (1-1½ inch) in the cod end. Jib trawl nets, 45 to 50 feet (14-15 meters) long are used, equipped with a TED. Tickle chains are used to improve the quantity of the catch. A try net 8-9 feet (3 meters) long is also used every 23-30 minutes, to give an indication of the abundance of the target species. Each vessel is equipped with 5 nets, four of which are used at any one time, in a double rig (twin trawling), with a sledge.

g. **Number of Vessels**: 92[9]

h. **Time and Areas of Operations**: Fishing is usually done for 12 hours in a 24 hour cycle, with 3-4 hours per drag, 6 drags in total. Fishing can be done in either the day or night, and is carried out in 10-11 fathoms (18-20 meters) of water. Fishing is done mostly in muddy substrate areas. The seabob fishery is carried out all along the coast during the year, depending on abundance.

i. **Species targeted**: The main target species if *Xiphopenaeus kroyeri*, with small amounts of prawn species as by-catch. Some finfish are also targeted, including Banga Mary and Butterfish.

j. **Units of Effort**: 2,000 to 2,500 gallons (9,000 to 11,400 liters) of fuel per trip are used. The crew comprises 6 persons, and the length of a fishing trip is 7 days. Each vessel makes approximately 2-3 trips per month, or 30 trips per year.

k. Details of Statistical/Sampling Programme: 41 vessels were sampled in 2003, representing 45% of the fleet.

3. Red Snapper Hook and Line Fishery

a. **Brief Description**: The Red Snapper Hook and Line fishery was practiced by Guyanese since the 1970's on a small scale using handlines. Due to its inefficiency, this fishery declined. However, foreign vessels, equipped with better technology, have revived this fishery, while Guyanese have resorted to the use of traps.

b. **Policy and Objectives**: The sustainable management of the Red Snapper fishery is being advocated. Although this fishery has only recently restarted, the fragile nature of the resource has been recognized. More data needs to be gathered, to facilitate informed decision-making.

c. **Legislation and Regulations**: The foreign vessels are licensed for a 6-month period, while fishermen are also licensed. All catch must be landed in Guyana. Trans-shipment at sea fishery products are illegal.

[9] Department of Fisheries Annual Report 2003

d. **Changes Over Time**: There has been a movement toward the use of live bait, replacing the sardine species previously used.

e. **Vessel Characteristics**: Wooden vessels are used, with dimensions of 56 feet in length by 15 feet in width by 7 feet in depth (17 x 4.5 x 2 meters). The vessels are powered by 200 horsepower Perkins, Yanmar or General Marine engines.

f. **Gear:** Long lines are used, with ten No. 4 or No. 5 Mustad hooks per line. Live bait is now being used, in addition to the previously used sardine.

g. **Number of Vessels**: 14[10]

h. **Time and Areas of Operation**: Fishing is done continuously, from 7 am to 6 pm. The area fished is the Continental Slope, at a depth of 35 fathoms (64 meters).

i. **Species Targeted**: Red Snapper, Lane Snapper, Grouper, Marlin and Sailfish.

j. **Units of Effort**: The crew comprises 10 persons. Details on hooks per boat, number of days at sea and number of trips per year could not be confirmed. However, previous unconfirmed information has indicated that each vessel is equipped with 6-9 lines, with 5 hooks per line.

k. **Details of Statistical/Sampling Programme**: 1 vessel was sampled in 2003, representing 7% of the Red Snapper Hook and Line vessels.

4. Red Snapper Trap Fishery

a. **Brief Description**: Guyanese fishermen prefer the use of traps to hooks and line, resulting in the majority of vessels being equipped with traps.

b. **Policy and Objectives**: The sustainable management of the Red Snapper fishery is being advocated. Although this fishery has only recently restarted, the fragile nature of the resource has been recognized. More data needs to be gathered, to facilitate informed decision-making.

c. **Legislation and Regulations**: Trans-shipment at sea fishery products are illegal.

d. **Changes Over time**: Approximately 5 years ago, traps were made using PVC coated “ Chicken Mesh”. Today, traps are made of biodegradable mesh.

e. **Vessel Characteristics**: Wooden vessels are used, with dimensions of 56 feet in length by 15 feet in width by 7 feet in depth (17 x 4.5 x 2 meters). The vessels are powered by 200 horsepower Perkins, Yanmar or General marine engines. Vessels are equipped with a Geographic Positioning System (GPS), radio, navigation aids, and a sonar “Fish finder”.

[10] Department of Fisheries Annual Report 2003

f. **Gear**: Conical shaped traps, of 5 feet length by 4 feet width by 18 inches depth (1.5 x 1.2 x .5 meters0 are used, with a 2-inch (5cm) mesh size. The frame is of metal, while the mesh is a biodegradable polymer.

g. **Number of Vessels**: 35[11]

h. **Time and Areas of Operation**: The area fished in the Continental Slope at a depth of 35 fathoms (64 meters). Traps are picked up 2 times per day, and once per night.

i. **Species Targeted**: Red Snapper, Lane Snapper, Grouper, Marlin and Sailfish. Bonito is used as bait, as well as other sardine-like species.

j. **Units of Effort**: Each boat has 5 crew members, and 70 traps. Each fishing trip lasts 15 days, and vessels make approximately 18 trips per year. Traps are submerged for 6 hours.

k. **Details of Statistical/Sampling Programme**: 6 vessels were sampled in 2003, representing 17% of the Red Snapper Trap vessels.

5. Chinese Seine Fishery

a. **Brief Description**: The Chinese Seine fishery operation uses a modified Fyke Net. While the operation is destructive to juvenile species, it has been recognized that this fishery is the only one to capture the White Belly Shrimp. Also, this fishery is extremely important to the poorer fishers. The fishery is somewhat naturally limited based upon the available fishing grounds.

b. **Policy and Objectives**: The policy of the artisanal fisheries as a whole is to increase yields to a sustainable level, which would enable the fishery to contribute significantly to local nutrition and export earnings.

c. **Legislation and Regulations**: The Chinese Seine fishing operations are carried out in “Pen Spots”. Specific regulations exist for the granting of licenses for the use of pen spots, on an annual basis.

d. **Changes Over Time**: Fewer vessels today use sails.

e. **Type of Vessel**: Small wooden vessels without cabins are used. These vessels are powered by Yanmar outboard engines of 25 horsepower or less, by paddle, and in some cases, by sails.

f. **Gear**: A funnel shaped net is used, with 8mm to 10 mm mesh size. The net is 55 feet long by 40 feet wide (17 x 12 meters) and is placed facing the incoming tide, secured to the seabed via wooden poles.

[11] Department of Fisheries Annual Report 2003

g. **Number of Vessels**: Not available.

h. **Time and Areas of Operation**: Nets fish for 6 hours per day, or 12 hours per day depending on if 1 or 2 tides are fished. 90% of the fishing occurs at the "falling tide" or high tide. Fishing is carried out at 2-6 fathoms (3.6-11 meters), on the mudflats mainly at the estuaries of large rivers. Ice is not used to preserve the catch, since it is marketed fresh.

i. **Species Targeted**: Gill Backer, White Belly Shrimps, various catfishes and Seabob.

j. **Units of Effort**: A crew of 2 persons is used, and the net usually fishes for 6 hours in a 24-hour period. Fuel use is low.

k. **Details of Statistical/Sampling Programme**: According to the 1997 Vessel count exercise, 373 Chinese Seine Vessels were present. 173 vessels were sampled in 2003, representing a probable 46% of the Chinese Seine Vessels.

6. Cadell Line Fishery

a. **Brief Description**: The Cadell Fishery in Guyana is well known for its production of catfish. Operations are kept simple, allowing for the landing of a fresh catch.

b. **Policy and Objectives**: The policy for the artisanal fisheries as a whole is to increase yields to a sustainable level, which would enable the fishery to contribute the local nutrition and export earnings.

c. **Legislation and Regulations**: Cadell vessels are licensed on an annual basis.

d. **Changes Over Time**: The use of various types of bait is now common, including beef, in addition to the previously used chicken intestines, small Banga Mary and catfish.

e. **Vessel Characteristics**: Small wooden vessels (approximately 25 feet [8 Meters]) without cabins are used. These vessels are powered by Yanmar outboard gasoline engines of 25 horsepower.

f. **Gear**: Each Cadell line is 20-30 feet (6-9 meters) long, and is oriented as a horizontal ground line, anchored at both ends. Every 12 feet (3.6 meters), extending at the side, are shorter lines, supporting hooks. Each entire line has approximately 2,000 baited hooks. The lines and hooks are stored in wooden trays, each tray holding 4-5 lines. Usually 4-5 trays per boat are used. Hooks used include Mustad brand, No. 6, 7 and 8. Hooks ar4e baited with small Banga Mary, catfish and beef.

g. **Number of vessels**: Not available.

h. **Time and Areas of Operation**: Fishing trips are made per tide, usually 1 to 2 tides per trip. Fishing is carried out in 5-10 fathoms (9-18 meters). Ice is not used to preserve the catch, since it is marketed fresh.

i. **Species Targeted**: Various catfish species and various shark species.

j. **Units of Effort**: A 3-person crew is used. 20 gallons (91 litres) of fuel are used per trip. The hooks are left in place for 6-12 hours.

k. **Details of Statistical/Sampling Programme**: According to the 1997 vessel count exercise, 80 Cadell Vessels were present. 49 vessels were sampled in 2003, representing a probable 61% of the inboard vessels.

7. Gill Net Polythene Fishery - Outboard

a. **Brief Description**: Gill Net outboard vessels land a variety of species, some of which are also landed by the outboard gill nets vessels. However, the sizes are usually smaller.

b. **Policy and Objectives**: The policy for the artisanal fisheries as a whole is to increase yields to a sustainable level, which would enable the fishery to contribute significantly to local nutrition and export earnings. Due to the selectivity of the gear, these vessels contribute to sustainable fisheries yields.

c. **Legislation and Regulations**: These vessels are licensed on an annual basis. The license fee takes into account the length of the vessel.

d. **Changes Over Time**: Approximately 5 years ago, 1,200 pounds of seine were used. Today, some vessels use as much as 2,500 pounds of seine.

e. **Vessel Characteristics**: Wooden boats are used, with dimensions of 48 feet in length, 8 feet in width, and 3 feet in depth (15 x 2.4 x 1 meters). These vessels have an icebox, but no cabin. They are powered by two “48”Yamaha, or one “55” Yamaha gasoline outboard engine.

f. **Gear**: These vessels use 1,500 pounds of polythene seine, of mesh size of 5 inch and 6 inch, with a few using 8 inch. The seine is approximately 1 mile (1.6 km) in length, and can be set to operate at various water depths.

g. **Number of Vessels**: Not available.

h. **Time and Areas of Operation**: Fishing is carried out in 10-20 fathoms (18-36 meters) of water, and occurs twice in a 24-hour period. It takes 1 hour to place the seine, which is then allowed to fish for 3-4 hours. The seine is then retrieved, which can take another 2 hours.

i. **Species Targeted**: Spanish Mackerel, Trout, small Bashaw, Snook, small Snapper, Cavalli, shark.

j. **Units of Effort**: Each vessel has a 6-person crew, and spends 12 days at sea. For every trip, 4 tons of ice is used, and 150 gallons (685 litres) of fuel.

k. **Details of Statistical/Sampling Programme:** According to the 1997 Vessel count exercise, 308 vessels were present. 78 vessels were sampled in 2003, representing a probable 25% pf the GNP Outboard vessels.

8. Gill Net Polythene Fishery - Inboard

a. **Brief Description**: Gill Net inboard vessels land a variety of species, the mesh size ensuring that only large fishes are caught.

b. **Policy and Objectives**: The policy for the artisanal fisheries as a whole is to increase yields to a sustainable level, which would enable the fishery to contribute significantly to local nutrition and export earnings. Due to the selectivity of the gear, these vessels contribute to sustainable fisheries yields.

c. **Legislation and Regulations**: These vessels are licensed on an annual basis. The license fee takes into account the length of the vessel.

d. **Changes Over Time**: Approximately 5 years ago, 1,500 pounds of seine were used. Today, some vessels use as much as 2,500 pounds of seine.

e. **Vessel Characteristics**: Wooden boats are used, with dimensions of 52 feet in length, 14 feet in width, and 6 feet in depth (16 x 4 x 2 meters). These vessels have a cabin and an icebox, and are powered by Lister, Perkins or General Marine diesel engines of 115-265 hp.

f. **Gear**: 2,000 pounds of polythene seine are used, with a mesh 8 inches. The seine is approximately 1½ miles (2.4 km) in length, and can be set to operate at various water depths.

g. **Number of Vessels**: Not available.

h. **Time and Areas of Operation**: Fishing is carried out in 10-20 fathoms (18-36 meters) of water, and occurs twice in a 24-hour period. It usually takes 2 hours to place the seine, which is then allowed to fish for 3-4 hours. The seine is then retrieved, which can take another 3 hours.

i. **Species Targeted**: Grey Snapper, Trout, Cuffum, Shark, Gill Backer.

j. **Units of Effort**: Each vessel has a 7-person crew, and spends 15 days at sea. For every trip, 6-11 tons of ice and 300 gallons (1,370 litres) of fuel are used.

k. **Details of Statistical/Sampling Programme**; According to the 1997 vessel count exercise, 63 vessels were present. 24 vessels were sampled in 2003, representing a probable 38% pf the GNP inboard vessels.

9. Gill Net Nylon Fishery

a. **Brief Description**: This fishery captures the majority of Banga Mary and Butterfish landed in Guyana. This fishery fill the gap left between the larger polythene gill nets and the smaller Chinese Seine and Pip Seine fisheries.

b. **Policy and Objectives**: The policy for the artisanal fisheries as a whole is to increase yields to a sustainable level, which would enable the fishery to contribute significantly to local nutrition and export earnings.

c. **Legislation and Regulations**: These vessels are licensed on an annual basis. The license fee takes into account the length of the vessel.

d. **Changes Over Time**: Some increase in the amount of seine has resulted. However, vessels in various parts of Guyana coast use various quantities of seine.

e. **Vessel Characteristics**: Wooden boats are used, with dimensions of 25 feet in length, 8 feet in width, and 3 feet in depth (7.6 x 2.4 x 1 meters). Vessels have an icebox, but no cabin. Boats are powered by one “40” Yamaha gasoline outboard engine.

f. **Gear**: 1,200 pounds of nylon seine are used, with a mesh 3 inches.

g. **Number of Vessels**: Not available.

h. **Time and Areas of Operation**: Fishing is carried out in 10-15 fathoms (18-27 meters) of water. This fishery works with the tide, with boats returning every 12 hours. The seine is in the water a total of 5-6 hours.

i. **Species Targeted**: Banga Mary and Butterfish.

j. **Units of Effort**: Each vessel has a 4-person crew, and spends 12 hours at sea. For every trip, 2 tons of ice and 20 gallons (91litres) of fuel are used.

k. **Details of Statistical/Sampling Programme**; According to the 1997 Vessel count exercise, 441 vessels were present. 155 vessels were sampled in 2003, representing a probable 35% of the GNN vessels.

10. Pin Seine Fishery

a. **Brief Description**: The Pin Seine fishery, which is a type of Beach Seine, was traditionally practiced mostly in Regions 2 and 6. However, this fishery is slowly declining, as fishers move to other, higher yielding fisheries.

b. **Policy and Objectives**: The policy for the artisanal fisheries as a whole is to increase yields to a sustainable level, which would enable the fishery to contribute significantly to local nutrition and export earnings.

c. **Legislation and Regulations**: These vessels are licensed on an annual basis. The license fee takes into account the length of the vessel.

d. **Changes Over Time**: The use of sail is declining. As a whole, the entire fishery is declining.

e. **Vessel Characteristics**: Small wooden boats 925 feet [7.6 meters] or less) are used. They may be powered by 25 horsepower gasoline engines, or by sail.

f. **Gear**: 500 pounds of polythene seine are used, with a mesh size of 1 inch.

g. **Number of Vessels**: Not available.

h. **Time and Areas of Operation**: This fishery works on a tidal basis. The seine is set at low tide, and picked up at next low tide. Ice is not used to preserve the catch, since it is marketed fresh.

i. **Species Targeted**: Mullet, Queriman, Banga Mary, Catfish.

j. **Units of Effort**: Each vessel has a 2-person crew. The seine fishes for 6-12 hours, depending on when the catch is removed.

k. **Details of Statistical/Sampling Programme**; According to the 1997 Vessel count exercise, 35 vessels were present. 14 vessels were sampled in 2003, representing a probable 40% of the vessels.

VI APPENDICES

a. Common and Scientific Names of Species Used in this Document

Common Name	Scientific name
Banga Mary	*Macrodon ancylodon*
Butterfish	*Nebris microps*
Bashaw	*Micropogonias furnieri*
Bonito	*Euthynmus alletteratus*
Black-tip Shark	*Carcharhinus limbatus*
Blue-back or Blue Sheriga Crab	*Callinectes bocourti*
Bunderi	*Cardiosoma guanhami*
Catfish	*Arius proops, bagre bagre*
Cavalli	*Caranx hippos*
Cuffum	*Megalops atlanticus*
Freshwater Pacu	*Colossoma macropomum*
Giant Malaysian Freshwater Prawn	*Macrobrachium rosenbergii*
Gill Backer	*Arius parkeri*
Grey Snapper	*Cynoscion acoupa*
Grouper	*Epinephelus spp.*
Hassar	*Hoplosternum littorale*
Kingfish	*Scomberomorus cavalla*
Lane Snapper	*Lutjanus synagris*
Lobster	*Panulirus spp.*
Lukunani	*Chicla ocelaris*
Marlin	*Makaira spp. Or Tetrapturus spp.*

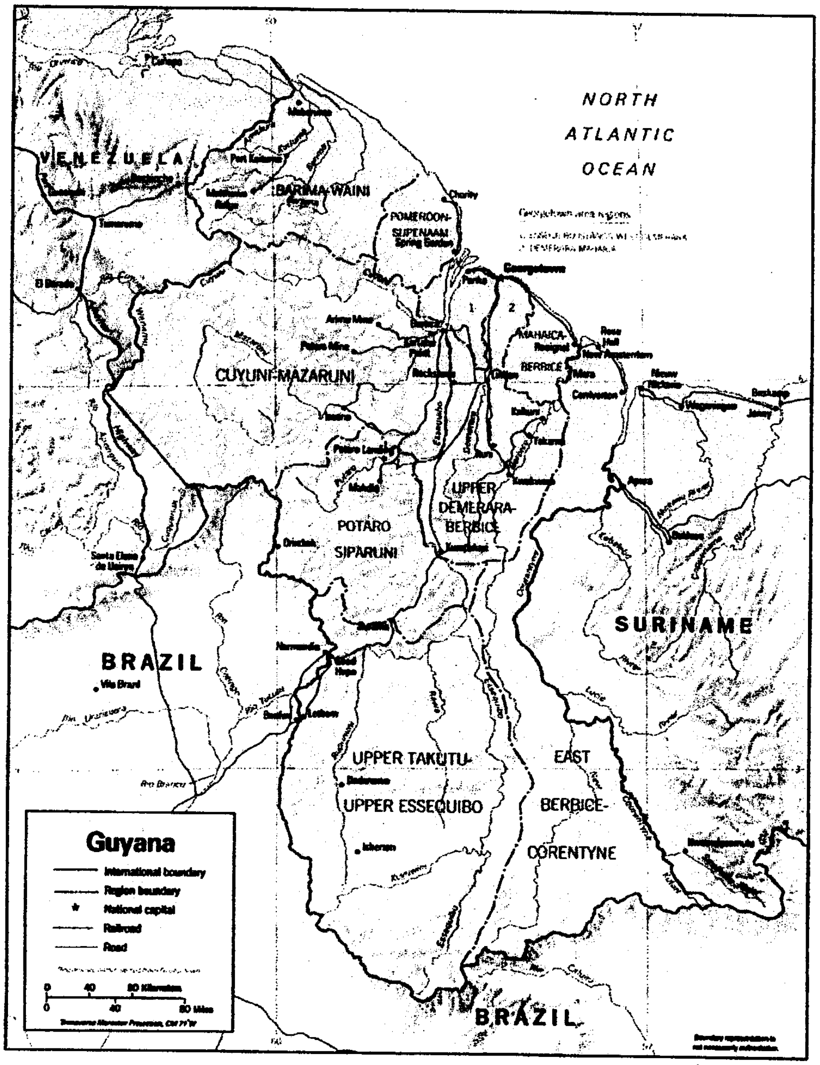
Mozambique Tilapia	*Oreochromis mossambica*
Mullet	*Mugil curema*
Nile Tilapia	*Oreochromis nilotica*
Prawn	*Farfantepenaeus (Penaeus) brasiliensis, F. notialis, F. schmitti and F. subtilis*
Queriman	*Mugil brasiliensis*
Red Sheriga	*Portunus rufiremus*
Red Snapper	*Lutjanus purpureus*
Sailfish	*Istiophorus albicans*
Seabob	*Xiphopenaeus kroyeri*
Shark	*Carcharhinus porosus, Rhizoprionodon porosus*
Silver Bashaw	*Plagioscion spp.*
Snook	*Centropomus undecimales*
Spanish Mackerel	*Scomneromorus brasiliensis*
Swamp Shrimp	*Mesopenaeus tropicales*
Trout	*Cynoscion virescens*
Vermillion Snapper	*Lutjanus spp.*
White Belly Shimp	*Nematopalaemon schmitti*

b. Fisheries Production

Table 1 – Guyana, Fish Production 1991-2001											
	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
1. **Capture Fisheries Marine** Atlantic seabob	4,412	3,208	5,614	6,737	9,800	12,752	15,720	11,091	10,396	16,733	23,712
King mackerel							270		398	263	
Marine fishes nei	35,265	37,097	37,151	38,122	37,000	33,971	34,841	39,189	37,534	27,666	25,181
Penaeus shrimp nei	264	147	558	708	400	84	79	1,935	1,595	1,132	1,671
Serra Spanish Mackerel						211	571		1,143	190	
Sharks, rays, skates, etc, nei						765	1,892		2,175		
Southern red snapper										570	524
Whitebelly prawn										1,464	1,356
Total marine	**39,941**	**40,452**	**43,323**	**45,567**	**47,200**	**47,783**	**53,373**	**52,215**	**53,241**	**48,018**	**52,444**
Inland (Freshwater fishes)	800	800	800	800	700	800	625	625	603	800	800*
Total Capture Fisheries	**40,741**	**41,252**	**44,123**	**46,367**	**47,900**	**48,583**	**53,998**	**52,840**	**53,844**	**48,818**	**53,244**
2. Aquaculture	65.5	85.5	140.5	209.5	230.5	250.5	270.5	300.5	606.5	605.5	606.5*
Total Fish Production	40,807	41,338	44,264	46,577	48,131	48,834	54,269	53,141	54,451	49,425	53,851

Source: Bureau of Statistics – Government of Guyana
* Provisional Figures.

c. Map of Guyana



VII. REFERENCES

Cervigon, F., Cipriani, R. *et al*. 1993. Field Guide to the Commercial Marine and Brackish-Water Resources of the Northern Coast of South America. FAO Rome.

Chakalall, B. 1991. Aquaculture in Guyana – A Preliminary Assessment. FAO Programming and Formulation Mission to Guyana. TCP/GUY/9151.

Chakalall, B. and A. Gumy. 2002. Programme for the Organisational and Operational Strengthening of the Department of Fisheries of Guyana. FAO Mission Report prepared for the Government of Guyana (Draft). Georgetown, Guyana, 23 April – 3 May 2002.

Fisheries Department. 2004. Annual Report 2003.

Geer, T. and Singh, K. 2003. An Overview of Aquaculture in Guyana.

Geer, T. and Singh, K. 2004. Report on the Activities of the Mon Repos Aquaculture Station, July 2001 to December 2003.

Laws of Guyana, 2002. Chapter 71:08. Fisheries Act.

Nafez Abu-Ayida. 1997. Overview of Aquaculture in Guyana and Proposals for Development. FAO/Department of Fisheries, Guyana.

National Development Strategy for Guyana (Shared Development through a Participatory Economy). Chapter 13 – Fisheries Policy, 1997-2002. Ministry of Finance, Government of Guyana.

National Fisheries Management and Development Plan for Guyana, March 1995. Prepared by GTA Consultants Inc./Agrodev Canada Inc. in association with the Guyana Department of Fisheries, Ministry of Agriculture and the Canadian International Development Agency (CIDA) Project 440/16650. (Draft)

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c. Mr. Mohamed Khan, Chairman, and Vessel Captains, Greater Georgetown Fishermen's Co-Op Society
d. Mr. Ramgobin, Chairman, No. 66 Fishermen's Co-Op Society

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d. Mr. Mohamed Khan, Chairman, and Vessel Captains, Greater Georgetown Fishermen's Co-Op Society
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NATIONAL REPORT - HAITI

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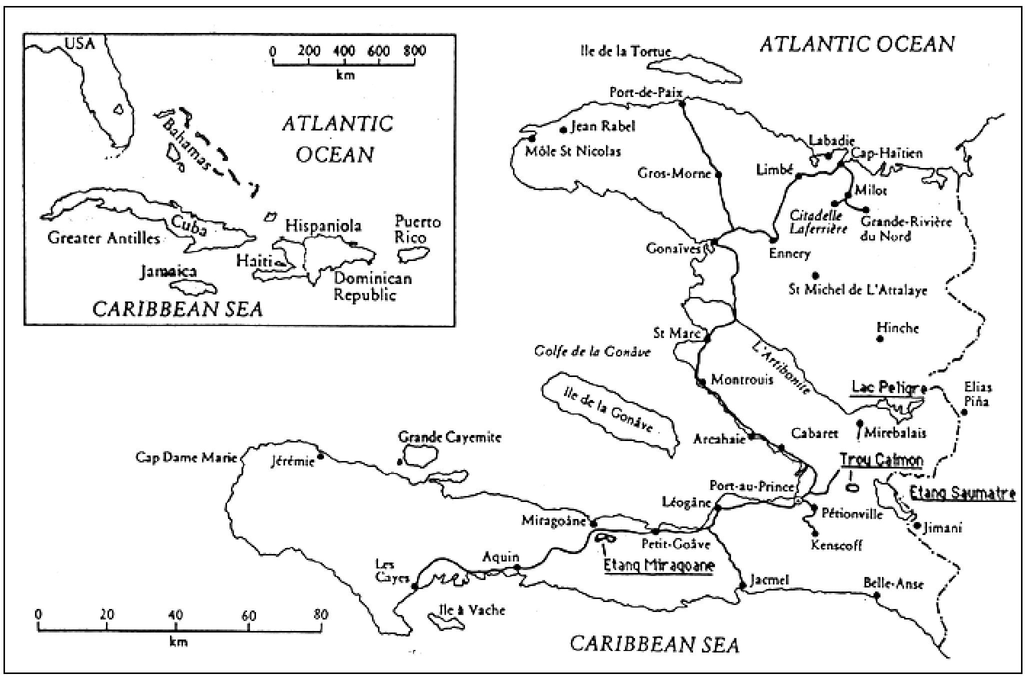
Ministry of Agriculture, Haiti.

Geographic Location

Haiti is a tropical, mountainous country located in the north central Caribbean, lying between 18^{o} and 20^{o} north latitude and $71^{o}30$" to 74^{o} 30" west longitude. With a total area of 27,750 km^2 (Cantave, 1996), Haiti occupies the western one-third of Hispaniola, with the Dominican Republic occupying the eastern two-thirds of Hispaniola and sharing a 270 km border with Haiti. Across the Windward Passage some 90 km to the north-west lies Cuba; Jamaica is located about 180 km to the southwest. To the north, only about 112 km away, the Bahamas Island chain forms closely-spaced stepping stones to the Florida peninsula which is some 900 km from Haiti.



Importance of fishing

Fishing has been an indispensable activity from time, in many areas for, social economic reasons it remains a main source of protein, which is actually the most limited food resource. Fish also contain a large variety of vitamins and minerals, and a high concentration of fatty acids important for brain development.

Although in purely economic terms the fishing activities are significant in Haiti. The number of people now dependent on fisheries for an income is growing, it is estimated that more than 30,000 people are making a living from fishing. The value of landings has been estimated at $ US 30 millions accounting for 2.5% GDP.

In spite of its contribution to the national economy and its nutritional value, compared with say agriculture, the fisheries sector has tended to receive a lower level of political attention at the Ministry of Agriculture leading to poor fisheries assessment and management. This report provides a description of the fisheries, examines method of data collection and storage, data analysis and reporting, and furnishes some quantitative information.

Fishery and Fleet descriptions

The fisheries in Haiti are made up of three components: marine fishery, inland fishery, and aquaculture. In the following paragraphs details will be provided for each one.

Marine Fishery

Exclusive Economic Zone
Haiti has a coastline of 1,535 km and a continental shelf area of 5,000 km^2. The area of Exclusive Economic Zone (EEZ) measures approximately 161x 10^3 km^2. The main living resources exploited within the EEZ are the demersal fishery resources and a limited quantity of pelagic fish resources either over the continental shelf or off shore.

Small Scale Fishery
The fishing fleet of small-scale fishery is composed of 5,000- 6,000 small artisanal fishing boats that operate mainly within the coastal waters. Many fishermen operate from small wooden artisanal boats, which are propelled by oars or sails. More than 60% (2,152) of the fishing boats operate from beaches on the west and southeastern parts of the country. Haitians fishers use mainly traps (Antillean “Z” type) made almost of bamboo, nets (gillnet, trammel net, cast net, bottom net, and different kind of fishing lines (surface line, long line, bottom vertical line, beach seine), free diving and hookah diving. There are about 30,000 small-scale fishermen. Approximately 80% of these are full time fishers and 20% are part time fishers.

Table 1: Showing different types of fishing gears

Fishing gears	**Types**
Traps	Antillean “Z”
Nets	Gillnets, trammel net, cast net, bottom net
Fishing lines	Surface line, long line, bottom vertical line, beach seine
Diving	Free diving and hookah diving
Fishing by feet	Mainly lines

The small-scale fishery provides the greatest part of Haiti exported marine products. The table below shows the amount of the main exported marine products.

Table 2: Showing the Haiti's main exported marine products from 2003-2004

Exported marine products	Amounts (in kg)
Lobster	73,062.9 frozen
Conch	21,930.3
Shrimp	4,926.0
Sea cucumber	15,404.0

Inland Fishery

This fishery involves the catching of fish in rivers, lakes, canal, and flood plains by subsistence or part time fishermen for their own consumption or sale. Activity tends to be influenced by the season and the down periods of agricultural (particularly in dry season) and other activities. Catches from this fishery account for 7 % of the country's total catch.

Table 3: Showing main places of inland fisheries

Lake	Surface in hectares	Numbers of fishers	Production T/year
Saumâtre	11,300	232	23.2
Peligre	4,800	466	?
Miragoâne	1,800	169	220
Trou Caiman	700	?	?

<u>Aquaculture</u>

Culture in Artificial lakes

Tilapia and carpes are the main species cultured in artificial lakes in Haiti. The two major places where these cultures are taking place are Pandiassou in the Plateau Central region and Ka Rouk in the Nippes region. The contribution of these cultures to the national production is unknown.

Policy and Regulations

The fisheries law of 1977 requires the registration of all fishermen operating in Haiti as well as the registration of fishing vessels. There are also resource management regulations designed to protect and conserve the fishery resources including, closed seasons for lobster and conch and minimum mesh size for certain type of fishing nets. However, there is generally no monitoring, surveillance or enforcement of fisheries regulations due to lack of resources and equipment, and low level of political attention to the fishery sector even it is recognized that there is a need for management.

The improvement of the system requires substantial efforts from the Government and supports from Regional and International Organizations. These will assist to develop and implement a regular data collection through sample-based survey and monitoring system; and to strengthen community education and participation.

General Statistics

In Haiti we do not have in place a system to collect data on a regular basis. Data are only collected from registration of the amount of marine products to be exported. This type of data collection showed severe weaknesses:

1. The information provided by the exporters was not verified.
2. Data were stored in folders without being analyzed.
3. Information on boats, gears, and effort could not be recorded.

Research

In order to enhance the situation, CRFM is supporting a data collection on fisheries. The general objectives of this data collection are: to collect information (on fleet type, type of effort, and trends in fishing patterns and practices) to assist in the formulation of a comprehensive sampling program for Haiti, as well as to facilitate decisions regarding fisheries development and management.

Data are collected in three phases:

Phase I
A form is used to collected basic data on the populations of fishers and fishing units at each landing site. These data is used to classify fishers and fishing unit into categories (according to type of fishing – vessel type and/or gear type and/or type of fishing targeted), and to develop a random stratified and hence representative sample for conducting part III of the survey.

Phase II
A questionnaire is used to collect social, economic, and technical data on all fishing units.

Phase III
A representative sample of fishing units is selected at random from stratified data collected during Phase I, and the fishers concerned are interviewed in order to examine fishing trends. These data will be analyzed using descriptive statistics (means, frequency…).

In addition to that there are some works planned in collaboration with CRFM aimed to collect biological information to know about the species caught in Haiti. With regard to the degradation of the inshore marine environment it is being planned the establishment of Marines Protected Areas in order to protect degraded habitats and facilitate fish replenishment. The Fisheries Division in Haiti is endeavoring to develop aquaculture in order to reduce pressure on marine resources (fish).

I wish that all works that are planning could be done. So, in the future we will be in a situation where we will be able to provide all the information requested. Having the information we will be in a better situation to take good decisions for the improvement of the fishing industry in Haiti.

NATIONAL REPORT - JAMAICA

Prepared by:
Data Assessment and Management Unit
Ministry of Agriculture, Fisheries Division, Jamaica

1. INTRODUCTION

Jamaica is an archipelagic state; the main island is located approximately 145 km south of Cuba and 161 km west of Haiti or (18d 15m north and 77d 45m west). Maritime Space is estimated at 274,000 km^2 which is approximately 25 times the size of mainland Jamaica. The island is 236 km long, between 35 and 82 km wide, with a total area of 10,940 km^2 and a coastline of approximately 1,022 km. The irregular coastline is punctuated by numerous coastal features such as harbours, bays, beaches, estuaries, mangrove swamps, rocky shores, cays, coral reefs and lagoons. Jamaica has a tropical maritime climate that is modified by northeast trade winds and land sea breezes. Average temperature is 27 degrees C, ranging from 23 degrees C in winter to 28 degrees C in summer.

Jamaica in 2003 had a population of approximately 2.6 million. The agricultural GDP (which includes fishing) in 1999 was 14.6% (Statistical Institute of Jamaica, 1999).

Geography	People
Location: See map on cover page **Area:**10,990 km2 **Coastline:**1,022 km **Maritime claims:** **EEZ:** 200 nm **Territorial sea:** 12 n.m. from archipelagic baseline. **International disputes:** none **Climate:** tropical; hot, humid; temperate interior **Terrain:** mostly mountains with narrow, discontinuous coastal plain. **Natural resources:** bauxite, gypsum, limestone **Environment:** subject to hurricanes (especially July to November); deforestation; water pollution Note: strategic location between Cayman Trench and Jamaica Channel, the main sea-lanes for Panama Canal.	**Population:** 2,590,400 (1999 est.) **Population growth rate:** 0.7% (1999 est.) **Ethnic divisions**: African 76.3%, Afro-European 15.1%, East Indian and Afro-East Indian 3%, white 3.2%, Chinese and Afro-Chinese 1.2%, other 1.2% **Languages**: English, Creole **Literacy**: age group 15 – 44, 82% (1999 est.) **Labour force**: 1,115,600 by occupation: agriculture 5.8%, unemployed 16.0% (October 1999)

1.2 Legislation

The Fishing Industry Act of 1975 and the Regulations of 1976 regulate the Jamaican Fishing Industry. There are a few other related Acts such as the Natural Resources Conservation Authority Act (1995), the Morant and Pedro Cay Act, The Maritime Area Act (1996), the Exclusive Economic Zone (EEZ) Act (1991), the Wildlife Protection Act 1951 which impact on the management of the Fishing Industry.

Under the **Fishing Industry Act** all vessels and persons must be registered and licensed in order to engage in fishing. The Act provides for the general administration of the Fishing Industry through regulations on registration and licensing, transfer of ownership of boats and vessel, reporting on the loss or destruction of vessels, and the cancellation and suspension of licenses. The Act makes provision for fishery protection in the form of Close Seasons and the Establishment of Fish Sanctuaries. Fishery Management measures currently being employed include:

- **Close Seasons**
  Close Season for Lobster - April 1 - June 30
  Close Season for Conch - August 1 - November 30.
- **Fish Sanctuaries**
  Bogue Lagoon in Montego Bay, St. James
- **Size Restriction**
  The taking of juvenile fish and conch is prohibited
  The catching of undersized and berried lobsters
- **Taking of reproductive fish**
  Taking of "berried' lobsters are prohibited.

The **Wildlife Protection Act** protects the fishery through:

- The prohibition of destructive fishing methods, e.g. dynamiting, toxic chemicals and poisons.
- Discouraging the capture of immature fish and protected species like turtles.

The **Natural Resources Conservation Act** provides for the establishment of Marine Parks and Protected Areas. Some areas which have been declared are as follows:

1. Montego Bay Marine Park
2. Portland Bight Protected Area
3. Port Royal Protected Area
4. Negril Marine Park
5. Ocho Rios Marine Park

2. DESCRIPTION OF THE FISHERIES

The Marine Capture fishery of Jamaica has 14784 registered fishers. Most of these are artisanal fishermen operating from open canoe or reinforced fiberglass plastic (FRP) type boats powered by either outboard motors or oars. There are 4324 registered boats. There is also a large percentage of persons operating without license. The over all estimate is that the industry could have as much as 20,000 fishers and 9000 boats.

Table 1: Number of Registered Fishers and Fishing Boats

	TOTAL
No. of Fishers	14784
No. of Boats	4324

The Industry also consists of industrial fishers who utilize motor fishing vessel, 12.3 meter and above, powered by inboard engines. The fishing areas can be divided in two main sections, the inshore fishery (this fishery takes place in the coastal waters of the island and includes nine proximal banks) and the offshore fishery (fishing operations that are based on the offshore cays, as well as deep-sea fishing including the Jamaica/Colombia Joint Regime Area).

There are six principal marine capture fisheries in Jamaica. These are conch, lobster, demersal reef fish, deep-slope fish, coastal and offshore pelagics, shrimps and other molluscs and crustaceans e.g. crabs and oysters. These fisheries are exploited on the island shelf, the inshore and offshore banks.

2.1 Description of Fishing Boats and Vessels

A variety of fishing boats operates in Jamaican waters. They may be mechanised or non-mechanised boats. The non-mechanized boats are generally propelled by oars and are made of wood or a mixture of wood and fiberglass. The mechanised boats are of the open canoe type. Outboard engines (25 - 75 HP) generally propel them. They are 8.4 x 1.5 x 0.9 m. The decked vessels are generally made of steel with lengths averaging 15 - 30 m. Ninety - five percent of the fishing fleet is open canoe type boats. Decked vessels account for the other five percent.

2.2 Description of Jamaica's Fishing Grounds

Jamaica's fishing grounds may be described as the inshore and offshore fishing areas. The inshore area being characterized by the island shelf and the offshore areas by the offshore fishing banks.

2.2.1 The Jamaica Island Shelf.

The island shelf around most of Jamaica is relatively narrow. The 40-meter contour usually lies about 1,000 m from land. On the south coast the island shelf is much larger than on the north coast. The south shelf extends from Kingston in the east to Black River in the west. At its widest, it is 28 km in width and approximately 150 km long.

On the north coast fringing reefs extend with few gaps, from Morant Point in the east to Negril in the West. Here the reefs tend to be small, patchy and often senescent. The north shelf is so restricted that the fringing reef and sill reefs are almost contiguous. On the south coast, large reefs are restricted to the eastern part of the South Jamaica shelf, near Port Royal and the entrance to Portland Bight. The sill reef is well developed along most of the edge of the South Jamaica Shelf.

2.2.2 Oceanic Banks

Most Oceanic Banks rise abruptly from depths of well over 500 m to a submarine plateau with mean depths of 20 - 40m. On some banks, depths of less than 20 m are encountered in areas where reefs, cays and shoals are present.

The oceanic banks may be described as proximal and offshore banks. The proximal banks to the south are New Bank, Blossom Bank, Waltham Bank; Dingle Bank to the Northeast is Grappler Bank, Henry Holmes, Formigas, Albatross, Morant Bank, Bowditch and Salmon Banks.

2.2.3 Offshore Banks

The offshore banks are the Pedro and Morant Banks and Alice Shoal (which is located in the Joint Regime Area). The Joint Regime area is a shared maritime space between the Jamaica and Columbia. The demarcation of which falls between Seranilla and Bajo Nuevo Banks.

2.3 Description of the Pedro bank

The general depth of the Pedro bank ranges from 0 - 10 m to a depth of about 50-m. The mean depth on the bank is 24.5 m; the area of the bank is 8,040 km^2 and the general circumference of the bank about 590 km. The bank is characterised by westerly currents of about 1.5 knots - 2.5 knots. The bathymetry is characterised by sand flats, sparse coral cover and seagrass beds. The Bank also has three cays Northeast Cay, Middle Cay and South Cay. Approximately 500 to 1000 fishers use the Northeast Cay and Middle Cay as a base from which they fish on the bank. These fishers reside on these cays for up to 11 months of the year.

2.4 Status of the Fishing Industry

Status of Production Sector

Coastal Pelagics
The south coast supports most of the small coastal pelagic fisheries. The most productive areas on the Island are Kingston Harbour and the Portland Bight area, which are all located on the south coast of the country. Guy Harvey 1986 reported that, for the greater shelf area of the south there is a correspondingly greater number of Atlantic Thread Herring and accordingly most directed commercial fishing takes place from beaches located along the island's South shelf. There is one recorded landing site on the narrow north coast of the country.

According to the latest analysis of the data collected on the fishery

Annual landings of *O. oglinum*

Year	Landings (MT)	Source
1971	363.8	Russell, 1973
1980	325	Harvey, 1984
1983	458	Harvey, 1984
1997	399.1	FD, 1997
1998	273.2	FD, 1998
1999	413.8	FD, 1999
2000		
2001		
2002		
Mean	334.7	

The Southern Jamaica fishery for Atlantic thread herring targets mainly spawning aggregations. As may be expected, therefore, the catch per unit effort in June which is the start of the spawning season is much higher than other months of the year. However considering that the fishery appears to be self regulating management recommendations for this stock are not considered at this time, but every effort should be made to continue and expand the field data collection programme so as to facilitate the analyses of (1) annual trends in catch rates and mean size, and (11) the social and economic framework and operational structure of the fishery.

Shrimp
The combined assessment for the period 1996-2000 showed that there is no evidence that the fishery is over exploited (Gailbraith & Ehrhardt, 1999; Jones & Medley, 2000). A plot of landings

against population biomass gives a positive trend line. This indicates that as population biomass increases, landings also increase.

The landings are concentrated between at and below a biomass of 130,000 lbs. The landings do not increase substantially above this biomass. This indicates that the population biomass can support more fishing effort.

This analysis was conducted June 1999, and October 2000 at the Third and Fourth Shrimp and Groundfish Workshop in Belem, Brazil, and it was concluded that the restricted fishery for *Penaeus schmitti* in the Kingston Harbour was being exploited at levels commensurate with the available abundance at a given time. The result suggested that the fishery was exerting levels of fishing mortality which was still below those that may result in maximum production from the stock. However, it was noted that in a few instances the fishing mortality rate closely approached the rate of monthly natural mortality adopted for the species (i.e. M = 0.16). Therefore, any further expansion of fishing effort should be cautiously implemented as the new effort may quickly drive the stock to full utilisation.

It is recommended that more rigorous data collection system be implemented as well as a more permanent statistical system is implemented. This will facilitate the future use of more accurate stock assessment methods. The information base should continue and collect data on the size structure of the landings by gear, sex and month. This should be obtained together with appropriate information on the level of effort exerted temporally and spatially over the stock. This information will provide for better future estimates of Fishing Power, hence a better base to standardise fishing effort.

However, any further expansion of the fishing effort should be cautiously implemented. For more detailed accurate stock assessment, considerable more research and analysis is required. The current monitoring programme should be refined and expanded to include collection of market data. (Gailbraith & Ehrhardt 1999; Jones & Medley 2000).

Lobster

The spiny lobster fishery is the second most important fishery (in terms of export earnings). The lobster populations in Jamaica have changed considerably since 1983. Fishing effort has increased significantly over recent years and the present level of fishing mortality appears to be greater than the optimum recommended for the fishery. From a biological perspective, fishing mortality should be reduced to minimize the risk of over-exploitation (Aiken 1993).

Lester Gittens 2001 carried out an assessment of recent (1996-2000) biological and socioeconomic characteristics of the Jamaican lobster fishery. He found that biological and social indicators from the south shelf indicate that the abundance levels of *P. argus* stocks are low. This is concluded from the small mean size of individuals in catches, the reported decline in catch rates and the existence of conflict among traditional.

He also found a high proportion of immature females in catches and this indicated a disregard for the minimum size regulation which provides evidence that the sustainability of the resource is being compromised and pushed towards recruitment failure.

Reef Fish

By the late 1960s fish biomass had already been reduced by up to 80% on the extensive but narrow fringing reefs of the north coast, mainly as a result of intensive artisanal fish trapping. With fish catches well above sustainable harvest levels, catch per unit effort has remained low over the past three or four decades. Mean fish size has declined below the minimum reproductive size and species composition has changed dramatically. (Plan for managing the Marine fisheries of Jamaica, 1997)

The coral reef finfish account for the largest catch category in Jamaica fisheries. The vast majority (98%) of the catch remains in Jamaica for either local or tourist consumption. (CFRAMP 2000. Jamaica National Marine Fisheries Atlas).

Conch

In 1991 The Jamaica Fisheries Division conducted a Preliminary study of the queen stocks on the Pedro Bank (the major conch fishing ground). The study focused on the population found at the range of depth where commercial fishers were diving. The results provided a rough first estimate of the biomass and the maximum sustainable yield (MSY) of queen conch available to the fishery on the bank.

The results suggested that the bank's conch stocks were being overexploited and if the levels of harvesting continued, the fisheries would collapse within a given period (Gillette 1996?).

The second survey of November 1997 found mean densities of conch to be: 0-10 m, 316 conchs/ha and 10-20 m, 513 conchs/ha. The observations of mean densities although on the same order of magnitude as the previous survey and probably higher, showed that densities of adult normal and stoned conch had decreased more than 50% in the 10-20 m depth zone where the majority of the industrial fishery takes place (Tewfik and Appeldoorn, 1998). There was no information regarding the 20-30 m depth zone as it was not covered during the survey. The impact that conch from this latter zone may have on the fishery was therefore not fully appreciated. Subsequently, MSY was estimated at 1366 MT. (Smikle & Appledoorn 2002).

Annual reported exports (=catch) and quotas in the Jamaican conch fishery since the time of the last survey (1997).

Year	Export (mt) = catch	Quota (mt)
1998	1904	1700
1999	1005	1366
2000	10	1216
2001	745	946
2002		
Average	916	1307

Source: 2002 Estimates of abundance and potential yield for the Pedro Bank Queen Conch Population (Smikle & Appledoorn 2002)

The 2002 Estimates of abundance and potential yield for the Pedro Bank Queen Conch population showed the mean exploitable stock density was 138 conch/ha with 95% confidence limits of 90- 180 conch/ha. According to Smikle & Appledoorn; 2002, since the last survey the average harvest rate of approximately 900 mt was sufficient to result in an apparent increase in stock size. They further recommended an annual harvest level of 800-900 mt.

In a report done by the Fisheries Division in collaboration with the Zoology Department of U.W.I., 3,760 canoes were recorded in 1981 and 16,000 in 1985. Since 1985, more persons have been attracted to the fishing industry, however, in 1997, 11,169 registered fishers were recorded. This indicates that a large number of unregistered fishers are harvesting the resources and thus contributing to the downward spiral of fish stock. The decline in fish yield, according to Aiken 1985, was due to over exploitation, which saw an increase in fishing effort and a decline in catch per unit effort, Clemetson 1993.

Severe fishing pressure has resulted in the reduction of several families of reef fish, for example, the family Scaridae declined by over 56% between 1981-1992. Also there has been a change in the species composition in respect to catch percentage of "Quality" species, which is declining, and low quality "trash" species which are on an increase, Clemetson et al (1993). In 1997, "trash" fish contributed 36% of the total weight and "quality" fish only 30%. In general, the total landing of fish by market category decreased from 14,495.98 MT in 1996; 7,691.41 MT in 1997; 6,045.18 MT in 1998; and increase slightly in 1999 to 8393.44 MT. (Fisheries Division 1996, 1997 and1998)

The other marine capture fisheries such as lobster and conch are also bordering on exploitation. The shrimp and coastal pelagic fishery seem to be viable and should be carefully watched for any signs of over-exploitation.

2.5 Fishing methods

The most important fishing methods are: fish traps or pots (Antillean Z-trap) used to catch demersal species and accounting for 54% of all fish catches; gill, seine, and throw nets are used mainly to catch oceanic and coastal pelagic species and accounting for 23% of all catches; hand lines, long lines and troll lines, used to catch both demersal and pelagic species and accounting for 17% of the total catch; and diving methods including hand-collection, spear guns and hooks used for demersal and pelagic species and in the capture of conch and spiny lobsters.

2.6 Fisheries Production

The quantity of fish caught on the south coast was approximately 93% of the total quantity caught in Jamaica.

The total landing of fish by market category decreased from 14, 484.77 MT (Metric ton) in 1996; 7,746.87 MT in 1997; 6,045.18 MT in 1998; and increase slightly in 1999 to 7,974.13 MT (Fisheries Division1996, 1997&1998).

FISHERIES PRODUCTION IN JAMAICA MT (1996 – 2003)								
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Finfish	**12477.72**	**5578.75**	**4160.98**	**6283.74**	**4586.03**	**4399.95**	**6423.71**	**5174.36**
Conch	**1432.00**	**1821.2**	**1700.00**	**1366.00**		**746.00**	**550.00**	**546.00**
Lobster	**394.14**	**269.63**	**169.99**	**329.90**	**517.30**	**308.92**	**308.92**	**300.00**
Shrimp	**180.91**	**67.04**	**14.54**	**4.49**	**36.67**	**38.50**		
Other		**10.25**						
Total	**14484.77**	**7746.87**	**6045.18**	**7984.13**	**5140.00**	**5693.37**	**7282.63**	**6020.36**

Several fishing pressures have resulted in the reduction of several families of reef fish; for example Scaridae declined by over 56% between 1981-1992. There has been a change in the species composition in respect to catch percentage of Quality species, which is declining, and low quality "trash" species, which are on an increase (Clemetson *et al* 1993).
In 1997, "trash" fish contributed 36% of the total weight and "quality" only 30%.

3. MANAGEMENT OBJECTIVE BY FISHERIES

The goal to be achieved from proper management of the marine fisheries of Jamaica is the sustainable use of fisheries resources for the maximum benefit of the people of Jamaica.

Shallow-Shelf and Reef Fishery
Objective: To rehabilitate reef fisheries to sustainable levels within the context of coastal zone management and conservation-oriented fishing practices.

Most of the catch is taken by artisanal fishers using mainly Antillean Z-traps. However prohibited fishing practices such as dynamite, poisons, and other noxious substances remain problematic. Fish biomass has already been reduced by up to 80% on the fringing reefs of the north coast, mainly as a result of intensive artisanal fish trapping. It is hoped that fishing activities could be diverted from the reef for a period, which would in effect reduce fishing effort. We have to encourage co-management of the fishery. Increased surveillance and enforcement of legislation is also needed to stop persons destroying the reef.

Deepslope Fishery
Objective: to prohibit fishing effort on spawning aggregations and protect areas where these species normally inhabit during the early life stages.

The deepslope fishing areas within Jamaican waters is relatively small. Catches from the deep slope represent approximately 10% of total annual catch of marine fish. The fishery needs to be better studied. There is also need for increased awareness among fishers of the vulnerability of the stock and the potential for over-fishing.

Coastal Pelagics
Objectives: to ensure the viability of the fishery through maintaining and enhancing habitat, and protection of nursery areas.

The coastal zone where this fishery is based is an area in use by many other interests (water sport, tourist, harbour use). Management strategy must include some arrangement to reduce conflicts, arrangement to control land-based pollution and coastal development and discourage the use any destructive practices in the zone.

Large pelagics
Objectives: to sustainable development of the fishery, to cooperate with other states (particularly Caribbean states) to assess protect and conserve the large pelagic resource.

This fishery will need to be studied preferable on a regional basis, and a regional management plan developed.

Lobster
Objective: to restore/rehabilitate the fishery through protection of lobsters and protection and enhancement of their habitat.

There is already legislation in place to prevent the taking of berried lobster, prohibit the landing of lobsters during the close season. There is need for gear restrictions effort reduction and co-management arrangements.

Conch
Objective: To ensure optimum sustainable yields and develop the fishery in other areas.

The introduction of a large-scale industrial fishery, which has almost totally displaced the artisanal conch fishery of the years prior to 1980, has increased production substantially. Conch is particularly susceptible to over-fishing because it is sedentary and aggregates in specific habitats. Estimated catches (based on export data) increased from 50 MT in 1987 to 2,051 MT in 1994; however actual catches may be much higher due to illegal fishing. The fishery therefore need close supervision and a strong management framework.

New regulations (The Fishing Industry (Amendments Of Schedule) Order 2000) provided for quantity of conch in storage to be declared before the closed season, provides for the inspection of conch in holding areas, establishes minimum size restriction for conch and reserve the coastal shelf for the artisanal fishery.

Shrimp
Objective: ensure sustainability and full efficient use of the fishery.

Some of the gears used in this fishery, takes excessive by catch due to the inefficiency of the gear. There is need therefore to introduce by catch reduction devices to the fishery.

4. PRESENT DATA COLLECTION SYSTEM BY FISHERY

4.1 SMALL COASTAL PELAGICS DATA COLLECTION PLAN

4.1.1 Introduction
The Pelagic fishery in Jamaica can be divided into two distinct groups: (1) Coastal fishery for Clupeids, Engraulids, Carangids, Mugulids, and Hemiramphids and (2) Offshore fishery for Scombrids and Istiophorids. The coastal pelagic fishery is an artisanal nearshore fishery. Fishers use powered fiberglass vessel, using gillnets (mainly sprat nets) and fishing is usually done at nights. The present status of the fishery is unknown.

Harvey (1994), indicated that there are eight (8) clupeid species in Jamaican waters, three (3) of which are commercially exploited for local consumption, *Opsitonema oglinum*, (Atlantic thread herring, locally known as sprat), *H. jaguana* (Scaled sardine) and *H. heralis* (Red-ear sardine, locally known as pinchers). *Opistonema oglinum* is the most heavily sought after species in Jamaica. Bait fish (e.g. Harengulids and Engraulids), caught by trammel and lift nets is very important as it supports the artisanal offshore (line) fishery and the recreational fishery.

4.1.2 Data collection Programme
Certain issues were considered in developing the data collection programme:
- Coastal pelagics are targeted for two reasons: food and bait fish

- Multi-gear fishery: main gear are sprat net and beach seine, others include china net, trammel net, hand line and pot.
- Species caught in Jamaica
- Sprat net varies in size (length and width) and mesh size (fishers are constantly adding to existing nets)

The coastal pelagic data collection programme focused on food fish. The extent of the bait fishery is unknown. The main coastal pelagic bait used in Jamaica is Engraulididae (Anchovies and White fry). These are caught by trammel nets and lift nets. Coastal pelagic, food fish, are caught mainly by sprat net and beach seine. The sprat net fishing operations are similar throughout the country.

Stratification was based on gear types (1) sprat net and (2) Beach seine (Table 5.1). Catch & effort and biological data is collected from two fishing beaches, namely Greenwich Town and Old Harbour Bay. Data collectors visit landing sites twice per month to capture catch & effort and biological data. Fishers are interviewed upon arrival at the landing site; the information is recorded on the data sheets. In cases where fishers were not interviewed, this information is recorded on the summary sheets. Information form both sheets are used to estimate total landings.

Table 5.1 Coastal Pelagic Sampling Programme

GEAR TYPE BEACHES	Number of Vessels	Type of data collected	Fishing Ground
SPRAT NET			
KINGSTON			
Greenwich Town	37	C&E; BIO	South Shelf; KH
Rae Town	15		KH
Hunts Bay	8		Hunts Bay; KH
Port Royal	1		Hunts Bay; KH
ST. ANDREW			
Bull Bay (Seven Miles)	4		South Shelf
Bull Bay (Nine Miles)	2		South Shelf
ST. CATHERINE			
Old Harbour Bay	12	C&E; BIO	Portland Bight
ST. ELIZABETH			
Black River	3		Black River Bay
ST. ANN			
Old Folly	1		Discovery Bay
ST. THOMAS			
Cow Bay	4		South Shelf
Morant Bay	2		South Shelf
Yallahs	6		South Shelf
WESTMORELAND			
Bluefields	3		South Shelf
Negril	6		South Shelf
HANOVER			
Lucea	2		Lucea Bay
BEACH SEINE			
KINGSTON			
Greenwich Town	1	C&E	South Shelf

WESTMORELAND			
Bluefields	1		
Negril	2		
Great Bay	2		

Key: C&E – Catch and effort data collection; BIO – Biological data collection

4.1.3 Limitations and Strength

4.1.3.1 Limitations

- Due to staff limitations, we are unable to increase the number of sampling day
- Need to obtain more information on the beach seine fishery
- Need to perform a selectivity study on the sprat net
- Data collection is focused on *Opsitonema Oglinum*; we need to collect information on the bait fishery.
- Need to collect social and economic information to assist in explaining the biological data (Grant *et. al*., 2000).

4.1.3.2 Strength

- Available information on the coastal pelagic fishery.

4.1.4 Recommendation

- ✓ The Fisheries Division should continue its' coastal pelagic data collection programme.
- ✓ Try to address the limitations to improve information for management
- ✓ Use information generated form assessment to develop a detailed management plan for the fishery

4.2 DEMERSAL AND OFFSHORE PELAGIC DATA COLLECTION PLAN

4.2.1 Introduction

Aiken (1984), Haughton (1988) and Munro (1983) suggested that the fishery is over-exploited; a suggestion was made that the Division needed to monitor the fishery through an on-going data collection programme. Areas of special interest to the Division are: Rosalind Bank, Pedro bank, North Coast, South Coast, Morant Bank, other offshore banks and Alice Shoal.

4.2.2 Catch & Effort Data System

The objective of the data acquisition system is to collect basic fisheries data for the demersal (reef and deepslope) and offshore pelagic fishery by sampling beaches representative of all the landings sites in Jamaica. The monitoring system should provide accurate data on catches, catch per unit of effort, catch by fishing ground, the value of the catch, length frequency and data on fishing gear.

4.2.2.1 Artisanal Inshore

Historically, it has been stated that Jamaica has 187 fishing beaches, including two (2) on the Pedro Bank and one (1) on the Morant Cays. This information, along with data on boats, gear, species and fishers collected by landing sites in 1994, and stored in the Licensing and Registration database (LRS), was analyzed and the result used in developing the present sampling programme for catch and effort and biological data collection for the artisanal component of the offshore pelagic and demersal fishery.

4.2.2.2 *Sampling Plan*

- Fourteen (14) of the 187 beaches will be sampled
- The country was divided into two geographical areas – NORTH and SOUTH coasts, based on the nature of the fishery.
- Landing sites were stratified by:
  - ✓ Fishing ground
  - ✓ Beach size (according to number of boats)
  - ✓ Gears
  - ✓ Fish Types
- Data sheets for catch and effort were developed, and revised with assistance from the NGO's. Example: South Coast Conservation Foundation (S.C.C.F)
- The data is being collected by data collectors from the Fisheries Division

4.2.2.2.1 NORTH COAST

The north shelf has a continuous reef system and it is less than one mile from the shore. The distribution of fishers by gear type on the North Coast is: Pots 74%, hand line 57%, troll line 37%, other gear<10% (Fisheries Division LRS data, 1996). Percent not equal to 100 as many of the fishers use more than one gear. Boats on the north coast are mainly non-mechanized (Fisheries Division LRS data, 1996). In areas where there are mainly mechanized boats, trolling is done. From this information the following assumptions were made:

1. The reefs on the North Coast are continuous and similar; therefore, productivity will be the same for beaches in the same group.
2. Similar gears among landing sites.
3. Landing sites within each stratum are internally homogeneous.

Table 5.2: North Coast sampled beaches by characteristics

CODE	# BEACHES	FISHING BEACHES	**FISHING GROUND**	**MAIN GEAR**	**FISH TYPE**	**TYPE OF DC**	**AGENT**
1	6	Rio Bueno	Discovery Bay	P	Reef	C&E; BIO	FIP
2	21	Old Folly Salem Rio Bueno Runaway Bay	Discovery Bay Discovery Bay Discovery Bay Discovery Bay	P P P P	Reef Reef Reef Reef	C&E; BIO C&E; BIO C&E; BIO C&E; BIO	FIP FIP FIP FIP
3	36	Braco	Discovery Bay	P	Reef	C&E; BIO	FIP
4	2	Pagee	Falmouth to Rocky Point	TL	OPelagics	C&E; BIO	FD
5	4	Mo-Bay	Lucea to Discovery Bay	TL	OPelagics	C&E; BIO	FD
6	1	Manchioneal	Formigas, Grappler, Henry Holmes, Albatross, shelf	TL/P	Opelagics Reef	C&E; BIO	FD

Source: LRS

KEY: TL-troll line; P-pot; C&E–catch & effort; BIO-biological data collection; FIP-Fisheries Improvement Project; FD-Fisheries Division; DC-Data Collection

The beaches were also divided into six categories (codes) based on beach size and gear type: Beach sizes: large (L) – beaches with more than thirty (30) boats; medium (M) – beaches with between 10-30 boats; and small (S) – beaches with less than 10 boats.

- Code 1: Large beach with pot as the main gear (L:P)
- Code 2: Medium beach with pot fishing as main gear (M:P)
- Code 3: Small beach with pot fishing as main gear (S:P)
- Code 4: Large beach with line fishing as main gear (L:L)
- Code 5: Medium Beach with line fishing as main gear (M:L)
- Code 6: Large beach with bank fishing (L:B)

Of the 69 active fishing beaches on the north coast, the beaches were grouped accordingly. At least one beach was chosen from each group for sampling (Table 5.2).

On the north coast, the Fisheries Improvement Project (FIP) provides data collected for their own research, to the Fisheries Division.

4.2.2.2.2 SOUTH COAST

The South Coast has a much wider area and larger offshore Bank. The shelf extends to a approximately seven (7) miles (24 km). On the south coast, percentage of fishers by gear type are: handline (35%), pot (32%), china net (23%) and trolling (17%) (Fisheries Division (LRS) data, 1996). The south coast was divided into four (4) categories (Table 5.3):

- Code 7: Large Beach (L) (> 40 boats)
- Code 8: Medium beach (M) (20-40 boats)
- Code 9: Small Beach (S) (<20 boats)
- Code 41: Carrier vessels

Table 5.3: North Coast sampled beaches by characteristics

CODE	# BEACHES	FISHING BEACHES	**FISHING GROUND**	**MAIN GEAR**	**FISH TYPE**	**TYPE OF DC**	**AGENT**
7	12	Rocky Point	South Shelf; Pedro Bank	M	Reef;Opelagics	C&E; BIO	FD
		Old Harbour Bay	South Shelf; Pedro Bank	M	Reef;Opelagics	C&E	FD
		Whitehouse	South Shelf; Pedro Bank	P;DL	Reef; DS	C&E	FD
8	21	Barmouth	South Shelf	M	Reef	C&E	FD
9	27	Welcome	South Shelf	N	Reef	C&E	FD
41	53	Pedro Cays		-	Reef	Landings	FD

Source: LRS

KEY: DL-drop line; P-pot; M-mix fishing; N-net; C&E–catch & effort; BIO-biological data collection; FD-Fisheries Division; DC-Data Collection

Sampling Schedule
Sites are visited twice per month. The dates are chosen randomly, weekends not included. Schedules are drafted before the beginning of the month, where data collectors and drivers are assigned. The information is added to the Division's data system (hard copy and Trip Interview Program Software (TIP)). Data is entered in the Trip Interview Program Software (TIP.)

4.2.3 Limitations and strengths of sampling plan

Limitations
- The absence of weekend sampling
- Inadequate sample sites within each code
- Need to randomly select landing sites for data collection.
- Resources (human, transport, financial, etc) limited.

Strength
- Trained data collectors
- Ability to estimate total landing

4.2.4 Recommendations

- ✓ The Division should continue its data collection programme and increase resource where necessary
- ✓ Use information from the census to restructure the programme. This will assist to simplify the present system

5.3 LOBSTER DATA COLLECTION

5.3.1 Introduction

The spiny lobster is widely distributed in the coastal waters and the offshore banks around Jamaica. Catch of spiny lobster comes mainly from the Pedro Bank (60%). The stocks particularly on the northern coast have been significantly depleted (Fisheries Division, 1996). Total landings have increased from 260t in 1981 (Sahney, 1983) to 600 t in 1993 (Fisheries Division, 1994). The increase in landings could be due to the changes of the fishery from artisanal (prior to 1982) to an industrial fishery with the introduction of 25-30 m class vessels. Aiken (1984), Haughton (1988) and Munro (1983) suggest that if the effort on Pedro Bank increases the fishery will become over-exploited.

Lobster is a high priced resource and represents an important component of the total value of the landings of the Jamaican commercial fisheries. Its' production supports a local market (mainly the hospitality industry) and an export market. The export market earns an average of US$4-6 million per year.

5.3.2 Catch & Effort Data System

5.3.2.1 *Mainland Artisanal Data Collection*
Fishers based on the mainland and near shore banks, are defined as mainland artisanal fishers. Most use traps; however, there are many full time fisher for which diving is the main method of fishing. The lobster is sold to the hospitality industry and housewives. Some also goes to small and large processors.

5.3.2.2 Catch & Effort

The catch and effort system target catch by gear types, since catch rates and effort differs by gear type. Lobster is caught using many different gear types; Antillean Z-traps, SCUBA, Free dive, Hookah and nets (Table 5.4).

Table 5.4 Lobster Sampling Programme

GEAR TYPE/BEACHES	SCUBA	Free dive	Hookah	Net
MANCHESTER				
Alligator Pond	4			
CLARENDON				
Rocky Point	3	6		20
ST. CATHERINE				
Old Harbour Bay	1	3		
Port Henderson (+ Hellshire)	20	3		
KINGSTON				
Hunts Bay	1	1		
Rae Town	1	1		
Greenwich Town		2		
ST. ANDREW				
Bull Bay (7 miles)			14	
ST. THOMAS				
Rocky Point	2	2		
Yallah	1	2		
PORTLAND				
Manchioneal		1		
ST. ANN				
White River	1	3		
Oracabessa		1		
ST MARY				
Pagee		2		
ST. JAMES				
River Bay	1	1		
Whitehouse	1			
WESTMORELAND				
Cook Street Bottom	1	1		
Cox Beach		1		
Negril		2		
St Mary's Beach		1		

Assumptions:

- Catch rates by gear types within stratum are similar
- The catch rates for SCUBA, Hookah and free dive are significantly different, thus the gears should be treated separate.

Catch, effort and biological data are collected by gear type. Old Harbour Bay and Hellshire are visited twice per month. Bull Bay, St. Thomas is also visited twice per month. The FD has been unable to collect landings information from Rocky Point, Clarendon.

5.3.3 Offshore Artisanal Data Collection

May be defined as fishers based mainly on Pedro and Morant Cays. The two main gears used are SCUBA gear and traps. The lobster is either transported back to mainland Jamaica, where it is sold to processors or vendors who in turn distribute it locally to the hospitality industry.

5.3.3.1 Catch & Effort

Landings of lobster from the offshore artisanal (Pedro and Morant cays) are caught by traps, SCUBA and hookah, supplied to carrier vessels, which land the catch on the mainland, Lobster processors send workers to the landing sites to purchase the lobsters. The Division collects the landings from the packer boats data collection programme. No effort data was collected.

5.3.4 Industrial Data Collection

Fishers who are based on the mainland but operate on the Pedro and Morant banks in 20 - 35m length vessels are defined as industrial fishers. These fishers are licensed to use lobster (Florida) traps. The operation is sometimes owned by the processor and 90% of the lobster is exported. There are 6 registered industrial vessel using Florida traps to fish lobster in 1996.

5.3.4.1 Catch & Effort

Log sheets/books are issued to the captains of industrial vessels. At the end of a trip or fishing season the Fisheries Division collects the log sheets from vessel captains.

5.3.5 Limitations and strengths of sampling plan

Limitation

- Lack of adequate resources (mainly human and transportation.
- Lack of observer(s) programme to gather more accurate information on effort.

Strength

- Data collection programme that captures information from all gear type.

5.3.6 Recommendations

- ✓ Continue data collection programme.
- ✓ Improve accuracy of information from the offshore artisanal and industrial fisheries.
- ✓ Improve data collection for hookah gear.
- ✓ Observer programme needed.
- ✓ Legislation must be enforced.
- ✓ Educational programme needed.

5.4 SHRIMP DATA COLLECTION

5.4.1 Introduction

The shrimp fishery of Jamaica is of significant economic importance, and there is the need to acquire accurate data on catch/landings, effort and species composition (Galbraith, 1995). The data acquisition and monitoring system is to provide accurate data on catches, catch per unit of effort by gear and prices for the shrimp fishery in Jamaica. The data will enable Jamaica to monitor the overall performance of the fishery and the changes in the resource. The data which the system will collect are also basic to other important fishery management activities, in particular stock assessment activities aimed at evaluation resource status and potential (Mahon et.

al., 1990). The LRS system recorded 12 fishing beaches, 44 boats (motorized and non-motorized) and 153 fishermen that fish for shrimp.

5.4.2 Catch & Effort

Features of the shrimp fishery that was taken into account in developing the catch & effort system:
Shrimp is targeted in two ways: (1) target fishery with coastal pelagics as the by-catch or (2) by-catch caught in fisher's net.
Shrimp is purchased for food fish (consumption) and/or bait.
It is a multi-gear fishery, thus samples must capture the different gears.
Species caught by landing site
Number of fishers engaged in shrimp fishing, its importance to the areas and production

Catch & effort sampling of shrimp is done within two stratums: (1) primary and secondary landing sites and (2) gear type. The landing sites are divided into two stratums based on number of fishing vessels; primary, less than 10 vessels and secondary, more than 10 vessels. Based on the above criteria, only one beach falls within the primary landing site, Hunt's Bay. The remaining beaches fall within the secondary site.

Hunts Bay is the major landing site in Jamaica. All the shrimp vessels in Kingston (Greenwich Town, Hunts Bay, Port Henderson, Hellshire and Port Royal) fish in Kingston Harbour and land their catch at Hunts Bay (Table 2). Of the five vessels from Old Harbour Bay one vessel fishes in Kingston Harbour.

Old Harbour Bay is sampled as a secondary landing site. The landings at the other landing sites (St. Mary's Beach, Alligator Pond, Leith Hall, Black River and Farquhar) are estimated based on the assumption that the catch per unit of effort by gear will be the same for the other beaches.

Table 5.5: Shrimp Sampling Programme

Landing Site	Gear Type	# Boats	Species	Catch rate	Use
HUNTS BAY	China Net	41	Ps	0.83lbs/hr	food
	Trawlers	4	mix	0.43lbs/hr	food bait
	Shove Net	1	mix		bait
	Pusher	10	mix		
Port Henderson	Otter Trawl	4	mix		food
Old Harbour Bay	Otter Trawl	1	mix		food
Port Royal	China Net	1	Ps		food
Greenwich Town	China Net	1	Ps		food
OLD HARBOUR BAY	China Net	3	Pn,Pb	1.10lbs/hr	food
	Otter Trawl	1	Pn,Pb		food
ST. MARY'S BEACH		2			food
BROUGHTON	China Net	2			food
ALLIGATOR POND		1			
LEITH HALL		1			bait
BLACK RIVER	Otter Trawl	2	Pn,Pb,Ps		food
FARQUHAR	Beach seine	1	Pn		food

Key: Ps-Penaeus schmitti; Pb-P. Brasiliensis; Pn-P. notialis; mix-mixture of shrimp

Hunt's Bay and Old Harbour Bay are sampled twice per month. Catch per unit of effort calculated is based on gear type to determine monthly production. Sampling at Hunt's Bay started in September, 1996. The Division has been unable to collect data from the shove netters and pushers. This will be addressed in the future.

5.4.3 Limitations and strengths of sampling plan

Limitations

- Availability of human and vehicle resources

5.4.4 Recommendations

- ✓ FD continues the data collection programme
- ✓ Publish documents for fishers to present assessment reports
- ✓ Continue working on the development of the Geographic Information System for the shrimp fishery
- ✓ Legislation needs to be implemented
- ✓ Educational programme for fishers
- ✓ Improve data capture for beach seine. To date little information has been collected.
- ✓ Due to the sporadic nature of this fishery in some areas, the FD needs to devise a way to capture information at other landing sites.

5.5 CONCH DATA COLLECTION

5.5.1 Introduction

The Queen Conch (*Strombus gigas)* fishery is the most valuable foreign exchange fishery in Jamaica. This resource is exploited on the island shelf and offshore banks. The predominant fishery occurs on the Pedro Bank. At present it is estimated that up to 95% of the conch landed in Jamaica originates from the Pedro Bank. However, small amounts are also fished from the Formigas Bank and Morant Banks. The amount of conch landed from the island shelf is so far not quantified but may be significant.

5.5.2 Catch & Effort

The conch industry is divided into an artisanal and industrial fishery.

5.5.2.1 Artisanal Fishery

The artisanal fishery may be described as:

(1) **Mainland artisanal** – these are fishers based on the mainland or island shelf of Jamaica. They were originally free divers who now use SCUBA gear for diving. These fishers are usually part time conch fishers. They sell Conch mainly to processors and the local market.
No catch & effort data is being collected from these fishers

(2) **Offshore artisanal** – these fishers are based on the mainland or island shelf of Jamaica. They use SCUBA or hookah gear for diving. These fishermen sell their catch to packer (small carrier) boats which ply the route from mainland Jamaica to the Pedro Cays. The packer boats operators sell the conch mean mainly to processing plants.

Catch data is obtained from Processing Plants; however, the Fisheries Division is not able to capture effort information.

5.5.2.2 Industrial Fishery

This fishery is dominated by large producers who harvest conch for export. These fishers are based on the mainland. They fish the Pedro bank using motor fishing vessels of 20-35m. Most of the vessels are leased from countries such as Dominican Republic and Honduras. The vessel crew contingent including fishers averages 30 persons of which most of the divers are foreigners.

A census on all vessels and trips are required. Vessel captains are issued log sheets. At the end of a trip, Captains return sheets to the Fisheries Division. The data is checked, and entered into Trip Interview Program Software (TIP.)

5.5.3 Limitations and strengths of sampling plan

Limitations

- The effort data on the log forms are not recorded accurately by vessel captain
- Unable to determine the level of poaching on the Pedro Bank

Strength

- Able to estimate total conch landing.
- Able to estimate catch and effort information.

5.5.4 Recommendations

- ✓ Continue the present data collection programme
- ✓ Develop a plan to capture landings from the mainland artisanal fishers
- ✓ Need an observer abroad vessels to (record more accurate and detailed information)

6.0 REFERENCES

Aiken, K. 1984. Lobsters – their biology and conservation in Jamaica. Jamaica Journal 17 (4):44-47

Banerji, S.K. 1974. Frame survey and associated sample survey design for the assessment of marine fish landing. FAO IOFC/DEV/74/39. 15p.

Caddy, J.F. and Bazigos, G.P. Guidelines for statistical Monitoring. FAO Fisheries Technical Paper 257.

Caddy, J.F and Garcia, S. 1986. Fisheries Thematic Mapping - A Pre-requisite for Intelligent Management and Development of Fisheries. Paper Presented to the Colloquium on Marine resources Atlases, London, 3-4 October 1985. 31-52p.

Clemetson, A. 1992. A re-assessment of the Jamaican Shelf Coral Reef Finfish Fishery. ICOD/UWI/Jamaica/Belize reef fisheries management planning project. 2: 144.

1995. Report on the biological data collection monitoring visit to Jamaica.

Espeut, P. and Grant, S.C. 1990. A socio-economic analysis of small- scale fishery in Jamaica. FAO

Grant, S.C., Smikle, S and Galbraith, A. 1996. Jamaica Fisheries Sampling Plan. Ministry of Agriculture, Fisheries Division.

Grant, S.C., Singh-Renton, S and Gordon, J. 2000. Descriptive analysis of the *Opistonema oglinum* (Atlantic Thread Herring) on the south coast of Jamaica. (unpublished).

Haughton, M.O. 1988. Population biology of *Panulirus argus* in Jamaican waters. M.Sc. thesis. University of Buckingham. 148 pp.

Harvey, Guy. 1986. Coastal Pelagic Fisheries Resources in the Caribbean Part IIA. UWI, Zoology Department Research Report #7 (iia).

Jamaica Fisheries Division. 1995. Plan for Managing the Marine Fisheries of Jamaica. Draft.

Kong, A.G. 1994. Conch Management Plan. Jamaica, Fisheries Division.

Mahon, R., Hartman, S and Charlier, P. 1990. A fishery data collection system for Suriname. FI: SUR/87/001 – Field Document No. 3. 31 pp.

Munro, J.L. 1983. Caribbean coral reef fishery resources. ICLARM Studies and Reviews 7, Manila, Phillippines.

Murray, P. Estimations used for the provision of fisheries management advice.

Phillips, T and Galbraith, A. 1995. Shrimp and Groundfish Subproject Specification Workshop, Country Proposal - Jamaica. Data acquisition and Monitoring System - Shrimp Fishery (draft).

Sahney A. K. 1983. Sample Survey of the fishing industry in Jamaica, 1981. Kingston, Ministry of Agriculture.

Smikle, S. 1996. Assessment of the Conch Fisheries of Jamaica. Work Plan. Ministry of Agriculture Fisheries Division.

Sparre, P; Ursin, E; Venema, S.C. 1989. Introduction to tropical fish stock assessment. Part 1. Manual. FAO Fisheries Technical Paper. No. 306.1. Rome, FAO. 337p.

Stamattopoulos, C. Basic concepts and approaches in sample-based fishery survey. A training manual. FAO.

Statistical Institute of Jamaica. 1996-99. External Trade.

Table 3.1: Fishery Management Objectives

Fishery	Target Fishes	Distribution	Life History	Management Unit	Resource Status
Shallow-Shelf and Reef Fishery	Hinds (Serranidae) Parrotfishes (Scaridae) Triggerfishes (Pamadosydae) Grunts ((Balistidae) Squirrelfishes (Holocentridae) Surgeonfishes (Acanthuridae) Butterflyfishes (Chaetodontidae)	Mangroves (Juveniles) Seagrass Beds (Juveniles) Coral Reefs (Adults)	**Growth** - Up to 50cm for most species **Mortality** – 4-6 years for most species **Spawning** – varies by most species but broadcast eggs into the plankton	Island shelf (incl. Beaches and estuaries) and offshore banks for juveniles and adults; may be wider distribution for early life stages due to larval drift.	Many coral reefs have been degraded through a combination of human (i.e, over-fishing, land based pollution) and natural distrubances (i.e, hurricanes, disease). Unless action is taken immediately, the reefs may not recover sufficiently to restore fish populations to previous levels
Deepslope Fishery	Snappers (Litjanidae) Groupers (Serranidae)	Shallow Water (Juveniles) Deep Water (Adults)	**Growth** – greater than one (1)m, in length for most species are slow growing **Mortality** – long lived **Spawning** – Groupers form large spawning aggregations, several species are hermaphroditic	Deep slope areas around the coastal shelf and oceanic banks for juveniles and adults.	The deepslope resources are probably already close to being fully exploited, a precautionary approach is warranted since foreign effort cannot be quantified and some species (i.e., groupers) are extremely vulnerable to over-exploitation while they aggregate for spawning
Coastal Pelagics	Scaled Sardine (Harengula jaguana) Red-ear Sardine (Harenjula humeralis) Anchovies (Engraulidae) Ballyhoo (Hemiramphus spp) Thread Herring (Opisthonema oglinum)	Near shore area, particularly over seagrass beds, within barrier reef. Principal fishing ground: - Kingston Bight, Kingston Harbour, Portland Bight, Milk River Bay, Black River Bay and Lucea Bay.	**Growth** – short lived **Mortality** – high **Spawning** – major spawning period for Thread Herring is April to July.	Island shelf for juveniles and adults, may be wider distribution for early life stages due to larval drift.	Anecdotal evidence suggests that the thread herring be heavily exploited in many coastal areas. Other species are perceived to be under-exploited because of their migratory nature. Most species are susceptible to coastal pollution.
Large Pelagics	Tunas, Wahoo, Bonitos, Mackerels (Scombridae) Dolphinfish (Coryphaena hippurus) Marlins (Istiophoridae) Sharks (Elasmobranchii)	Most species are highly migratory. Stocks which are probably contained within the Caribbean Region are Dolphinfish, Kingfish, Wahoo, Blackfin Tuna, Stocks which extend throughout the Atlantic or at least the western Atlantic are (i.e., yellowtail tuna, skipjack tuna)	**Growth/Mortality** Can grow to several meters in length. Most species are relatively long lived. **Mortality** – Life span is 10 + years **Spawning** – Reproductive behavior is poorly known for most species	For most ocean wide species the entire Atlantic is the Management Unit	The resource status is not fully known but it is believed that it is adequate to allow for the expansion of the fishery.

Lobster	Spiny Lobster (Panulirus argus)	Larvae are planktonic for about six (6) months, Juveniles – shallow coastal habitats such as: seagrass, mangrove and coral rubble in protected bays. Adults – deeper water and offshore reef habitats.	**Growth** – Legal sized reached by males in three (3) years and females in four (4) years. Minimal size at sexual maturity is 80-90mm **Spawning** – Late summer, early fall, spring.	Coastal shelf, offshore bank and coral banks.	Could be over-fished.
Conch	Queen Conch (Strombus gigas)	Larvae are planktonic. Juveniles inhabit shallow coastal habitats, such as seagrass, and sandy bottoms in protected areas. Adults prefer similar habitats in deeper water.	**Growth** – Shell length stops increasing at the onset of sexual maturation typically at an age of about 3-3.5 years. **Mortality** – Maximum life span is about thirty (30) years. **Spawning** – The spawning season in Jamaica is thought to occur between July and November.	Island shelf; nearshore Banks; offshore banks.	The conch fishery is probably fully exploited in fact it could be on the verge of being over- exploited.
Shrimp	White Shrimp (Penaeus schmitti) Pink Shrimp (Penaeus notialis) Red-Spotted shrimp (Penaeus brasiliensis)	Shrimping activity occurs in mangrove areas where fishermen use shove nets, push nets, china nets and along muddy bottoms where trawling is possible.	**Growth** – Food abundance, temperature and salinity are the primary factors affecting growth. **Mortality** – Natural mortality is estimated to be 20-30% per month for adults. **Spawning** – Peck spawning period, February to April.	South shelf, particularly Kingston Harbour.	Potential yield of the fishery is unknown.

NATIONAL REPORT – SAINT LUCIA

Introduction

Saint Lucia, an independent island state, in the Eastern Caribbean, is approximately 539 km^2 in area and lies between latitude 13 ^{o} and 14^o north and longitude 60 ^{o} and 61 ^{o} west (Fig. 1). With a population of 133,308 (Statistic Department, 2001), Saint Lucia enjoys a tropical climate moderated by the northeast Trade Winds. Nearshore fishing takes place along the coastline, which extends for 158 km. The island has a narrow coastal shelf area of 522 km^2 and a total Economic Exclusive Zone (EEZ) of 4700 km^2 (Department of Fisheries, 1999). The western coast is characterized by a narrow, steep, insular shelf in contrast to the eastern coast, which has a fairly extensive, less steep, insular shelf. The southern coast has a wider shelf area extending southwards.

Similar to other islands of the Lesser Antilles, two water bodies wash its shores, the Atlantic Ocean on the east and the Caribbean Sea on the west. The marine habitat comprises the full range of tropical marine and coastal habitats including estuaries, mangroves, lagoons, seagrass beds, fringing, patch and barrier reefs, slopes off the island platform, deep bank reefs and open oceans. Nearshore, at depths between 30 m and 80 m on the outer island shelf, are submerged Holocene or early Pleistocene reefs (Mahon, 1990). Two important fishing banks with a total shelf area of 14 km^2 are located a few miles south and northeast within the 200-m depth contour (Figure 4).

Figure 1: Map of Caribbean Basin

Description of the Fishery

The major fisheries resources of Saint Lucia comprise demersal, coastal pelagic and offshore pelagic fisheries. Although there is some year-to-year variability among these resources in terms of time, the fishing year of Saint Lucia can be divided into two main seasons: a "high' season that extends from December to May when significant landings of offshore migratory pelagics occur and a "low" season that extends from June to November when relatively large quantities of demersal fishes are landed. However, the main "pot-fishing" season extends from June to February (Gorbert & Domalian, 1995; Andre-Bigot, 1995).

The offshore pelagic fisheries contributed 69% of the annual landings by weight (Department of Fisheries, 2003) which is made up of a number of migratory species including dolphinfish (*Coryphaena hippurus)*; mackerel (*Stromberomorus* spp*.)*; Wahoo (*Acanthocybium solandri)*; blackfin tuna (*Thunnas atlanticus)*; yellowfin tuna (*Thunnus albacares)*; Skipjack tuna (*Katsuwonus pelamis)*; sharks (various families); billfishes (Istiophoridae, Xiphiidae) and flying fish (*Hirundichthys affinis)* (Figure 2).

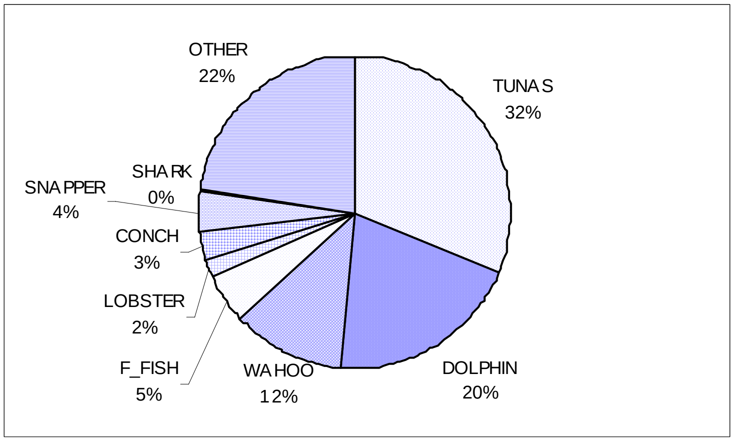


Figure 2: Percentage of landings for different families 2003.

In the coastal pelagic fishery, an array of species is targeted including: ballyhoo (Hemiramphidae spp.); barracudas (Sphyraenidae spp.); creole wrasse (*Clepticus parrae)*; herrings (Clupeidae spp.); jacks (Carangidae spp.); mackerels (*Decapterus macarellus)*; needlefishes (Belonidae spp.).

Whilst the demersal fishery lands the most highly priced and valuable species for the local, tourism and export sectors including: snappers (Lutjanidae spp.); groupers (Serranidae spp.); Caribbean spiny lobster (*Panulirus argus)*; Caribbean queen conch (*Strombus gigas)* the contribution of this fishery to the total annual landings has steadily decreased. This decreasing landings trend observed in the demersal fishery can be attributed in part to the expansion of the offshore fishery during this period and the movement of some fishers into the tourism industry.

Policy and Regulations

The primary legislations governing management of the island's marine resources are the Fisheries Act (No. 10 of 1984) and Fisheries Regulations (No. 9 of 1994) which are based on the Organization of Eastern Caribbean States (OECS) harmonized legislation. The Fisheries Regulations specify conservation measures such as gear restrictions, fishing method restrictions, close seasons and creation of marine reserves. The policy of the Government of Saint Lucia for the fishing sector focuses on development and management of the fishing industry through the promotion of sustainability of the sector through self-sufficiency by increased production from capture fisheries and the aquaculture sector (Department of Fisheries, 2001). Another major objective outlined within the fisheries policy is the social and economic advancement of fishers and their families. The Fisheries Management Plan, developed through a consultative process with resource users, guides the work program of the Department of Fisheries and outlines specific management plans for major fisheries of Saint Lucia (Department of Fisheries, 2001).

The Department of Fisheries is cognizant of the need to ensure that proper management regimes are in place to guide the management and development of the fisheries sector. In light of such, the Department of Fisheries with technical assistance from the Food and Agricultural Organisation, in 2001, reviewed the existing legislation with the aim of revising the legislation to encompass many of the new fisheries management paradigms. Many consultations and meetings were undertaken with stakeholders resulting in a proposed new Fisheries Act and Fisheries Regulations, which will be submitted to the Attorney's General Officer for their review shortly.

General Statistics on Fleet Types, Type of Effort and Trends in Fishing Patterns and Practices

The Department of Fisheries has 669 vessels registered in its database (Department of Fisheries, 2004). In 2003, the Department of Fisheries undertook a verification exercise of the registered fishing vessels database. Vessels that were known to no longer be in existence or no longer engaged in the fishery were removed from the database. In 2002, fishing vessels were reclassified under the following categories: canoes; pirogue; transom, shaloop; whaler; longliner and other (Table 1). Efforts by the Department of Fisheries to ensure a movement from the canoe to the more stable fibreglass pirogue by fishers appears to have been a success, with the fibreglass pirogue accounting for 62% of registered vessels in 2003 compared to 41% in 1998 (Figure 3).

Table 1: Categorisation of Saint Lucia Fishing Vessels

Vessel Category	Canoe	Pirogue	Transom	Shaloop	Whaler	Longliner	Other	Total
Total	168	418	41	26	7	5	4	669

(Source: Department of Fisheries, 2003)

On average fishing vessels engaged in the fishery in Saint Lucia are 7m long but range between 5-9 meters and are propelled mainly by 75 horse power outboard engines. Due to the multi-species nature of the fishery in Saint Lucia, fishing vessels are generally equipped with the following gear: trolling lines; flyingfish nets; longlines (palangs); gillnets; handlines; and fishpots (traps). Gillnets and seine nets are less common. Seines and fillets are primarily owned and operated by west coast fishers, but gillnets are operated around the island with the exception of the Soufriere Marine Management Area, where their use has been banned.

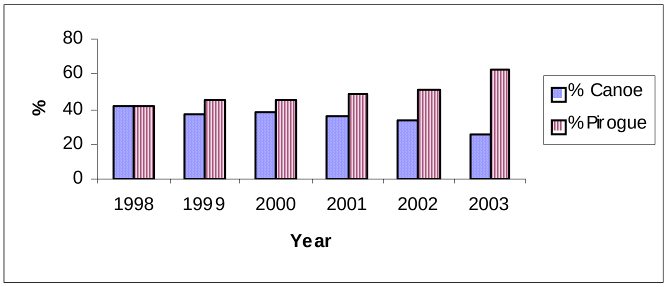


Figure 3: Percentage of registered canoes and pirogues from 1998-2003

Fishing communities are located both along the Caribbean and Atlantic coast. This, coupled with the fact that the majority of vessels are equipped with outboard engines makes access to the different coast and water bodies (Atlantic and Caribbean) relatively easy. Most fishers fish within 15 miles of the coastline and fishing trips generally do not exceed twelve hours.

Sampling Plan

Current fisheries data collection systems include several components such as gathering of data on catch, effort, registration of fishermen and vessels, SCUBA diving and snorkeling establishments, sports fishing vessels and spear gun fishers, in addition to licensing data of fishers and fishing vessels, dive and snorkel leaders.

The catch and effort data collection plan is based on a stratified random sampling regime of three major strata: primary, secondary and tertiary landing sites, based on the number of vessels operating, the fishery types and the volume of fish landed. The island fishery operates out of 22 landing sites. However, catch and effort data are collected at eight landings sites based on a random stratified system. The sites presently sampled include: Gros Islet, Castries, Soufriere, Choiseul, Vieux Fort, Micoud, Laborie and Dennery (Figure 4).

At each of the sites being sampled, catch and effort data are collected for every other returning vessel for fifteen days (randomly selected) monthly. Information such as area fished, species caught, gear used, hours fished, and total vessels out, are recorded and submitted monthly to the Data Section. In terms of area fished, the island's coastal waters are divided into two zones; for offshore pelagics, A and B, and three zones for nearshore and bank species C, D and E.

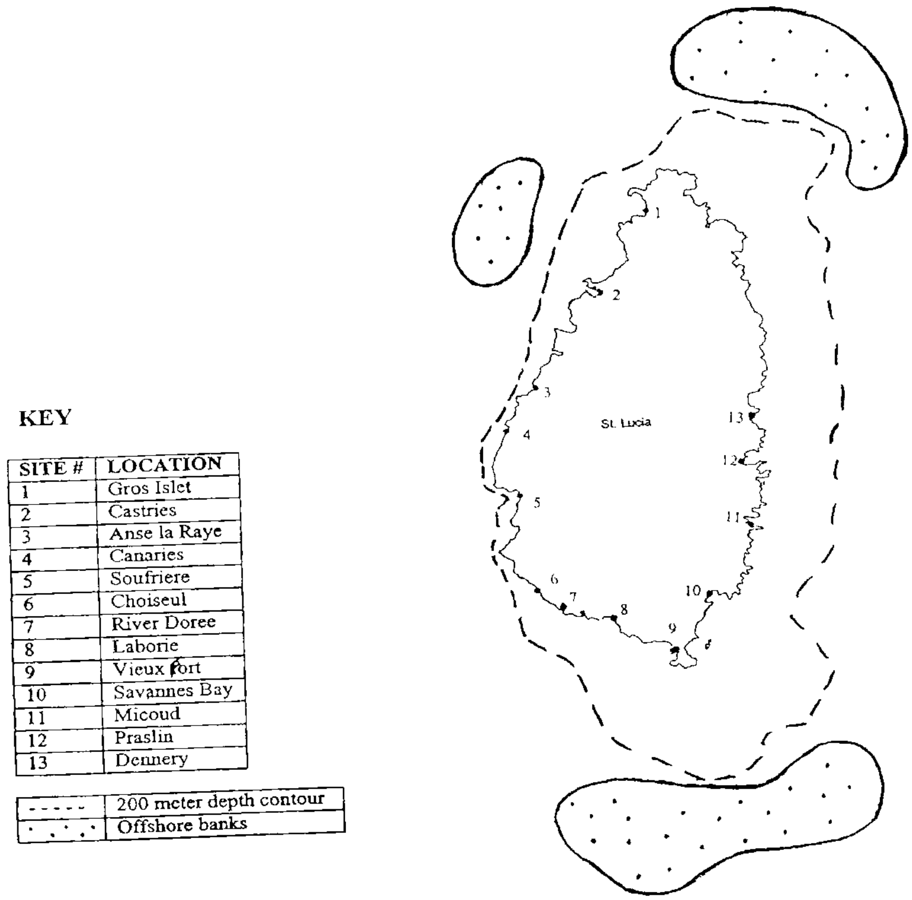


Figure 4: Selected Landing Sites and Fishing Banks

Lobster Fishery

Introduction

Panulirus argus is the most abundant and commercially important of the three *Panulirus* species (*P. argus, P. guttatus* and *P. laevicanda).* However, *P. guttatus* is protected from commercial exploitation since it rarely attains the legal size limit of 95 mm. The majority of Caribbean lobster landings come from traps set in depths in excess of 30 m (Luckhurst & Auil-Marshalleck, 1995). Previously, lobsters were fished with trammels nets that are now banned from the island fishery; however, they are still used illegally on a small scale. Caribbean spiny lobsters are also illegally fished with spearguns by recreational fishers.

The fishery for lobster sustains important artisanal fisheries during the “low” fishing season. It is regulated with an eight-month fishing season, extending from 1st September to 1st May, inclusive.

The Department of Fisheries, recognizing the need to reduce effort in nearshore fishery implemented a limited entry system for the pot fishery (the main gear used to fish for lobsters) in the 2000 pot-fishing period. Funding for implementing this management regime was provided by the European Union as part of the Sustainable Fisheries Development Project. The main objectives for implementation of such a management measure were to address the problem of over-fishing plaguing this fishery, due to the continued use of illegal mesh sizes for fish pots, the open access nature of the fishery, the recurrent problems of theft of gear and catch, incidental ghost fishing and declining catches. A collaborative approach for developing conditions for the management regime was used (Department of Fisheries, 1999).

In 1999, prior to its implementation, consultations funded by the British Department for International Development through the Organization of Eastern Caribbean States – Environmental Sustainable Development Unit (ESDU) formally OECS - Natural Resource Management Unit (OECS-NRMU), were held with resource users, mainly pot fishers (Department of Fisheries, 1999). The benefit of such an approach is that the resource users are directly involved in the identification of a strategy for sustainable use, resulting in greater compliance when implemented. Consequently, this management regime was first implemented in 2000, in the southern half of the island, where the largest pot fishing communities exist and the following year, it was implemented nationally. The following list of requirements and conditions were mandatory in order for fishers to qualify to engage in the fishery:

- Fishing vessels must be registered and licensed.
- Only full time traditional pot fishers would be licensed to engage in this fishery.
- Pots and buoys should be clearly marked with identification tags (that is, PVC tags with vessel identification number on it to allow for effective enforcement. (Funding covered the cost of supplying PVC for the first year only).
- No undersized lobsters should be kept in holding pots.
- All pots should have degradable panels and must not be constructed with mesh smaller than 1 1/4 in.
- Pot fishers should have at least 15 pots

Further, pot fishery licenses must be presented during any sale or trade in lobsters. The Department also adopted a policy of discouraging and denying new entrants to fishing access to pot fishing.

However, due to a number of constraints such as the cost of the tags used on the pots, the continued incidents of pot theft and the limited capacities of the Department of Fisheries and the Marine Police Unit for enforcement and gear authorisation, the limited entry pot fishery system was discontinued.

Trends in catches or landings during 1990-2003

Table 2 gives an indication of the annual production of *P. argus* between 1991 and 2001 giving an average annual production of 19.7t. during this period.

Table 2: Lobster landings (tonnes) from 1991-2003

Year	Total Landings (tonnes)	Lobster Landed (tonnes)
1991	1038	10
1992	968	21
1993	1114	15
1994	883	15
1995	981	13
1996	1315	13
1997	1311	13
1998	1461	32
1999	1718.14	30
2000	1860.1	24.9
2001	1967.2	36.1
2002	1607.84	9.52
2003	1446.99	23.37

(Source: Department of Fisheries, 2004)

Although lobster landings do not contribute significantly to the total landings (Figure 2), in general, lobster landings have increased. Recorded lobster landings for 2002 were unusually low. This may be attributed to the pot fishery project where the majority of lobsters were sold directly to hotels and restaurants and not landed at landing sites. The majority of lobster landings occur during the first four months of the fishing period.

The lobster fishery is economically significant to the livelihood of pot fishers of coastal communities, particularly during the low period, since there is not much opportunity for alternative employment.

Collection of catch and effort statistics during 1999-2003

Collection of catch and effort data on lobsters is based on a stratified random sampling regime. Although the island's fishery operates out of 22 landing sites, catch and effort data are only collected at eight landings sites. During 1999-2001 the sampling plan was revised in that River Doree, Anse la Raye and Savannes Bay were removed as sampled sites and replaced with Choiseul and Laborie (Figure 4).

Research Conducted during 1999-2003

From November 1996 to April 1999, as part of a sub-project jointly funded by the Government of Saint Lucia and CARICOM Fisheries Resource Assessment and Management Program (CFRAMP), a total of 6469 Caribbean spiny lobsters, *P. argus* were sampled from commercial Antillean Z-traps deployed off the southwest and southeast coasts of Saint Lucia in areas fished by commercial trap fishers, at depths ranging from 5 m to 50 m, and landings at two sites, River Doree in the southwest and Savannes Bay in the southeast (Joseph, 2000). The project was divided into two components; the first component, which ended in 1998, examined 4128 lobsters landed at the abovementioned landing sites during the open season for this fishery.

The second component of the project, the maturity study, which ended in 1999 involved year-round sampling at sea by fishermen, under regular supervision by staff of the Department of Fisheries, from Savannes Bay and River Doree. Data on carapace length, sex and weight were obtained for all lobsters. However, females were further examined for the presence of eggs (ovigerous) or spermatophoric mass (deposition of spermatophores on the sternum) (Joseph, 2000). Eggs were described as orange (freshly laid) or brown (ready to hatch) and spermatophores were described as intact (pre-fertilization) or eroded (post-fertilization) (Anon, 1996). Caribbean spiny lobsters sampled at sea were tagged by perforation of a hole in the telson to avoid double sampling, particularly during the close season. *P. argus* less than 95 mm were returned after observation however, during the close season, all lobsters were returned. In addition, effort data collected included estimation of depth, number of traps hauled, soak time and estimated total catch (Joseph, 2000). At least four sampling trips were conducted each month and all Caribbean spiny lobsters caught in the traps were sampled. Carapace lengths were measured to the nearest millimeter with steel vernier callipers (Joseph, 2000).

Findings from the maturity study showed a decrease in mean carapace length and an increase in the proportion of undersized lobsters, lobsters with a carapace length less than 95 mm (Joseph, 2000). The presence of berried females in pots although evident at both sites, was found on the south west coast throughout the year, whilst two distinct peaks were observed for lobsters caught on the south east coast (Joseph, 2000).

These findings have serious implications for the management of the spiny lobster fishery in Saint Lucia particularly, in the timing of the close season, as one of the objectives of the managment of the lobster fishery, as outlined in the Fisheries Management Plan, is the protection of breeding adults.

Fisheries legislation and regulations in effect during 1999-2004

The primary legislation governing management of the lobster fishery are the Fisheries Regulations No. 9 of 1994. Under these regulations, it is illegal to harm or have in one's possession any lobster that is undersized, carrying eggs, or moulting. It is also illegal to spear, hook a lobster, or remove the eggs from a lobster. Lobsters are protected from fishing between 1st May to 30th August in any year. Finally, lobsters smaller than 95mm carapace length are protected within the regulations.

In 2001, the Department of Fisheries with assistance from FAO, embarked on an initiative to review and revise the existing fisheries legislation. The following are proposed amendments regarding lobster management:

I *No person shall:*

- *Attempt to catch or catch lobster with the use of SCUBA and/or Hookah*
- *Keep any lobster confined to a holding pot during the closed season; and*
- *Disturb, damage, take from the fishery waters, have in his possession, purchase, import, expose for sale, or sell any lobster from the 1st day of January to the 30th day of June in every year, or during a closed season as declared by the Minister by notice*

published in the Gazette and in a newspaper which is printed or circulated in the State.

II *All establishments engaged in the sale and trade of lobsters and their products shall declare their lobster stocks to the Department of Fisheries by 1st July of every year. All establishments engaged in the sale or trade of lobster shall dispose of all lobsters within one month from the allocated close season.*

Consultations were undertaken with different stakeholders, lobster/pot fishers, hoteliers and restaurateurs, fish purchasers and processors, and enforcement officers where the proposed amendments were presented to them for discussion. In total nine consultations were held. Most persons supported the re-implementation of the limited entry system through the issuance of pot fishery licences. There was generally consensus by stakeholders on the implementation of a one-month trading period for the sale of lobsters from the first day of the closed season. Stakeholders' opinion, however, varied on the date of the open season for lobsters, with many suggesting that the open season be shifted to August - March.

Conch Fishery

Introduction

The Queen conch, *Strombus gigas* (Linaeus, 1758) is one of the single species nearshore fisheries of Saint Lucia. Presently, nearshore stocks have been over exploited, resulting in the exploitation at deeper depths with the use of SCUBA gear. Although this species is thought to be distributed around the island, only two significant populations have been identified, one to the north and the other to the south of the island (Nicholas & Jennings-Clark, 1994). Information obtained from a recent survey of vessels targeting conch resources (Walker, 2003) indicated that divers harvest conch regularly from various areas off Cas en Bas, Esperance, Grand Anse, Gros Islet, Mennard and Marisule in the north; Vieux Fort and Caille Bleu in the south; and Dennery on the east coast. Conch vessels target, on average, three areas on a rotational basis. Conch are mainly landed at two landing sites: Gros Islet, located at the north of the island; and Laborie on the south west coast. Conch are more heavily targeted in the north of the island than the south (Walker, 2003).

Conch is exploited commercially all year by over 40 fishers in depths ranging from 11 m to 43 m. Fishers operate mainly out of fiberglass pirogues ranging in length from 7.02 m – 8.45 m, powered by outboard engines of 115 – 250 hp. Walker, (2003), reported that whilst conch are targeted commercially by some fishers throughout the year, others fishers focus their efforts on this resource during the low period for "offshore" pelagic species, for an average of five months. Most conch fishers undertake more than three dives a week and land an average of 300 conch per trip. The number of conch landed per trip is dependent on the number of divers and the number of dives undertaken during a trip, and can range from 100 - 500 conch (Walker 2003). Walker (2003) indicates that two divers enter the water per trip and that each diver undertakes between three to four dives (inclusive of decompression dive). Subsistence exploitation occurs in shallower areas, but the extent is unknown.

Due to the nature of the fishery, the marketing system, and an informal policy of the Department of Fisheries, the majority of Queen conch harvested are landed whole (live) and then sold immediately or stored in wire-meshed cages in shallow areas close to shore until sale is obtained.

Two management objectives have been defined for this resource and are articulated in the *Plan for Managing the Fisheries of Saint Lucia (2001- 2005).* They include rebuilding the near shore stocks and ensuring sustainable use of this resource. Options identified for attaining these objectives include initiating a flared lip thickness restriction, controlling effort through a licensing system, implementing closed areas or seasons and co-management arrangements with resource users.

Trends in catches or landings during 1993-2003

Landings of Queen conch have increased steadily in the last few years (Table 3). This increasing trend can be attributed to an increase demand both in the tourist and local markets. Table 3 gives an indication of the annual production of Queen conch between 1993 and 2001 giving an average annual production of 33 tonnes during that period.

Table 3: Landings of conch from 1993 to 2003

Year	Total Landings (tonnes)	Conch Landed (tonnes)
1993	1114	13.31
1994	883	19.75
1995	981	31.92
1996	1315	26.8
1997	1311	24.53
1998	1461	28.16
1999	1718.14	33.31
2000	1860.1	40.3
2001	1967.2	41.4
2002	1607.84	60.44
2003	1446.99	47.51

(Source: Department of Fisheries, 2004)

Although conch does not contribute significantly to the total landings (Figure 3), this fishery is economically significant to the livelihood of fishers, particularly in Gros Islet where the highest landings of conch are recorded.

Collection of catch and effort statistics during 1999-2003

Over the past decade, very little information on major single species fisheries such as conch has been collected on a consistent basis. Prior to 2001, conch landings were only captured for Gros Islet in the north, where the majority of conch are landed.

In 2001, the sampling plan was revised to include two other sites in the southwest, where fishers from one of these sites are also known to target conch. This revision has improved the information base for this species. Analysis of the 2002 data indicated that conch is now landed at four landing sites: Gros Islet, Castries, Laborie and Vieux Fort.

Fisheries legislation and regulations in effect during 1999-2003

The Fisheries Regulations No. 9 of 1994 provide the mandate for the management of the conch fishery at the national level by prohibiting the harvesting of conch of less than 180 mm total shell length, less than 1 kg total weight and less than 280 g meat weight, not including digestive glands. In addition, these Regulations restrict harvesting of immature conch, defined as individuals without a flared lip. However due to financial and manpower limitations, enforcement focuses on only one of these Regulations - the harvesting of individuals with flared lips due to the ease of implementation in the field. The Fisheries Regulations also make provisions for a closed season but, to date, this management measure has not been implemented.

In 2001, the Department of Fisheries with assistance from FAO, embarked on an initiative to review and revise the fisheries legislation. The following are amendments regarding conch proposed in revised the fisheries legislation:

(1) *No person shall -*

I. *take from the fishery waters, sell, purchase, or at any time have in his possession any immature conch; or*

II *take from the fishery waters, expose for sale, purchase or at any time have in his possession any conch during the closed season for conch or taken from a closed area for conch as specified by the Minister by notice published in the Gazette and in a newspaper which is printed or circulated in the State*

III. *take from the fishery waters, have on board any fishing vessel or land any conch out of its shell.*

(2) *In this Regulation -*

- *"conch" includes the whole or any part of any conch;*
- *"immature conch" means a conch with -*
    - *a shell with a lip thickness of less than 5 millimetres;*
    - *a total weight of less than one kilogramme or*
    - *a shell which does not have a flared lip.*

Large Pelagic

Introduction

This fishery, like the other fisheries in Saint Lucia, is primarily conducted from small, open boats, with trolling lines operated by hand. The offshore pelagic fisheries contributed 64% of the annual landings by weight (Department of Fisheries, 2004) which is made up of a number of migratory species including dolphinfish (*Coryphaena hippurus)*; mackerel (*Stromberomorus* spp.*)*; Wahoo (*Acanthocybium solandri)*; blackfin tuna (*Thunnas atlanticus)*; yellowfin tuna (*Thunnus albacares)*; Skipjack tuna (*Katsuwonus pelamis)*; sharks (various families); billfishes (Istiophoridae, Xiphiidae).

The catch is highly seasonal, with the majority of activity and landings occurring between December and June, but peaking between January and April each year. This fishery is active at

all landings sites, but is more prominent at Dennery located to the east and Vieux Fort to the south of the island.
The Department of Fisheries, cognizant that many of the nearshore resources are exploited to over exploited for the last few years, has promoted the offshore pelagic fishery through the introduction new fishing technologies such as Fish Aggregating Device (FADs), and new fishing techniques such as longlining.

Unlike the nearshore fisheries, such as lobster and conch, which are regulated at the national level under the Fisheries Act No.10 of 1984 and the Fisheries Regulations No. 9 of 1994, the pelagic fishery is currently not regulated at the national level. The management objectives for this fishery, as outlined under the Fisheries Management Plan, include:

- The promotion of the sustainable development of the commercial and sport fisheries for large pelagic species;
- Cooperation with other Caribbean States to manage the large pelagic resources

Trends in catches or landings during 1990-2003

Generally the trend in landings of large pelagics have steadily increased in the last few years with large pelagics accounting for 64% of the annual landings in 2004 (Table 4).

Table 4: Pelagic Landings (tonnes) from 1990-2001

Year	**Pelagic Landings (Tonnes)**
1990	389
1991	562.04
1992	615.52
1993	677.59
1994	494.78
1995	593.84
1996	871.77
1997	928.49
1998	870.14
1999	1227.45
2000	1276.5
2001	1081.8
2002	975.47
2003	918.02

(Source: Department of Fisheries 2004)

Figure 5 indicates that large pelagics over the last few years made up the largest proportion of the total landings. This increasing trend in pelagic landings may be contributed to the efforts undertaken by the Department of Fisheries to promote the fishery as an alternative to the nearshore fishery.

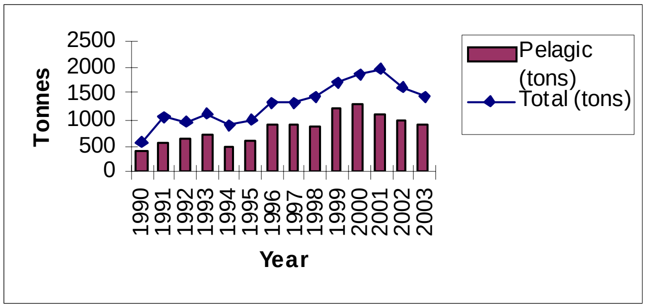


Figure 5: Proportion of large pelagics that contributed to the total landings between 1990 to 2003

Gear Trends during 1990 - 2003

As part of its efforts to encourage more fishers to enter the pelagic fishery, the Department of Fisheries through its Extension Unit has trained many fishers in the use of longline fishing on the Department's research vessel. However, few fishers have been able to adapt this technique to their open pirogues, and as a result of this, trolling is the predominant fishing method used to target pelagics.

Fishers have also adopted a fishing method from the French islands, known as drift line fishing. Under this method a vertical line between 50 to 100 meters with one or two hooks is attached to a buoy and placed in the water.

Introduction of new fishing technologies during 1999 -2003

Offshore pelagics remain the major focus for developmental initiatives within the fisheries sector. The Department of Fisheries is actively promoting the deployment of Fish Aggregating Devices (FADs) to assist fishers with their catch. Over the last decade, the Department of Fisheries in collaboration with fishing communities have deployed several FADs in waters adjacent to fishing communities.

In addition, the DOF staff conducted a number of awareness and sensitisation programmes within the major fishing communities to sensitize fishers as to the benefits of FADs and highlight certain practices that they should not engage in while fishing near a FAD.

Collection of catch and effort statistics during 1999 - 2003

Landings information on pelagics are collected at the eight landing sites that are presently sampled with Vieux Fort and Dennery accounting for the highest landings of pelagics on the island. Presently, the Department of Fisheries is unable to verify the proportion of pelagics captured near FADs and, as a result, the impact that FADs are having on pelagic catches.
Large pelagics are grouped under the following categories: tunas, dolphinfish, wahoo and shark. Analysis of landings of these species between 2000-2003 with the exception of 2003 data show highest landings for dolphinfish followed by tunas (Table 5).

Table 5: Landings of Large Pelagics (tonnes) from 2000-2003

Year	Tunas	Wahoo	Dolphinfish	Shark
2000	473.4	243.1	555.1	4.9
2001	404.4	214.0	427.0	4.5
2002	319.91	242.92	402.17	10.47
2003	456.17	169.3	286.62	5.93

(Source: Department of Fisheries)

Fisheries legislation and regulations in effect during 1999-2001

Due to the migratory nature of pelagics, there are currently no regulations controlling the harvest of these species for commercial fishing within national waters, as management regimes need to be established at the regional and international scale.

However, under the Fisheries Regulations No. 9 of 1994, the Department of Fisheries regulates sportsfishing, which targets pelagic species. The following rules apply to sportfishing:

(a) *A person shall fish by the traditional method of angling with a hook or lure attached to a line held in the hand or attached to a pole, rod or reel;*
(b) *A person unless otherwise authorised by the relevant licence, shall not use a spear, fish trap, or net other than a cast net or a landing net;*
(c) *The owner or operator of the vessel shall not use more than six rods or reel; unless he is in possession of a licence authorising the use of more rods or reels;*
(d) *Any migratory fishery resource that is caught shall not consist of more than 18 kingfish, dolphinfish or wahoo per person on the boat, and any resource not intended to be used shall not be injured unnecessarily but shall be returned to the sea alive;*
(e) *No vessel shall have on board any turtle;*
(f) *No vessel shall have on board more than ten conch or six lobsters per person at any time;*
(g) *No owner or operator of the vessel shall catch any demersal piscine resource less than 482.6 millimetres in total length.*

References:

Anon (1996) Maturity Study for Spiny Lobsters in Saint Lucia: Project Proposal and Implementation Plan. CARICOM Fisheries Resource Assessment and Management Unit.

Department of Fisheries (2004) St. Lucia Landings Report, 2003. Department of Fisheries.

Department of Fisheries (2001) *Plan for Managing the Marine Resources of St. Lucia*. Department of Fisheries St. Lucia.

Department of Fisheries (1999) Report on the implementation of pot fishery licence in St. Lucia. (Unpublished).

Joseph, W.B. (2000) Assessment of the status of the Caribbean spiny lobster (Panulirus argus, Latrielle 1804) fishery in St. Lucia and proposals for sustainable management. A Dissertation submitted in partial fulfilment of the requirements for the Degree of Masters of Science in Fisheries Science in the University of Hull.

Luckhurst & Auil-Marshalleck (1995) Subproject Initiation Mission Report and Background Review for Spiny Lobster and Conch. CFRAMP Research Document No. 17.
Mahon, R. (1990) Fishery Management options for Lesser Antilles countries. FAO, Rome, Italy. FAO Fisheries Technical Paper No 313.
Nichols K., & S. Jennings Clarke (1994) An overview of the Conch Industry in St. Lucia, West Indies In R.S. Appledorn & B. Rodriquez (Ed) Conch Biology, Fisheries and Mariculture. Fundacion Cientifica Los Roquez. Caracas, Venezuela.
Statistics Department (2001) Census 2001: Government of St. Lucia.
Walker, L. (2003) An overview of the St. Lucia Conch Fishery. (Unpublished).

NATIONAL REPORT - SURINAME

A. FISHERY AND FLEET DESCRIPTION

Fishing vessels operating in Suriname waters can be classified into trawlers, snapper boats, Guyana type: open or decked and canoes. A few fishing units are operated without a boat. Fleets can be defined as combinations of boat and gear.

Trawl net operates from shrimp trawlers and different types of finfish trawlers. Large stern trawlers using high opening trawls have been introduced recently in Suriname, in 1993. Part of their catch consists of fin-fish species that have been little exploited by other fleets before (small sandy-bottom demersal fish). The potential yield of this resource is not yet well known. The other part includes species that were already under exploitation by earlier fleets (soft-bottom demersal fish). This fleet catches demersal as well as pelagic species. There is difference in trip, an average trip is two weeks. Licenses are given to these boats to operate from 15 fathom and up over the entire EEZ. In 2002, also two stern trawlers vessels started to exploit small pelagic, which has result in the catching of large coastal pelagics. In 2004, 6 licenses are issued.

Stern trawlers, exploiting deepwater shrimp**,** is totally foreign owned and operated. The potential yield of this resource is not yet known. These vessels are allowed to operate in waters at least 90 meters of depth.

Outrigger trawlers, exploiting shrimp, is almost totally foreign owned and operated. A one-month closed season is proposed around the peak of recruitment of brown shrimp, between June the 15th and July the 15th. The exact dates could be set each year, in agreement with the fishing industry, in order to follow the peak of recruitment as accurately as possible.

Outrigger trawlers, exploiting deepwater shrimp, is targeting for scarlet shrimp. The potential yield of this resource is not yet known, and until precautionary approach is recommended. The number of vessels should therefore be limited to 3 boats until details are known on the yield. These vessels should not be allowed to operate in less 90 meters of depth.

Outrigger trawlers, exploiting sea-bob, has developed very recently (from 1996), and a precautionary approach is recommended until the potential of the resource has been estimated, and the impact of this new fishing activity on other resources and other fleets has been investigated. Constraints on the vessel and gear should be similar to those imposed on outrigger trawlers targeting penaeid shrimp and fin-fish (450 HP maximum; 4.5 minimal cod-end mesh size; TED). The fishing zone is set beyond 10 fathom of depth.

Outrigger trawlers, exploiting fin-fish, converted shrimp trawlers, and are generally the property of national investors. As this fleet is exploiting species that are found in shallow waters, and therefore necessarily interferes with the artisanal coastal fleet, it not allowed to expand beyond a level of 5 vessels. For the same reason, the minimal depth is set at 10 meters, and the stretched mesh size at the cod-end should be not smaller than 8 cm. The converted shrimp trawlers operate in shallow waters between 10 - 20 m depths, catching mainly demersal species. Trip for these vessels last for approximately two weeks.

Tuna trawlers came in operation in May 2001. Two American vessels are catching tuna in and out of the EEZ of Suriname. These vessels stop operation for reason unknown by the government.

The snapper fishery is owned and operated by foreign fishermen. As the snapper fishing grounds are distributed between 50 and 80 meters depth, depth limits could also be established for this fishery, in order to suppress the risk of overlapping with other fisheries. A minimal depth of 40 meters is proposed. The snapper boats are catching *Lutjanus purpureus*, *L. synagris, Rhomboplites aurorubens*, other snappers, Mackerels (*Scomberomorus sp*.) and a small size Serranidae. They make use of vertical hook & lines, because traps are forbidden.

Tuna trawlers came in operation in May 2001. Two American vessels are catching tuna in and out of the EEZ of Suriname. These vessels stop operation for reason unknown by the government.

The coastal drifting gillnet ("driftnet") fishery, is carried out by two types of boats using a similar fishing gear: the so called “Guyana boats” (with/without deck). It estimated that the MSY of the target resource, the large demersal fin-fish, has been reached, and has even be already exceeded in the last years. It is therefore necessary to restrict the access, both by limiting the number of licences and by curbing illegal fishing. All the decked gillnets use 8 inches stretched polyethylene nets. Open Guyana type boats also use polyethylene nets of 5-7 inches stretched, while gillnets operate in estuaries use different sizes of Nylon nets.

Constraints are also proposed on the fishing gear: a minimal mesh size could be set at 20 cm (the same as the current size) for the decked boats and at 16 cm for the open type of boat. The nets should not be longer than 5 km and 4 km respectively for the decked and the open type.

In the river mouth fishing is done by canoe type boats. Chinese seines do have 3 different types, of which one is mainly for catching finfish. Therefore they are categories as large (FJ, for fish), medium (FK) and small (FN) for seabob, and white belly shrimp and juvenile’s fish caught together in the net. The Chinese seines use polyethylene net of different sizes.

Fixed gillnets use in the lagoons are made of number nylon nets of 20m in length. The nets are attached to poles on the top side as well as the bottom side. The mesh size use is ranging from 1.25 inches up to 1.75 inches.

River seine boats use gillnets with mesh size ranging from 2 to 2.5 inches. The net is set in a circular way using one boat.

B. POLICY AND REGULATIONS

Legislation

Fisheries in Suriname are currently regulated by Decree on Marine Fishery (Decree C-14), operational since 1 January 1981. This legislation is being revised and a new fisheries law was been drafted in 1992. The new law i.a. prescribes the elaboration of annual management plans, in which all concrete regulation measures will be established, providing a flexible tool to adapt fisheries management to the changing conditions of the exploitation.

There is a compulsory registration of the boats. An annual fishing rights, which is different for all fleet types. All trawlers had to report their position daily to their base. A landing report has to be prepared and delivered to the Fisheries department within 3 days after delivering the catch. The entire catch has to be landed in Suriname. Transshipment at sea is prohibited.

Pelagic fishery.
This fishery is conducted with large and small trawlers. They use semi-pelagic nets and are licensed to fish from 15 fathom and beyond. No close seasons. The annual fee is according to the demersal finfish trawlers.

Control and Surveillance

TED Inspection

- Dock Inspection

Twice a month at every shrimp fishing harbour (4 harbours)

- At Sea Inspection

3- 4 trips per year.

Surveillance

Corantyne River: twice per year

Coppename/Saramacca River: twice per year

Other Rivers: six times a year

Summary of proposed regulations by fleet.

Type ofVessel	Type of fishing gear	Maximum # of licences	Limits on the vessel	Constraints on fishing gear	Depth limits / fishing grounds	Closed seasons	Licence fee (US $)	Monitoring
Stern trawler	**deepwater shrimp**	2	Hp 1000	4.5 cm minimum cod-end stretched mesh size. TED	> 90 m		20,000	
	Midwater trawl	5	HP max	8 cm minimum cod-end stretched mesh size	> 25 m		10,000	
Florida type trawler	**Shrimp trawl**	100				30 days in June/July	15,000	Logbook Landing report Observers
	Deep sea shrimp	3	HP max 450	4.5 cm minimum cod-end stretched mesh size TED	> 90		15,000	
	Seabob trawl	24			>10m		5,000	
	Fish trawl	10		8 cm minimum cod-end stretched mesh size	> 10 m		1,000	
Snapper boat	**Vertical lines**	50			> 40 m		4,000	Logbook and landing report
Decked Guyana	**Drifnet**	60		20 cm minim stretched mesh size 5 km maximum net length			500	
Open Guyana	**Drifnet**	200		16 cm minim stretched mesh size 4 km maximum net length			250	
	Njawarie	20		2 km maximum net length				
	Longline							
Korjaal (estuaries)	**Drifnet**			2 km maximum net length				
	Longline							Landings only at registered landing place(s)
	Large Seine (FJ)	1 net per licence	HP max 25		Specify river		100	
	Medium Seine (FK)	2 nets per licence						
	Small Seine (FN)	7 nets per licence						
Korjaal (river)	**River Seine**						50	
Korjaal (lagoons)	**Fixed gillnet**		HP max 15	* m maximum total net length per licence	Specify lagoon		20	

Source: Fisheries Management Plan (1998).

C. GENERAL STATISTICS ON FLEET TYPES, TYPE OF EFFORT, AND TRENDS IN FISHING PATTERNS AND PRACTICES

Fishing grounds by fleet

Type of boat	Type of gear	Fishing grounds	depth zone
Trawler	Shrimp trawl	sea	25 - 90 m
Trawler	Bottom trawl	sea	20 - 45m
Trawler	Semi-Pelagic trawl	sea	25 - 50 m
Trawler	Tuna Long line	sea	>>100 m
Snapper boats	Hook & Line	sea	40 - 90 m
Decked Guyana	Driftnet	sea	5 - 25 m
Open Guyana	Driftnet	sea	5 - 15 m
Decked & Open	Pin seines(Njawari)	sea	0 - 5 m
Open Guyana	Bottom Long line	sea	2 - 10 m
Canoe	Driftnet	estuaries	2 - 5 m
Canoe	Chinese seines (3 types)	estuaries	2 - 5 m
Canoe	Bottom Long line	estuaries	2 – 5 m
Canoe	Fixed gillnet	brackish lagoons	0 - 1 m
Canoe	River seines	rivers	
Canoe & no boat	Other	rivers & inland	

Type of fleet	Species composition	# of Vessels 2002	DAS	Landing (tons)
Deep sea fishing Shrimp	Penaeus subtilis, P. brasiliensis, P. notialis, P. schmitti, Pleisopenaeus edwardsianus, Solenocera acuminata and Parapeneaeus longirotris	87	60-100	4.000
Seabob	Xyphopenaeus kroyeri	24	6-12	10.026
Demersal finfish	Lutjanus synagris, L. purpureus, Rhomboplites aururubens, Serranidae, Haemulon spp, Calamus spp, Cynoscion virescens, C. similes, Scianids, Arius proops, Arriids, Barracuda, Mackerel, Shark	14	7-30	2500
Coastal Pelagic	Barracuda, Mackerel, , Trachurus lathami Caranx spp, Prepilus paru Chloroscombrus chrysus,	4	7-28	1025

	Selene spp Hemicaranx amblyrhynchus, , Shark, Trachinotus spp, Cynoscion spp, Clupids, Haemulon, Rays, Chaetodipterus faber			
Large Pelagic	Sarda sarda, Thunnus alalunga, Th.albacore, Th. atlanticus, Coryphaena hippurus, Scomborumeros cavalla, Shark	0		
Snapper	Lutjanus purpureus, L. synagris, L. jocu, Rhomboplites aurorubens, Scomborumeros spp, Coryphaena hippurus, Shark	62	15-23	794
Coastal fishing				5,529
Driftnet	Cynoscion spp, Arius spp, Megalops atlanticus, Shark, Ephinephelus itajara	289	7-15	
Pin seines(Njawari)	Macodon ancylodon, Nebris microps, Cynoscion spp, Arius spp	14	7-15	
Bottom Long line	Arius spp, Cynoscion virescens, mackerel	5	3-10	
Inland fishing				1,979
Driftnet	Cynoscion spp, Arius spp, Shark, Elops saurus, Centropomus spp	72	1-3	
Chinese seines	Xyphopenaeus kroyeri, Nematopalaemon schmitti, Macodon ancylodon, Nebris microps, Cynoscion spp, Arius spp	321	1	
Lagoon gillnet	Muglidae, Megalops atlanticus, Tilapia mossambica, Arridae	103	1	
River seines	Plagioscion surinamensis,	8	1	
Other	Callichthydae, Erithrinidae, Aequidens spp, Ucides cordatus	91	1	

D. SAMPLING PROGRAM

Biological Sampling

The Fisheries Department has the following biological sampling on shrimp, sea-bob and fin-fish.

Sampling on shore/landing sites

- Head off shrimp landings at SAIL: by commercial size categories: composition by species and gender. Sampling should be conducted twice a week. Since 2000 very difficult to complete this activity.

- Head on shrimp landings at SUJAFI: by commercial size categories and by company: species and gender composition. Sampling should be conducted once a month (2 days).

- Sea-bob sampling at sea: Observers collect samples on board from every haul (±1 kg). The samples are to be processed at the laboratory, and species and gender composition, length frequencies and sample weight will be recorded. Sampling should be conducted, every month.

- Fish measurements at landing sites. Since, 2001 there had not been any measuring at landing sites. Sampling is nowadays conducted at the office or at processing plants.

Observers program

After a few trials carried out in 1991, an observers program was launched in 1993. Its objective was essentially to obtain the type of information that cannot be recorded on shore through the Fisheries Information System. One of the most significant developments in the fisheries in Suriname during the last years being the introduction, from 1993, of stern- trawlers exploiting fin-fish (and referred to as "kotters"), the observers program first concentrated on this fleet. After 1995 the program diversified and included other fleets, particularly the shrimp trawlers fleet in 1996 and 1997, and the emerging sea-bob fleet in 1997.

Table 1. The observers program in Suriname from 1999 - 2002

	1999	2000	2001	2002	
# observers trips	33	10	12	24	
# days at sea	302	63	88	222	
# observed hauls	1,416	248	249	670	

Source : Fishery Department

In 2000 and 2001 only on seabob vessels observation are being made by Japanese investigator, working at the Fisheries Department, under a JICA project to see the interaction between seabob and other commercially important Penaeus shrimp.

In July and August, 2001 the Fisheries Department made an attempt to place observers on Red snapper vessels.

Purpose

1. Gathering information on the fish behavior and techniques, for better stock assessment purposes, determine the Total allowable catch (TAC), total number of license to be issued, population dynamics, influence of the gear on the stock and others.
2. The interaction with other fishery types, such as the fish trawls.
3. Provide decision-makers with adequate information for sustainable use of the resources.
4. Assist all stakeholders and share the results of the investigation with them.

Fish Quality management

The fisheries department has a laboratory, which can be divided, into two sections:

1. Freshness laboratory for freshness tests on fish
2. Microbiological lab.

Freshness laboratory

The purpose of this lab is to test fish with a subjective and also an objective method in order establish standard curves for each parameter (for example pH, TVB-N). Since 1997, standard curves have been established for the following fish species; *Macrodon ancylodon*, *Cynoscion acoupa* and *Oreochromis mozambicus.* The standard curves established in laboratory conditions have to be extrapolated to be of use as standards of export.

Microbiological lab

The purpose of this lab is to set up a monitoring program to control the cleaning and disinfection of the fish processing plants. In May the laboratory was installed and in June this year the protocols for several apparatuses and the different sampling methods, was written. In July we picked out one plan to start monitoring and now we control each plant every month, so that we can establish hygienograms for these plants.

We also do monitoring on: Ciguatera (done in Lab for freshness)
Mercury
Histamine (Scombrotoxine)
In the past: Heavy metals; Arseen, Cadmium, lead
Residue of agriculture pesticides

Ciguatera:

Why the ciguatera monitoring. Suriname lies in a region where there is a risk of ciguatera poisoning. Further more there are Venezuelan vessels in Suriname, which catch fish in Venezuelans waters, where there are coral reefs. The monitoring is done with immuno-reactivetest from Oceanit (a firm in Honolulu).

Monitoring on ciguatera begun in September 1999 and stopped in July 2000 because of lack of finances. This monitoring was initiated, because Suriname lies in a region where ciguatera fish poisoning occurs. Ciguatera is a form of human poisoning caused by consumption of subtropical and tropical marine finfish, which have accumulated naturally occurring toxins through their diet. The toxins are known to originate from several dinoflagellate (algae) species that are common to ciguatera endemic regions in the lower latitudes. For the testing, we've used the Cigua-Check of Oceanit Test Systems, Inc. (Honolulu).

Mercury

It is not recommended to consume fish with a ciguatera-concentration greater 1 ppb.
Till now a small percentage of the tested fish has a value above 1 ppb.

The purpose of this monitoring was to examine if our fish meets with requirements of the EU standard. (0.5 ppm and 1 ppm for some specific species).

This monitoring was done in cooperation with CELOS (Centrum for Agriculture Research) and was finance by ABOS. The preparation of the samples was done at CELOS and the analyses were done in Gent, Belgium. Samples were taken from the Suriname Rivers and Atlantic Ocean.

The results of some species of some part of the interior are high (greater then 0.5 ppm). These fish may not be exported. We are busy to realize cooperation with the university of Surinam to do the analyses for us.

<u>Heavy metals: Arseen, lead, cadmium.</u>
Fish samples were sent to Gent, Belgium, in 1998 to examine the level of these heavy metals. The levels of Arseen, lead and cadmium are below the maximum admitted level.

<u>Residue of agriculture pesticides</u>
In June 1998, some fish samples were sent to Belgium (LOVAP) to examine the levels of pesticides (as PCB, Aldrien, Diquat). The levels of these pesticides are far beneath the maximum admitted level.

<u>Histamine (Scombrotoxine)</u>
Ingestion of histamine may cause scombroid poisoning in humans. Because of its potential for human illness, the E.U has required that the monitoring on histamine in fish must be done.
A project proposal for the monitoring of Histamine was sent to ABOS. It is approved and this type of monitoring will commence in the near future.

In 1999 the Microbiological Laboratory was installed to monitor the hygiene of the processing plant. Each month the quality-inspectors of the Department of Fisheries carry out microbiological testing on surfaces in production premises. Various methods are used and shall be mentioned briefly:

- Testing with Rodac plates. In these methods petri dishes with agar media are applied to surface to be examined, followed by incubation and counting of colony forming units.
- Dipslides for testing Coliforms and *Enterobacteriacea.* These contact slides with selective media are applied to the surface to be examined, followed by incubation and counting of colony forming units.
- HY-LITE:ATP-method. ATP (present in all living cells- also in the bacteria) is detected specifically by reaction with a Luciferin/Luciferase mixture in buffered solution. The light emitted in the process is detected and displayed by the HYLITE luminometer. This method is almost a “real time” method giving the answer within minutes.

Since February 2002 testing have been done using Veratox Quantitative Histamine test. This test is a competitive direct enzyme-linked immunosorbent assay (CD-ELISA) for the quantitative measurement of histamine in scombroid species of fish.

E. ECONOMIC ASPECTS

The only economic data that is being collected by the fisheries department is export data from the shrimp companies. Also, the amount of local sales is being reported. These data are collected on a regular basis, because most companies need a health certificate.

Data on operational costs had been collected a few times, but not regularly. This type of information can be extracted from the annual reports of the bigger enterprises (such as the processing companies).

Table . Amounts exported and average prices by species (2000 – 2002)						
	2000		2001		2002	
	Netto (ton)	Value	Netto (ton)	Value	Netto (ton)	Value
Total Fish	7,856.5	4,767.9	7,718.7	5,16.7	10,302	8,289.4
Prawns	1,529		1,709.1	23,327.9	1,725.5	22,343.4
Seabob	3,195		3,301.5	5,787.5	4,963.8	7,684.1
Culture Shrimp	62		230.3	2,655.6	143.4	8,289.4

Source: Fisheries Department and Immigration office

F. REFERENCES

Charlier, Babb-Echteld and Chin A Lin, Suriname Fisheries Report # 11: Fisheries Management Plan (updated).
Babb-Echteld Y. 2001. Description of the Fisheries in Suriname.
Babb-Echteld Y. 2004. Chinese Seine Fishery in Suriname, in prep.
De Boer-Ho R., Colli-Wonsoredjo, J. 2001. TOR for the technical assistance for the Quality Laboratory of the Fisheries Department in Suriname (2002)

NATIONAL REPORT – TRINIDAD & TOBAGO

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1. INTRODUCTION

The fisheries sector of Trinidad and Tobago contributed TT$74 million to the Gross Domestic Product (GDP) in 1998. This represented approximately 9% of the agriculture GDP and 0.2% of the national GDP. Annual fish exports for the period 1997 to 2001 average just over 6,100 metric tonnes with the value averaging TT$ 59 million (Central Statistical Office). Total annual landings for the fisheries of Trinidad and Tobago for the period 1999/2000 are estimated at 14,000 metric tonnes with an ex-vessel value of TT$130 million. The fisheries sector is thought to employ an estimated 6,000 persons of whom about 4,000 are engaged in harvesting the resources (Kuruvilla *et al*. 2002). The sector contributes significantly to rural stability as the well being and livelihood of many coastal communities is dependent upon fishing due to limited alternative employment opportunities.

Total annual landings for the fisheries of Trinidad and Tobago for the period 1999/ 2000 are estimated at 14,000 metric tonnes with an ex-vessel value of US$21 million

International trade in fish and fishery products is based mainly on the export of shrimp, snappers, swordfish, tuna and flyingfish and other pelagics. Fishery products are exported mainly chilled or frozen, and processing technology is generally limited to primary processing and packaging. Approximately 4,000 metric tonnes of fish valued at US$10 million (TT$62 million) was exported in 2000 of which over 40% in terms of revenue went to CARICOM markets, 30% to the United States and 22% to Canada (Central Statistical Office records for 2000). Trinidad and Tobago has not been eligible to export to the European Union since 1999 and is at present taking measures to meet the required quality control criteria.

Table 1: Numbers of fishers, vessels, national production and exports for 1997 to 2001.

FISHERIES STATISTICS	1997	1998	1999	2000	2001
Number of fishers (Trinidad & Tobago)	3,469	(Kuruvilla et al. 2002)			
Number of vessels (Trinidad & Tobago)	1,570	(Kuruvilla et al. 2002)			
Artisanal (including shrimp for all fleets) (Trinidad)					
Landings (tonnes)	8,054.25	9,188.75	8,369.07	8,435.53	11,355.00
Value (TT$000,000)	73.85	93.91	85.55	83.59	108.54
Semi-Industrial Longline (Trinidad)					
Landings (tonnes)	461.40	417.00	389.90	171.30	306.00
Value (TT$000,000)	4.50	(annual avg)			

Table 1: Numbers of fishers, vessels, national production and exports for 1997 to 2001.

FISHERIES STATISTICS	1997	1998	1999	2000	2001
Semi-Industrial Fishpot/A La Vive (Trinidad)					
Landings (tonnes)	970.00	(annual avg)			
Value (TT$000,000)	15.60	(annual avg)			
Exports (Trinidad & Tobago) (Central Statistical Office)					
Quantity (tonnes)	10,064.58	6,961.00	7,199.80	4,160.83	2,153.74
Value (TT$000,000) FOB	59.08	76.42	67.79	64.01	27.93

2. DESCRIPTION OF THE FLEETS

The commercial harvesting sector in Trinidad is largely artisanal, typified by manual operations and day fishing, but includes some semi-industrial and industrial trawlers, pelagic longliners and multi-gear vessels which are mechanised and may fish for multiple days at a time (Chan A Shing, 1999). There are about 1570 commercial fishing vessels in the national fleet of which 1491 are artisanal vessels operating in inshore coastal waters, 35 are semi-industrial multi-gear vessels operating in inshore and offshore areas and 25 are industrial vessels operating off the west and south coasts of Trinidad (Martin *et al*. 2004).

The recreational or part time harvesting sector consists of a range of vessel types and sizes operated mainly by individuals and also charter companies. Additionally, on average five (5) sport fishing tournaments are held in Trinidad and two (2) in Tobago annually.

Table 2: Numbers of vessels in 1998 by primary gear for Trinidad (Chan A Shing, 1999).

GEAR	# VESSELS
Trawl	114
Multifilament Gillnet	195
Monofilament Gillnet	133
Italian Seine	12
Beach Seine	18
A La Vive	44
Trolling / Towing	47
Switchering	17
Banking	156
Palangue	40
Longline	4
Fishpot	63
Joined Multi / Monofilament	2
Bait Seine	5
Spearfishing	1
Turtle Net	1
Unknown	399
Total	**1251**

The following fleet descriptions are in the main compiled in Chan A Shing (2002).

2.1 THE ARTISANAL MULTI-GEAR FLEET

The vessels, called pirogues, are wooden, fibreglass, or fibreglass-coated, open boats 7-10 m in length, propelled by outboard engines; two 60 hp engines being the fleet average (Chan A Shing, 1999). La Croix (1984) described the engine power range as 15 to 235 hp. A number of gear types are utilised in the fleet and fishermen typically switch fishinggears according to the seasonality or availability of resources. In general one gear type is deployed per fishing trip. Descriptions follow of the various fishing gears utilised in the artisanal sector.

Gillnets

Artisanal gillnets are either monofilament or multifilament (fillet) drifting nets. The former are made of transparent nylon, while the latter are heavier nets commonly made of nylon and other synthetic twines. Monofilament nets are used either by day or night and are set below the surface of the water. Multifilament nets are generally fished at night at the surface of the water. One or two net sets may be made per trip (Hodgkinson-Clarke, 1990). The nets are left to soak for between 3 to 5 hours; the soak time range for monofilament nets is 2 to 12 hours and for multifilament nets 0.5 to 6 hours (Hodgkinson-Clarke, 1994). The (stretched) mesh size utilised ranges from 3.75" to 5" (Hodgkinson-Clarke, 1994). The average stretched mesh size for monofilament nets is 3.75". For multifilament nets the average stretched mesh size is 4" (Chan A Shing, 1999). Various styles of combination mono/multifilament gillnets appear to have been introduced during the early 1990's. The combination nets are used for net strengthening or reinforcement or to improve fishing power (Hodgkinson-Clarke, 1994). Gillnets are fished on all coasts year through but more in the latter part of the year during the rainy season when carite landings are generally higher (Chan A Shing, 1999; Hodgkinson-Clarke, 1994). Fishing area is influenced by season Hodgkinson-Clarke, 1994).

Surface handlines

Surface Line methods include "a la vive", trolling or towing and switchering. A la vive refers to fishing with live bait using hooks and nylon twine line. In trolling or towing four (4) to six (6) lines are towed from bamboo outriggers off the vessels. Leader lines vary between 20m and 90m in length and usually there is one (1) hook per line. Artificial lures or "spoons" are used. Switchering is surface line fishing using dead bait. The line is deployed while the boat is stationary. The method is commonly practised on the south coast at sites such as Erin and Moruga. Other artisanal surface line methods are most popularly used off the north and east coasts, and around offshore structures such as rigs.

Demersal lines

The demersal line methods are locally termed banking and palangue. Banking gear consists of one (1) to several hooks attached to a weighted main handline. The line is set on banks. Banking is done mostly on the west and south coasts. The palangue is a demersal longline operated at both the artisanal and industrial levels (see section on the semi-industrial multi-gear fleet). Vessel size, trip duration, fishing depth, hook size and gauge of the main line differentiate artisanal and industrial activity levels. The gear consists of a mainline, which carries a number of branch lines with hooks. The number and size of hooks used vary depending on the species being targeted. There are two (2) types: a "small palangue" (1000 - 5000 hooks) used for small snappers and sharks and a "large palangue" (200-500 hooks) generally for sharks. The palangue is used mostly on the west coast.

Fishpots

Fishpots are used mostly on the west, east and south coasts of Trinidad and are also fished by semi-industrial multi-gear fleet. A variety of square and arrowhead fishpots with one opening are used. The numbers of pots set are as variable as the dimensions of the pots used. Artisanal pots are constructed of chicken wire on mangrove or wild coffee frames (Chan A Shing, 1999).

Seines
Beach/land seines are made of multifilament net and fished in the day at Mayaro (south east coast) and on the south west coast of Trinidad. The seines, which range in length from 340 to 660m, are deployed via a boat from the shore out to sea, by a crew of up to six (6) and may be retrieved by as many as 40 persons (Sturm and Julien, 1983; Chan A Shing, 1999). Bait seines are smaller seines used to catch bait species near the shore. These seines are operated by three (3) to four (4) persons. Italian seines are purse seines made of multifilament net and can be up to 366m long (Chan A Shing, 1999). The seine is deployed from a pirogue by 6 to 12 crew members, encircling schooling species (Chan A Shing, 1999). Tuck seines are no longer common and in some areas the name “Italian seine” is used.

2.2 THE TRAWL FLEET

The trawl fleet has been categorized into four types based on vessel length, engine horsepower and degree of mechanization (Fabres, 1989).

- Artisanal Type I vessels are pirogues, 6.7-9.8 m in length, with two 56-hp outboard engines from which one (1) stern trawl is manually deployed. The average headrope length of the trawl net is 10.4 m (Kuruvilla, Ferreira and Soomai, 2000). There are 47 such vessels (2003 Fishing Vessel Census).
- Artisanal Type II vessels are 7.9 - 10.4 m in length with 90-110-hp inboard diesel engines. These vessels also manually operate one stern trawl net with an average headrope length of 10.7 m (Kuruvilla et al. 2000). There are a total of 55 vessels of this type (2003 Fishing Vessel Census).
- Semi-industrial Type III trawlers are larger at 9.3-13.1 m in length with 165- 174-hp inboard diesel engines. These use a single net with average headrope length of 12.9 m operated by a hydraulic winch (Kuruvilla et al. 2000). There are currently 10 Type III trawlers.
- Industrial Type IV vessels are 18.7-24.3 m in length and have 365 hp inboard diesel engines. Two (2) nets attached to twin outriggers are used. The nets with average headrope length of 15 m are set and retrieved using a hydraulic (double-drum) winch (Kuruvilla et al. 2000). Currently about 20 to 25 Type IV vessels operate out of Trinidad.

Artisanal vessels conduct one-day trips (8-20 hours), while semi-industrial vessels make trips of one to five days, and industrial vessels five to eleven days (Fisheries Division catch and effort records 1992-2002). The average number of hauls per day for a Type I artisanal trawler is six with the average duration of a haul being 0.5-1hr, while a Type II artisanal trawler would make an average of 4-5 hauls/day at about 1-2 hrs/haul. Semi-industrial trawlers also make an average of 4-5 hauls/day but with an average duration of 3-4 hrs/haul, while the industrial trawlers make 3-4 hauls/day at 2-4 hrs/haul. The average vessel speed for an artisanal, semi-industrial and industrial trawler is one, two and three knots, respectively. The average stretched mesh size in the cod end of the trawl net is 3.5 cm for the semi-industrial and industrial trawlers, and 3 cm for the artisanal (interviews with vessel owners 2004).

Vessel numbers have remained more or less constant since 1991 except for the artisanal Type I fleet which showed a decline of 88% in the 1998 vessel census as compared to the 1991 census (from 113 to 13 vessels). The decline resulted from the termination of access to fish in the Orinoco Delta of Venezuela in 1995 under a bilateral fishing agreement between Trinidad and Tobago and Venezuela. The current numbers in the Type I fleet represent 42% of the 1991 fleet.

All trawlers operate in the Gulf of Paria on the west coast of Trinidad year round. The industrial trawlers, and to a much lesser extent the semi-industrial trawlers, also operate in the Columbus Channel on the south coast year round, and on the north coast. Since 1998 operations on the north coast have been restricted to the area west of Saut D'eau from November 15 to January 15.

2.3 THE SEMI-INDUSTRIAL MULTI-GEAR FLEET

Semi-industrial multi-gear commercial vessels, which are 14-23 m in length, stay at sea for periods between 7 and 15 days and operate off the north and east coasts of Trinidad. These vessels fish palangue gear (see section on demersal lines in the artisanal multi-gear fleet) and fishpots. They may carry 40 - 60 collapsible pots made of synthetic mesh or 'BRC' per trip (Chan A Shing, 1999). The fleet was scheduled for technological and economic analysis in 2004 by the Fisheries Division.

2.4 THE SEMI-INDUSTRIAL PELAGIC LONGLINE FLEET (Martin *et al.* 2004)

The pelagic longline fleet increased from two vessels in 1988 to a maximum of 13 in 1990. There are currently 10 vessels in the fishery. The fleet is characterised by a single category of semi-industrial vessels that are equipped with electronic fishing aids. Table 3 gives details on the physical characteristics of the fleet.

Table 3: Physical characteristics of pelagic longliners.

Length (m)	Tonnage *(tons)	Engine Power (Hp)	Onboard facilities/Storage	Gear/Deck equipment	Electronic equipment
14 - 25	60 (GT) 27 (GRT)	160 - 400	Fish hold, ice pump Average fish hold capacity 4-9 tonnes of fish	Deck: Main spool with a capacity of 40 miles of line, leader and balldrop carts Gear: monofilament lines (main, leader, balldrop), buoys (beeper, bullet), high flyer, polyball Accessories: hooks, snaps, swivels, crimps, lightsticks	Fishing Aids: Fish finder, radar (to locate high flyer), depth sounder, temperature gauge Navigation equipment: ADF (Auto Directional Finder), GPS Communication equipment: radios (VHF and SSB), EPIRB (Emergency Position Indicating Radio Beacon)
***** Gross Registered Tonnage (GRT)					

Pelagic longline gear consists of a 900lb test monofilament mainline between 35-40 km long with 360 - 900 hooks attached, set about 40 m below the surface of the water. Monofilament leader lines, each 4 m in length and 400lb test, are snapped onto the main line at about 100 m - 150 m (check) intervals. One baited hook is attached to each leader line. Buoys or polyballs are attached by a balldrop line to the main line after every 4-6 leaders using 200lb test monofilament line. High flyers and beeper buoys are attached to the end of each section of approximately 50 hooks. "Cyalume" light sticks may be attached after every 2 hooks when targeting swordfish. Bait includes squid and clupeids.

The number of fishermen on board a longliner ranges between four (4) and seven (7), however most vessels carry 4 fishermen, the captain and three (3) crew members.

The fleet operates in the Western Central Atlantic, Area 31of the FAO major fishing area coding system. Reported average fishing depth ranges from 400 to 3000 metres. Longliners operate all year round. A fishing trip lasts between 17 and 21 days of which two days are used for travelling to and from the fishing grounds. The average length of a trip is 18 days and the average number of fishing days per trip is 13.

2.5 THE RECREATIONAL FLEET (Mike 1993)

The following description of the recreational fleet is based on a study of the recreational/part time fishing operations in the northwestern peninsular of Trinidad. Recreational fishing activity also occurs to a lesser extent in the southern region of the island.

Three vessel types are used in the recreational fleet: cabin cruisers between 10 and 11m long, pirogues 9 to 11m long and power boats 6 to 8m long. Pirogues form the majority of vessels in the fleet followed by power boats and cabin cruisers. The vessels are often outfitted with fishing aids including most commonly, bait wells, and fish finders. Outriggers and rod holders are also fairly common. A variety of fishing methods are employed including: a la vive, trolling, banking, spear fishing, fish pots, gillnets, and palangue.

The recreational fleet maybe considered a part time fishing fleet since many of the participants sell their catches. Reasons given for the sale of catch include: to cover the cost of fishing trips, to dispose of excess catch and to source additional income. Recreational/part time fishermen indicated, however, that they fished at least in part for leisure and entertainment. A few of the fishermen enter sport fishing competitions and other fished to support their incomes.

3. DESCRIPTION OF THE FISHERIES

The mixed marine environment of Trinidad and Tobago results from the differing oceanographic regimes around the islands created by the influences of the north and south equatorial currents and outflows of large South American rivers including the Orinoco and Amazon. In the northeast the waters are mainly oceanic as a result of the passage of the north and south equatorial currents, whereas in the southeast of Trinidad which is directly downstream of the major river systems, the environment is estuarine in nature. The combined effect of oceanographic regimes and the country's geographic location on the continental shelf is a variety of habitats and hence a diversity of marine fisheries resources (Fabres and Kuruvilla, 1992). The resources have been grouped according to habitat (Fabres and Kuruvilla, 1992) and form the basis of the fisheries descriptions.

The following section, taken largely from the Chan A Shing (2002) publication, provides some details for each fishery on the main species exploited, fishing gear used, and fishing areas.

3.1 THE COASTAL PELAGIC FISHERY

The principal species targeted by this fishery are *Scomberomorus brasiliensis* (carite), *Scomberomorus cavalla* (kingfish), and the elasmobranchs *Sphyrna tudes, Rhizoprionodon lalandii, Carcharhinus porosus*, and *C. limbatus*. Many other species are exploited by this fishery, but may not be specifically targeted. These include *Selene vomer*, *Oligoplites saurus,* *Diapterus rhombeus, Selene spixii, Caranx hippos,* and *Caranx crysos* (Henry and Martin 1992b). Both commercial and recreational fleets exploit coastal pelagic resources.

The commercial vessel most commonly used in the coastal pelagic fishery is the pirogue. The gillnet is the principal gear used in the fishery. Other major fishing gears are surface handline (trolling/towing, a la vive, switchering). Kingfish is targeted by a la vive gear, but carite and other species are also caught. Beach/land seines, italian seines (purse seine), tuck seines and bait seines are also utilized.

Research

Assessments conducted for carite and kingfish in 1991-1992 and 1987 respectively, showed these resources to be fully exploited (citations - Henry and Martin, 1992; Sturm, 1987). It was recommended that 1) there should be no increase in fishing effort; 2) gillnet mesh sizes should not be less than approximately 12 cm (4¾ in) stretched mesh; and 3) line fishing should be encouraged over the use of gillnets. The assessments concluded that there is no potential for expansion in the exploitation of these species. An assessment was conducted for one species of shark in 1992 which found the stock to be underexploited and potential for exploitation is considered to be limited.

Legislation

For the gillnet fishery, the *Fisheries (Amendment) Regulations 2002*, regulations make provisions for the following:

- minimum mesh size (diagonal stretched mesh) of approximately 11 cm (4¼ in) except where mullet is targeted;

- monofilament nets with diagonal stretched mesh not less than approximately 9 cm (3½ in) may be used for catching mullet;

- no species other than mullet may be landed in excess of 15% of the total catch when using the prescribed monofilament net for catching mullet; and

- monofilament nets with a diagonal stretched mesh less than approximately 11 cm (4¼ in) may not be carried on board a vessel together with nets of another mesh size.

3.2 SOFT-BOTTOM DEMERSAL (SHRIMP AND GROUNDFISH) FISHERY

This fishery targets mainly shrimp species: *Litopenaeus schmitti, Farfantepenaeus subtilis, F. notialis, F. brasiliensis, Xiphopenaeus kroyeri*, and associated groundfish: *Micropogonias furneri and Cynoscion jamaicensis.*

Shrimp resources are exploited mainly by the trawl fleet and by beach/land seines of the artisanal fleet to a minor extent. Apart from trawl gear, groundfish are also exploited by gillnets (depending on how they are deployed), banking (bottom handline), and palangue (bottom set longline).

Catches of groundfish can be considered incidental by most of these gear since they generally target the higher valued species such as shrimp or the mackerels and other coastal pelagic species. Groundfish of commercial importance commonly caught in trawl gear are the sciaenids (*Cynoscion jamaicensis, C. acoupa, Macrodon ancylodon, Micropogonias furnieri*), clupeids, gerreids (*Diapterus spp*.), lutjanids (*Lutjanus spp., Rhomboplites aurorubens*), engraulids, haemulids (*Haemulon spp., Genyatremus luteus, Orthopristis spp*.) and ariids (*Bagre spp, Arius spp*)).

Groundfish species commonly caught in gillnets and lines are Salmon (*Cynoscion spp., Macrodon spp*.), croaker (*Micropogonias furnieri*), blinch (*Diapterus spp*.), grunt (*Haemulon spp., Genyatremus luteus, Orthopristis spp*.), redfish/snapper (*Lutjanus spp., Rhomboplites aurorubens*) and catfish (*Arius spp*.).

Estimated landings for the entire trawl fleet in 2002 were 940t of shrimp valued at TT$23.9 million and 1,005t bycatch (groundfish) valued at TT$4.8 million. Generally, shrimp landings and catch rates are higher in the first half of the year, that is, the dry season. The highest catch rates have been observed for the artisanal fleet operating in Venezuela (3-9kg/hr at sea), followed by the industrial fleet (2-7kg/hr at sea). The shrimp catch rate for the artisanal fleet operating in the southern Gulf of Paria is generally about 2-4kg/hr at sea, while that for the artisanal fleet operating in the northern Gulf of Paria as well as the semi-industrial fleet is about 1-3kg/hr at sea (Fisheries Division catch and effort records 1992-2001).

The artisanal fleets operating in the Gulf of Paria catch *F. notialis*, *F. subtilis*, *L. schmitti*, and *X. kroyeri* with *L. schmitti* being particularly dominant in the catches from the northern Gulf. Catches from Venezuela by the artisanal fleet from Trinidad comprise largely *F. subtilis* and *L. schmitti*. *F. notialis* is the dominant species landed by the semi-industrial fleet with smaller amounts of *F. subtilis* and *L. schmitti* also being landed. The industrial fleet lands predominantly *F. subtilis* and *F. notialis*.

Research

Shrimp

F. subtilis (brown shrimp) is one of the dominant species exploited by both the Trinidad and Venezuelan trawl fleets in the Orinoco-Gulf of Paria region. Joint biological analyses were conducted for 1973 to 1996 (Alió *et al*. 1999) and 1973 to 2001 (Die *et al*. 2004). It is to be noted that the data obtained from the Trinidad industrial fleet for these assessments were limited. Results of the first study indicate a maximum sustainable yield (MSY) of approximately 1,300 metric tonnes at a fishing effort of 13,000 days-at-sea for both fleets combined, and the fishing effort should be maintained sufficiently below 13 000 days-at-sea for several years to allow the stocks to rebuild. The second study indicates that the resource is severely overfished and that overfishing has been taking place since the 1970s. The current fishing mortality is estimated to be more than three times greater than Fmsy and the current biomass less than one quarter (23%) of Bmsy with MSY being approximately 1,000 to 1,200 tonnes. It is recommended that measures be introduced to reduce fishing mortality and that Venezuela and Trinidad and Tobago should develop a common strategy for effort control. An assessment conducted for white shrimp, *L. schmitti*, and brown shrimp, *F. subtilis*, (1990-1991), exploited by the Trinidad artisanal fleet in the Orinoco Delta showed these resources to be fully to overfished (Lum Young *et al*. 1992). No increase in fishing effort was recommended. A preliminary assessment of the *F. notialis*, female stock exploited by Trinidad trawlers over the period 1992 to 2001 indicated that the catch is predominantly very young, small shrimp and recommended that larger shrimp should be targeted (Medley and Ferreira 2004).

Bio-economic analyses for the shared Trinidad and Tobago – Venezuela shrimp fishery for 1995 to 1998 indicate that at current levels of effort (8175 days at sea for the Trinidad fleet and 9348 for Venezuela) there is a 39% probability of the biomass of *F. subtilis* falling below sustainable levels (Seijo et al. 2000; Ferreira and Soomai 2001). The studies suggested that the shrimp resources were over-exploited and a reduction to 80% of current levels of effort will reduce this probability to 15% and improve profits to the fishery by 12%.

Groundfish

Biological and bio-economic assessments for croaker and salmon were conducted for 1989-1997 using data from the artisanal and semi-industrial trawl fleets, and the artisanal gillnet (monofilament and multifilament) and line (banking, palangue, a-la-vive) fleets of Trinidad and Tobago (Soomai *et al.* 1999; Soomai and Seijo 2000). In addition a joint analysis for croaker was conducted for 1987-1998 using data from the Venezuelan and Trinidad trawl fleets and the artisanal gillnet and line fleets of Trinidad (Alió *et al.* 1999). Results show that the current level of effort exceeds the levels at which yields of both species are maximised. The Maximum Sustainable Yield (MSY) for croaker is 1500 tonnes and has generally been exceeded from 1987-1994 and in 1998 with landings ranging between 1800 to 2800 tonnes per annum. These analyses used limited information from Trinidad's industrial trawl fleet as well as information on the size structure of the species caught by Trinidad's trawl, gillnet and line fleets.

A major decline in yield, net revenues and biomass of both species is expected if an 'open access fishery' is continued. The net present value and the biomass of croaker were examined under alternative management strategies including combinations of limiting or banning certain gears. The recommended management option was to limit effort of all fleets to maintain the resource and the profits to the fishery at sustainable levels.

Legislation

A management regime is in place for the trawl fishery involving areas of operation and gear specifications (*Fisheries [Control of Demersal (Bottom) Trawling Activities] Regulations 2001*, *Fisheries (Conservation of Marine Turtles) Regulations, 1994*) as well as numbers of vessels (1988 Cabinet decision) as follows:

- Trawling is permitted on the north coast of Trinidad outside of 2 nautical miles in the area west of Saut D'eau from November 15 to January 15, but not under cover of night.
- Trawling is permitted on the south coast of Trinidad outside of 2 nautical miles.
- Trawling is subject to a zoning regime in the Gulf of Paria:
- Artisanal trawlers are permitted to operate outside of 1 nautical mile from the coast.
- Semi-industrial trawlers are permitted in depths of 6 fathoms or more.
- Industrial trawlers are permitted in depths of 10 fathoms or more.
- Trawling is prohibited on the east coast of Trinidad and within 12 nautical miles of the coast of Tobago.
- The stretched mesh size in the cod end of the trawl net must be no smaller than approximately 7.5 cm (3 in) when trawling for fish, and approximately 3.5 cm (1.4 in) for shrimp.
- Semi-industrial and industrial trawlers are required to use Turtle Excluder Devices (TEDs) on their nets.
- A ceiling has been placed on the numbers of artisanal, semi-industrial and industrial trawlers.

3.3 HARD BOTTOM DEMERSAL FISHERY

This fishery includes those fish caught by several gear, namely fishpots, bank lines and other demersal lines. Commercial fishermen exploit these species on artisanal and semi-industrial scales. In addition, recreational fishermen target these resources.

The species targeted by this fishery are mainly snappers: *Lutjanus* spp., *Rhomboplites aurorubens*, and groupers: *Epinehelus* spp. and *Mycterperca* spp. Bycatch normally includes Lobsters: *Panuliris* and Grunts: *Haemulon* sp.

Research

Assessments conducted in 1992 for Plumhead snapper, redfish, yellowedge grouper, and sweetlip showed the stocks to be fully exploited. It was recommended that fishing for the Plumhead be restricted and that effort be limited for redfish and mesh size of fishpots increased. An assessment for the Lane Snapper (1980-1981) indicated that the stock may be fully to over-exploited and recommended that the age of first capture of the species be increased. There is virtually no potential for expansion of the fisheries for Plumhead and yellowedge grouper and limited potential for redfish and lane snapper.

Assessments were conducted on the artisanal component of this fishery and not the industrial or semi-industrial. The assessments did not include the impact of other fleets known to harvest these resources.

3.4 OCEANIC (HIGHLY MIGRATORY) PELAGIC FISHERY

The fishery targets the tunas *Thunnus albacares* and *T. obesus* and swordfish (*Xiphias gladius).* Dolphinfish (*Coryphaena hippurus)*, marlins (*Makaira nigricans* and *Tetrapturus albidus*), sharks and wahoo (*Acanthocybium solandri*) are considered bycatch. No discards are reported. Involved in this fishery are semi-industrial longline vessels, semi-industrial multi-gear vessels, and recreational vessels.

Research & Management

Highly migratory pelagic species are currently the management responsibility of the International Commission for the Conservation of Atlantic Tunas (ICCAT) of which Trinidad and Tobago is a contracting Party. Assessments are conducted and reviewed annually by ICCAT.

In the case of yellowfin tuna there is a 3.2 kg minimum size limit on individual fish (taking and landing), with a tolerance of 15% of the number of fish landed with fishing effort not to exceed 1992 level. There are no catch limits on the harvesting of Atlantic yellowfin tuna. There is considered to be some limited potential for harvesting.

Bigeye tuna is considered to be overexploited with some limited potential for harvesting. Management recommendations include: total catch in the Atlantic be maintained at the 2001 catch level; minimum size limit of 3.2 kg (taking and landing), with a tolerance of 15% of the number of fish landed.

Swordfish (north Atlantic stock) is considered to be fully exploited. There is a 10-year (2000 to 2009) rebuilding program in effect. A total allowable catch of 14 000 t has been set for the years 2003 to 2005, of which Parties and Entities that have actively fished the resource are allocated shares. Trinidad and Tobago's share (catch limit) for 2003, 2004 and 2005 is 125 t. There is a total dead discard allowance (i.e. the allowance applies to all countries combined) of 100 t for 2003 only. The dead discard allowance is subtracted from the total allowable catch for 2003 and is eliminated from 2004 onwards. There is a minimum size limit of 25 kg live weight on swordfish (taking and landing), with a tolerance of 15% of the number of swordfish landed. Alternatively, a minimum size limit of 15 kg may be chosen in which case there is to be zero tolerance for the taking and landing of swordfish smaller than 15 kg.

Blue marlin and white marlin are considered to be overfished. There is a rebuilding plan in effect for blue and white marlin (2001 to 2005). The annual amount of blue marlin that can be landed is to be no more than 50% of the landings of 1996 or 1999, whichever is greater. For white marlin the amount that can be landed is no more than 33% of the 1996 or 1999 landings, whichever is greater. Trinidad and Tobago's 2001 and 2002 catch limits respectively are 9.0 and 10.3 t for blue marlin and 0 t for white marlin. The current year catch limits are adjusted based on the previous years' landings. Parties and Entities are encouraged to promote the voluntary release of live blue and white marlin. All blue and white marlins that are brought to vessels alive should be released in a manner that maximises their survival. Parties and Entities are required to adopt domestic regulations that establish minimum sizes for landings of blue and white marlin.

Skipjack tuna stock is considered to be stable with some limited potential for harvesting. There are no management recommendations. Albacore (north Atlantic stock) is fully exploited with management recommendations as follows: catch not to exceed 1997 level; limit number of vessels to average number 1993-1995. Albacore (south Atlantic stock) is close to fully exploited and the management recommendation is to limit catch to 29,200MT. Swordfish (south Atlantic stock) is close to fully exploited. There are country specific quotas; 125/119cm (lower jaw fork length) minimum size limit. There is considered to be some limited potential for Atlantic sailfish.

Legislation (Martin *et al.* 2004)
There is no legislation specific to the operations of this fishery. This is an open access fishery. There are no regulations specific to the gear, the fishing areas or the seasons in which the fishery occurs. In keeping with national responsibilities as a member of the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Fishery is managed based on the informal implementation of ICCAT conservation and management measures for the target species.

In accordance with United States Law (Title 50, Code of Federal Regulations Part 630), all shipments of swordfish (*Xiphias gladius*), exported to the United States of America must be accompanied by an "Atlantic Swordfish Certificate of Eligibility" issued and authorized by the exporting country. The Government of Trinidad and Tobago, through the Fisheries Division, issues Certificates of Eligibility for Atlantic swordfish caught only by Trinidad and Tobago flagged fishing vessels. Each shipment of swordfish bound for the United States is inspected to ensure compliance with specified size and catch limits.

The quantity of *X. gladius* caught is also monitored via a trip reporting system. The International Commission for the Conservation of Atlantic Tunas (ICCAT), of which Trinidad and Tobago is a Contracting Party, has implemented a rebuilding program for the species which prescribes national catch limits. When the catch limit has been met, the targeting of *X. gladius* is curtailed through a combination of voluntary action on the part of the industry and prohibition of the issue of export licences by the government.

4. FISHERIES POLICY

The Government's management objectives and main policy directions as outlined in the marine fisheries policy document (Fisheries Division and FAO 1994) and the goals outlined in the strategic plan (Fisheries Division 2002) are given below. The objectives for management are to:

- Implement efficient and cost-effective management;
- Ensure through proper conservation and management that fisheries resources are not endangered by overfishing;
- Ensure that the exploitation of the fisheries resources and the conduct of related activities are consistent with ecological sustainability;
- Maximise economic efficiency of commercial fisheries;
- Ensure accountability to the fishing industry and the community at large for fisheries management;
- Achieve appropriate cost-sharing arrangements between all the beneficiaries of sound fisheries management.

The Government recognizes the importance of empowering stakeholders through the provision of information, education and training, and the involvement of these stakeholders in decision-making as regards policies and management plans.

In the interest of the sustainable management of the fisheries resources, the Government is committed to the establishment of monitoring systems, development of management plans and establishment of the regulatory framework. The Government recognises that a major factor contributing to over-fishing and over-capitalisation is the present "Open Access" regime which allows unregulated fishing effort. The Government in association with the fishing industry will attempt to manage fishing effort on the resources by controlling the number and type of local vessels within a given limit, and by implementing time and area closures, and fishing gear changes. The Government will embark on a licensing programme for all commercial fishing vessels as a means of monitoring the effort applied to the fisheries.

With regard to financial assistance to the fishing industry, the Government intends to phase out many elements of the concessions, rebates and incentives since increased fishing activity is not to be encouraged. Bearing in mind the stability fishing has traditionally provided to rural communities, the Government will give priority to the maximisation of employment opportunities through the development of projects for those displaced from the fishery due to effort limitations. The Government will also, through negotiation with neighboring countries, aim to reduce levels of fishing effort on shared fishing grounds. It will also increase its capacity for fisheries surveillance to prevent unauthorised fishing operations in the waters of Trinidad and Tobago.

The high proportion of finfish by-catch in the trawl and gillnet fisheries and its negative impact on the coastal ecosystem, as well as on the resources harvested by other fisheries, also influences policy decisions on these fisheries. The Government therefore favours methods which minimise the amount of by-catch taken, and will accordingly, monitor international developments and undertake local studies to investigate the most effective approach, including the use of alternative gear and the introduction of by-catch reduction devices.

In order to optimally utilize the fisheries resources to enhance social and economic benefits to the fisheries sector, the Government will promote the appropriate post harvest technologies and establish systems to facilitate trade and trade related activities.

In its policy directions, the Government will continue to protect domestic fishing interests by supporting the regional initiatives under CARICOM, participation in the international fora such as ICCAT that address these issues and co-operate in regional and international data exchange, assessment and management of commercially important species.

Legislation

The principal legislation governing domestic fishing in Trinidad and Tobago is the *Fisheries Act 1916* and the subsequent 1966 and 1975 amendments. The Act empowers the Minister responsible for fisheries to make regulations to prescribe mesh size of nets; to restrict the size of fish, shrimp, crabs and turtles caught, and prohibit their sale or prevent the catching of these species either absolutely or by season or area.

The *Fishing Industry (Assistance) Act, 1955*, makes provisions for the granting of financial assistance to the fishing industry by such means as fuel rebates, tax waivers and subsidies on fishing equipment.

The *Marine Areas (Preservation and Enhancement) Act 1970*, provides for the designation of restricted areas. The Act is currently applied only to the management of coral reefs.

The *Archipelagic Waters and Exclusive Economic Zone Act of 1986* provides for the declaration of archipelagic waters and the establishment of a 200-mile exclusive economic zone (EEZ), and governs access to these waters by foreign fishing vessels.

The 1995 *Draft Marine Fisheries Management Act*, on finalisation will repeal the *Fisheries Act of 1916* and the relevant sections of the *Archipelagic Waters and Exclusive Economic Zone Act of 1986*. The *Marine Fisheries Management Act* will provide for the preparation of fishery management plans and will, in accordance with these plans, control and limit access to fish resources through the establishment of a licensing system for both local and foreign fishing vessels.

Related legislation includes the *Fish and Fishery Products Regulations, 1998* under Section 25 of the *Food and Drugs Act Chapter 30:01* which authorizes the Minister with responsibility for health to grant licences for the import and export of fish which have been handled and packed under conditions conforming to health and safety standards prescribed under the Act.

5. DATA COLLECTION

The following description is taken largely from Ferreira (2003). The data collection system of the Fisheries Division includes collection of information on fishermen, fishing vessels, engines and gear; fish landings and fishing effort data; fisheries biological data including species, length, weight, maturity, sex, age, location/time/depth of capture, associated physical and chemical parameters; fish exports and imports; fisheries economic data including costs and earnings data on fishing activities. Fisher, vessel and engine information are collected via the Fisherman, Vessel, and Engine Registration Forms. Data on fisheries subsidies and fish imports and exports are obtained via application forms submitted to the Division. Economic data collection is limited largely to ad hoc costs and earnings studies of specific fisheries. This would involve conduct of interviews with fishermen and filling out of questionnaires. With regard to the ongoing programmes for the collection of catch and effort data and biological data, further details are provided below.

5.1 CATCH & EFFORT DATA

Statistical Collectors record landings and effort data at twenty (20) beaches out of a total of 65 landing sites around Trinidad for at least 20 days (selected at random by the Fisheries Division) in a month. Data are collected for each vessel on: Vessel Registration Number; Times departed and returned; Number of crew; Gear type used; Weights of "species" landed (grouped by "Local Names"); Ex-Vessel price per "species", and Area Fished. The numbers of active boats by fishing method on each day of the month is also recorded. In addition a questionnaire is conducted each month to establish the total number of fishing days at enumerated sites.

The existing system of data collection covers mainly the artisanal fleet such that each enumerated site is assumed to be representative of artisanal fishing activity within a zone. In 1991 the coastline of Trinidad was divided into nine statistical sampling regions such that fisheries within a region were similar. This was based on a national fisheries census of vessels which provided information on vessel distribution, gear type, species composition of landings.

This system does not cover the semi-industrial and industrial fisheries. In 1991 under a UNDP/FAO project, logbooks were introduced for the semi-industrial and industrial shrimp trawlers. In these, the captains recorded catch data for each of the shrimp and fish components of the catch (including quantities discarded) by haul. However, this system collapsed after only six months and there are plans to re-implement the system in the near future. A trip report system, a simplified version of the logbook, was implemented for the local longline fleet at the end of 2001 to collect data on effort as well as landings and discards by species.

Monitoring programmes for large migratory pelagics will be implemented in the near future to ensure compliance and enforcement of ICCAT resolutions and recommendations, and Trinidad & Tobago’s port state obligations as indicated in the United Nations 1995 Agreement relating to the Conservation and Management of Straddling Stocks and Highly Migratory Fish Stocks. Programmes will include data collection and reporting related to transshipment operations; vessel sightings and at-sea transshipments; port inspection and identification of vessels engaged in illegal, unregulated and unreported (IUU) fishing activities and import prohibition.

Data from the recreational fishery are presently collected only through game fishing tournaments. Generally, data are collected at all of the annual tournaments including: landings by species (all attempts are made to include the weights of individual fishes that are retained on board and not brought to the scales due to competition minimum size rules), lengths of individual fishes, number of vessels, number of anglers, number of fishing hours and identification of fishes that are tagged and released. Maturity and ageing data may also be collected.

Estimation of Total Artisanal Landings

Landings and effort statistics collected at major (enumerated) sites are used to generate data for secondary (non-enumerated) sites, where it is assumed similar fishing occurs, at the same intensity. The recorded landings and effort data are raised by two factors (MIS 1996). The First Raising Factor (1^{st} RF) adjusts the statistics recorded at an enumerated site to account for the non-enumerated fishing days, that is, fishing days on which the Collector did not work. This factor is a monthly ratio (Total Number of Fishing Days divided by Total Number of Enumerated Fishing Days) that is determined for each of the 20 enumerated beaches. The Second Raising Factor (2^{nd} RF) adjusts the first raised statistics to account for non-enumerated vessels, that is, vessels based at sites where no data were recorded. This factor is determined as the ratio of the Total Number of Boats to Total Number of Enumerated Boats and is applicable to a zone. The number of boats is obtained from a fishing vessel census which is conducted every few years.

Estimation of Trawl Landings

Trawl landings are summarized for each beach by trawler type (I, II, III, IV) and fishing area (North Gulf of Paria, South Gulf of Paria, South coast, Venezuela). The application of the 1st RF adjusts the recorded statistics to account for non-enumerated days and is identical to the one used for landings from other methods (Shim 1997). The first raised trawler landings by fleet type and fishing area, for individual sites are then used to estimate total trawler landings for Trinidad by fleet type and fishing area.

5.2 BIOLOGICAL DATA

The ongoing biological data collection programme is limited to the major commercially important species, namely shrimp, carite, kingfish and shark. The shrimp biological sampling programme commenced in March 1991 under a UNDP/FAO project. Weekly sampling is conducted at five of the major trawl landing sites. Each sample of shrimp landings is sorted by species and gender, and carapace lengths recorded. The total weight of shrimp sampled per vessel is recorded as well as the total weight of shrimp landed by the vessel sampled. If the catch sampled is sorted then these weights are recorded by size category. Collection of length data for shrimp ended in 2002 and since 2004 shrimp landings are sampled in order to obtain the species composition.

With regard to the analysis of the shrimp length data, each length frequency distribution for a particular shrimp species and gender for a particular trawl fleet, fishing area and month obtained from each sample is first raised to the landed weights of shrimp of the vessel sampled. The raising factor would be the total landed weight of all shrimp from the trawler divided by the weight of shrimp sampled from that trawler. Such raised length frequency distributions for a particular species and gender from all samples from a particular trawl fleet, fishing area and month are added across length classes. This is then raised to the total shrimp catch for the fleet, area, and month by applying the raising factor: total shrimp catch (all species) for fleet, area, month divided by total landed weight of shrimp from all vessels sampled. This total catch in numbers by species and gender is then converted to weights using length weight relationships.

During 1992, under an FAO UNDP project and between 1995 and 1997, under the CFRAMP project, length frequency, maturity, and age and growth data were collected for King mackerel (*Scomberomorus cavalla*) and Serra Spanish mackerel (*Scomberomorus brasilensis*) and some species of shark (*Carcharinus porosus, C. limbatus, Rhizoprionodon lalandii, Sphyrna lewini*, and *S. tudes*). The data were captured monthly for the major gears of the artisanal fisheries that target the two mackerel species (gillnets and pelagic handlines). Biological data collection for King mackerel (*Scomberomorus cavalla*), Serra Spanish mackerel (*Scomberomorus brasilensis*) and Crevalle jack *(Caranx hippos)* resumed in 2004.

In addition to the ongoing shore-based programme, an at-sea sampling programme was initiated for the artisanal and semi-industrial trawl fishery in 1999 to capture data on discards. There are also plans to implement an Observer Programme for the offshore trawl, longline and multi-gear fleets in the near future.

6.0 REFERENCES

Alió, J.J., D. Die, L. Ferreira, K. Gooriesingh, S. Kuruvilla, L. Maharaj, L. A. Marcano, I. Ramnarine and A. Richardson-Drakes. 1999. *Penaeus subtilis* stock within the Orinoco and Gulf of Paria region. In FAO/Western Central Atlantic Fishery Commission. National reports presented and stock assessment reports prepared at the CFRAMP/FAO/DANIDA Stock Assessment Workshop on the Shrimp and Groundfish Resources of the Guiana-Brazil Shelf, Port of Spain, Trinidad and Tobago, 7-18 April 1997. *FAO Fisheries Report*. No. 600. Rome:FAO.

Alió, J.J., L.A. Marcano, S. Soomai, T. Phillips, D. Altuve, D. Die, and K. Cochrane. 1999. Analysis of industrial trawl and artisanal fisheries of whitemouth croaker, *Micropogonias furnieri*, of Venezuela and Trinidad-Tobago in the Gulf of Paria and Orinoco River Delta. Third CFRAMP/FAO Workshop on Stock Assessment of Shrimp and Groundfish Fisheries of the Brazil-Guiana Shelf. Belem, Brazil, 25 May- 9 June 1999 (in press).

Chan A Shing, C. 1999. Report on 1998 census of fishing vessels (Trinidad). Fisheries Division, Ministry of Agriculture, Land and Marine Resources; Port of Spain (Trinidad and Tobago). Fish. Internal Rep. no. 3, 42 p.

Chan A Shing, 2002. Atlas – Marine Fisheries of Trinidad and Tobago, Part 1, Trinidad Inshore Fisheries. Fisheries Information Series 10. Ministry of Agriculture, Land and Marine Resources, Port of Spain, Trinidad.

Die, D., Alió, J.J., L. A. Marcano, L. Ferreira, and S. Soomai. 2004. Assessment of demersal stocks shared by Trinidad & Tobago and Venezuela. Stock assessment report of the Trinidad & Tobago – Venezuela Meeting under the FAO/Western Central Atlantic Fishery Commission *ad-hoc* Working Group on the Shrimp and Groundfish Resources of the Guiana-Brazil Shelf. Chaguaramas, Trinidad and Tobago, 18-22 November 2002. DRAFT.

Fabres, B. 1989. Trinidad and Tobago National Report. In: FAO Western Central Atlantic Fishery Commission (WECAFC). Report of the 2nd workshop on the biological and economic modeling of the shrimp resources on the Guyana-Brazil shelf. Cayenne, French Guiana, 2-6 May 1988. FAO Fisheries Report No. 418 FAO, Rome, Italy. p. 60-63.

FAO, Rome, Italy. 1993 Establishment of data collections systems and assessment of the fisheries resources. Trinidad and Tobago project findings and recommendations. FAO/UNDP; Paris (France). FI:DP/TRI/91/001. 32 p. Terminal project report.

Ferreira, L. 2003. National Report – Trinidad & Tobago. Prepared for CFU/FAO Fisheries Statistics and Data Management Workshop. March 10-22, 2003, UWI Campus, Barbados. Ministry of Agriculture, Land and Marine Resources, Port of Spain, Trinidad.

Ferreira, L.A. 1998. Economic analysis of the shrimp trawl fishery of Trinidad and Tobago with management implications. Thesis: Dalhousie University, Halifax, Nova Scotia, Canada. MMM. 114 p.

Ferreira, L; Maharaj, L. 1993. Preliminary costs and earnings study of the artisanal shrimp trawlers operating in the "Special Fishing Area" adjacent to the mouth of the Orinoco River (Venezuela). Tech Rep. 42 p.

Ferreira, L., S. Soomai. 2000. Status of shrimp and groundfish stocks in Trinidad and Tobago including results of bio-economic analyses and implications for management. Fisheries Division, Ministry of Agriculture, Land and Marine Resources; Port of Spain (Trinidad and Tobago). Fourth Workshop on Assessment and Management of Shrimp and Groundfish Fisheries on the Brazil-Guianas Shelf. Cumana, Venezuela; 2 October- 13 2000.

Fisheries Division, Ministry of Food Production and Marine Exploitation; FAO. 1991 Establishment of data collection systems and assessment of the fisheries resources: terminal report project TRI/91/001. Ministry of Food Production and Marine Exploitation; Port of Spain (Trinidad & Tobago). 26 p.

Hodgkinson_Clarke, F.M. 1990. The carite (*Scomberomorus brasiliensis*) fishery of south Trinidad. 8 p.
Kuruvilla, S.; Chan A Shing, C.; Ferreira, L.; Martin, L; Soomai, S; Lalla, H; Jacque, A. 2002. study on subsidies in the fisheries sector of Trinidad & Tobago. Fisheries Division, Ministry of Agriculture, Land and Marine Resources; Port of Spain (Trinidad and Tobago). 110 p..
Kuruvilla, S.; Ferreira, L.; Soomai, S. 2000. The trawl fishery of Trinidad and Tobago. Fisheries Division, Ministry of Agriculture, Land and Marine Resources; Port of Spain (Trinidad and Tobago). Fish. Info. Ser. no. 9, [18 p.]
Kuruvilla, S.; Ferreira, L.; Soomai, S; Jacque, A. 2000. Economic performance and technological features of marine capture fisheries: the trawl fishery of Trinidad and Tobago. Fisheries Division, Ministry of Agriculture, Land and Marine Resources; Port of Spain (Trinidad and Tobago). 49 p. Regional Workshop on the Effects of Globalization and Deregulation on Fisheries in the Caribbean. Castries (St. Lucia); 4 Dec 2000.
Lum Young, P., L. Ferreira and L. Maharaj. 1992. Preliminary stock assessment for the shallow water shrimp trawl fishery in the "Special Fishing Area" adjacent to the mouth of the Orinoco River (Venezuela). Technical report of the project for the Establishment of Data Collection Systems and Assessment of the Fisheries Resources. FAO/UNDP: TRI/91/001/TR9. Port of Spain, Trinidad and Tobago: Ministry of Agriculture, Land and Marine Resources.
Management Information Systems (MIS), Port of Spain, Trinidad, WI. 1991a. Fisheries Management Information Systems: System analysis and design. Harvest (catch/effort) module. Commercial landings. Management Information Systems; Port of Spain (Trinidad and Tobago). 92 p.
Management Information Systems (MIS), Port of Spain, Trinidad, WI. 1991b. FISMIS commercial landings module: User documentation. Management Information Systems; Port of Spain (Trinidad and Tobago). 57 p.
Management Information Systems (MIS), 61-63 Edward Street, Port of Spain, Trinidad, WI. 1996. Proposal to Fisheries Division, Ministry of Agriculture, Land & Marine Resources for the development & implementation of a raised statistics system. Management Information Systems; Port of Spain (Trinidad and Tobago). 9 p.
Martin, L., Soomai, S., Kuruvilla, S. 2004. Economic performance and technological features of marine capture fisheries: the longline fishery of Trinidad and Tobago. Fisheries Division, Ministry of Agriculture, Land and Marine Resources; Port of Spain (Trinidad and Tobago). 28 p.
Mc Clure, R.E. 1991. Establishment of data collection system and assessment of the fisheries resources. FAO; Rome (Italy). FAO TRI/91/00. 12 p. Mission report.
Medley, P., and L. Ferreira. 2004. Preliminary assessment of the *Farfantepenaeus notialis* stock of Trinidad and Tobago. Report of the CARICOM Shrimp and Groundfish Assessment Workshop, 26-30 January, 2004. Chaguaramas, Trinidad and Tobago. DRAFT.
Ministry of Food Production, Marine Exploitation and the Environment, Fisheries Division, Port of Spain, Trinidad, WI.; International Development Research Centre (IDRC), Canada. 1988 Development of a fisheries management information system (FISMIS). Fisheries Division, Ministry of Food Production, Marine Exploitation, Forestry and the Environment; Port of Spain (Trinidad and Tobago). 45 p.
Parkinson, K. 1992. Production costs and revenues for the gillnet fishery of Trinidad, 1991. Ministry of Agriculture, Land and Marine Resources, Fisheries Division; Port of Spain, Trinidad and Tobago. Fish. Occas. Pap. Ser. No 1, 41 p.
Shim, S. 1997. Fisheries Management Information Systems: Systems analysis and design. Harvest Module. Trawling raised statistics. 20 p.
Shim, S. 1998a. Fisheries Management Information Systems: User documentation. Harvest module. Trawling raised statistics. 38 p.

Shim, S. 1998b. Fisheries Management Information Systems: System documentation: Harvest module. Trawling raised statistics. 16 p.

Seijo, J.C., L. Ferreira, J. Alió, and L. Marcano. 2000. Bio-economics of shrimp fisheries of the Brazil-Guyana Shelf: dealing with seasonality, risk and uncertainty. In FAO/Western Central Atlantic Fishery Commission. Report of the third Workshop on the Assessment of Shrimp and Groundfish Fisheries of the Brazil-Guianas Shelf . Belém, Brazil, 24 May - 10 June, 1999. *FAO Fisheries Report.* No. 628. Rome, FAO. 2000. pp 173-185.

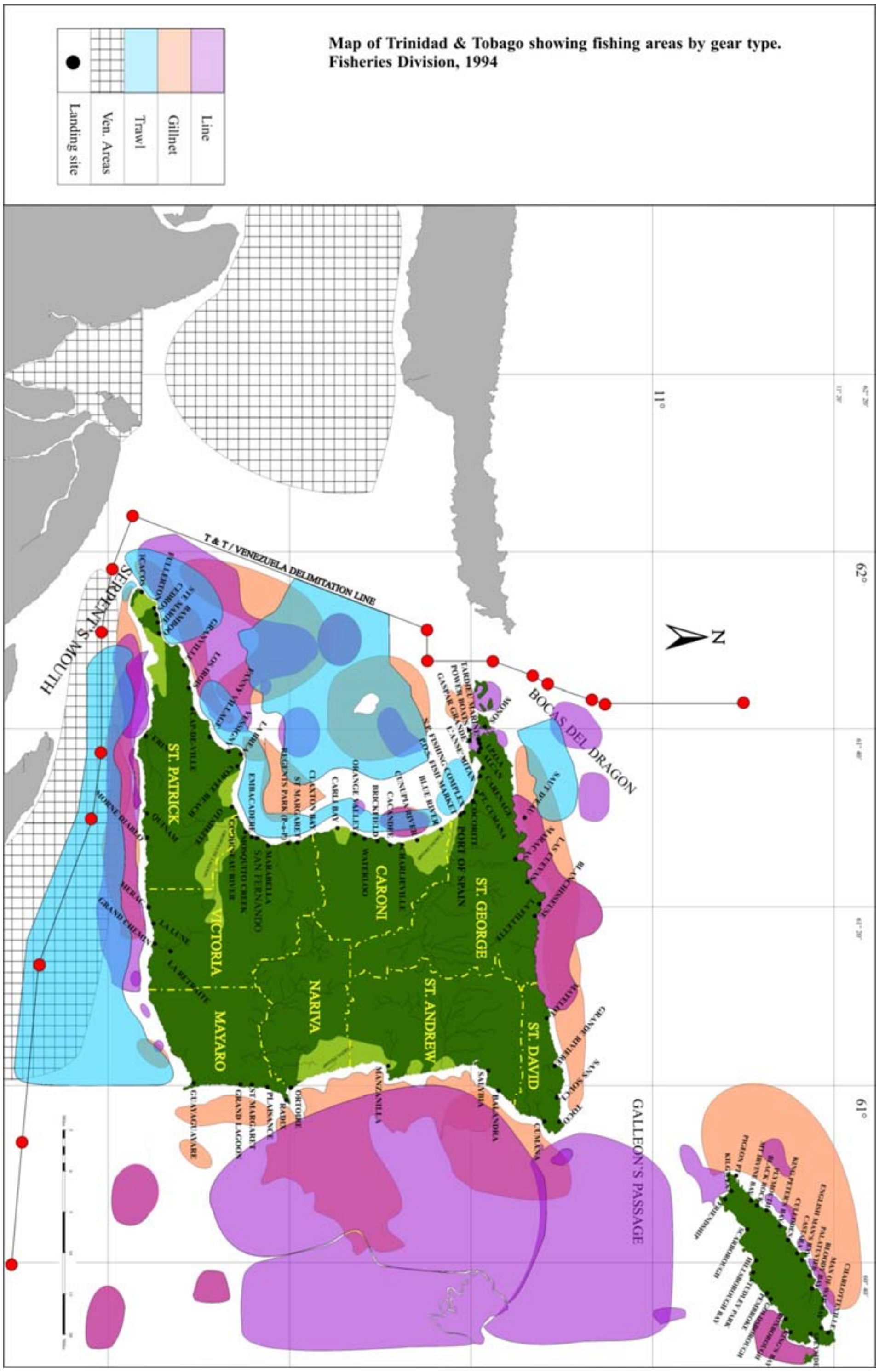
Seijo, J.C. and S. Soomai 1999. Bio-economic Analysis of the Artisanal Fishery of Trinidad and Tobago. FAO/Western Central Atlantic Fishery Commission Third Workshop on the Assessment of Shrimp and Groundfish Fisheries of the Brazil-Guianas Shelf . Belém, Brazil, 24 May - 10 June, 1999.

Soomai, S. 1999. Stock assessment of *Micropogonias furnieri* and *Cynoscion jamaicensis* in the Gulf of paria, Trinidad and Tobago. Third CFRAMP/FAO Working Group on the Shrimp and Groundfish Resources of the Guianas-Brazil Shelf. Belem, Brazil, 25 May-9 June 1999. Port of Spain, Trinidad and Tobago: Ministry of Agriculture, Land and Marine Resources.

Soomai, S., N. Ehrhardt, K. Cochrane and T. Phillip, 1999. Stock Assessment of Two Sciaenid Fisheries in the West Coast of Trinidad and Tobago. Third CFRAMP/FAO Workshop on Stock Assessment of Shrimp and Groundfish Fisheries of the Brazil-Guiana Shelf, Belem, Brazil, 25 May-9 June, 1999 (in press).

Soomai, S.; Seijo, J.C. 2000. Case study for a technologically interdependent groundfish fishery: the artisanal multi-species, multi-fleet groundfish fishery of Trinidad. 16 p. Fourth Workshop on Assessment and Management of Shrimp and Groundfish Fisheries on the Brazil-Guianas Shelf. Cumana, Venezuela, 2 October 2000. Fisheries Division, Ministry of Agriculture, Land and Marine Resources; Port of Spain (Trinidad and Tobago).

Appendix 1: Map of Trinidad showing landing sites and catch and effort sample zones.



Map of Trinidad & Tobago showing fishing areas by gear type.
Fisheries Division, 1994

NATIONAL REPORT ON THE QUEEN CONCH AND LOBSTER FISHERIES – TURKS AND CAIÇOS ISLANDS

Prepared by

Department of Environment and Coastal Resources
Grand Turk, Turks and Caicos Islands

INTRODUCTION AND DESCRIPTION OF THE FISHERIES

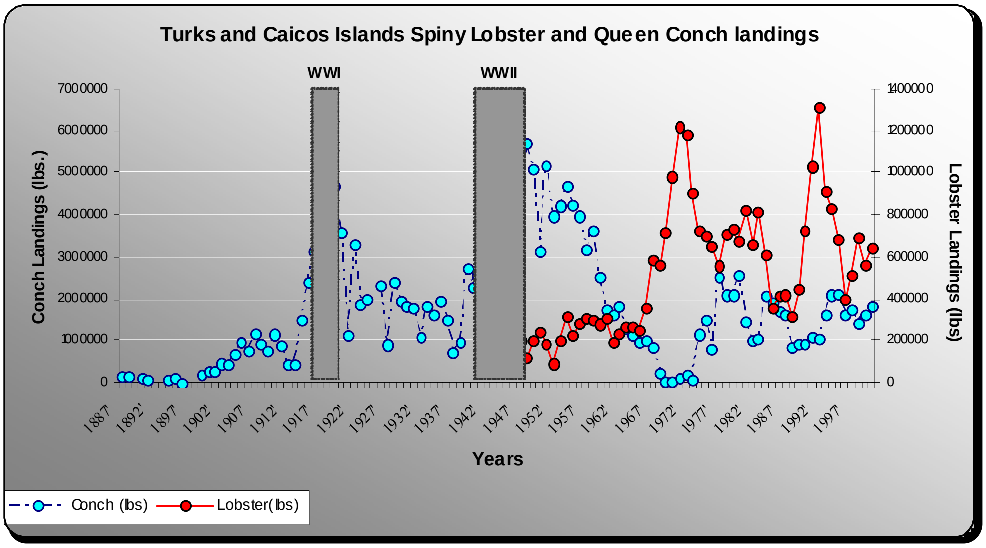
The Turks and Caicos Islands (TCI) are a group of calcareous islands located at the south-eastern end of the Bahamian archipelago, approximately 145 km north of Hispaniola. The Turks and Caicos Islands consist of eight main islands and a series of uninhabited cays dissected by three shallow water banks: the Caicos Bank, the Turks Bank and the Mouchoir Bank.

The queen conch (*Strombus gigas*) and spiny lobster (*Panuliras argus*) fisheries are very important in the Turks and Caicos Islands. They are a major source of income from exportation. The importance of the fisheries is further exemplified through job creation; particularly in the lesser developed islands such as South Caicos, Middle Caicos and North Caicos.

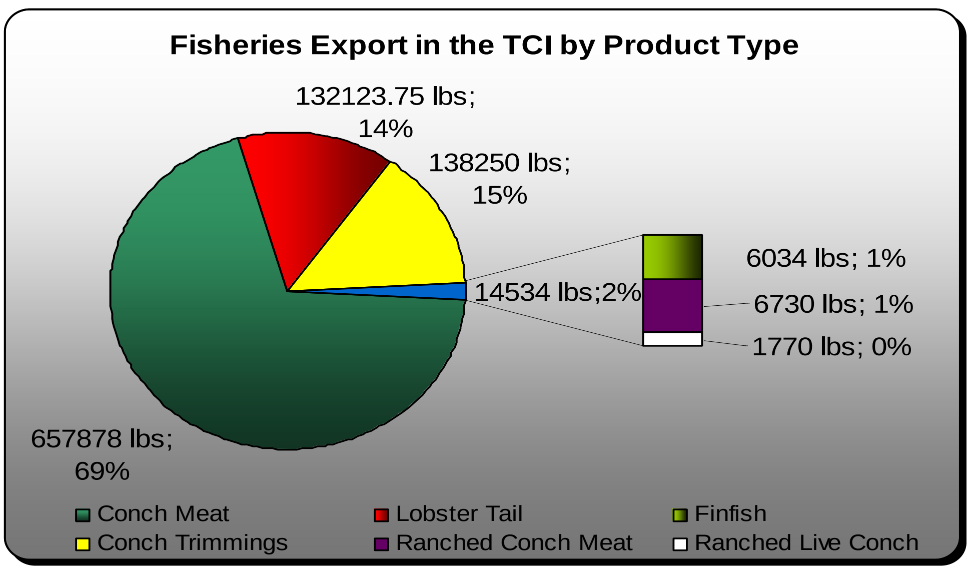
Within the past ten years, the queen conch fishery has directly employed an average of 377 fishers per year. In 2003/2004 fishing season, the number of commercially licensed persons increased by 17%, from 378 in 2002/2003 to 454. Similarly the number of commercially licensed vessels remained the same at 219 in 2002/2003 to 219 vessels in 2003/2004.

TRADE STATISTICS, TRENDS AND ISSUES

Spiny Lobster and Queen Conch are largest exports from the Turks and Caicos Islands. In 2002/2003 nearly 400,375 lbs. of spiny lobster were landed at the processing plants. Queen Conch was the largest fishery landed at the plant with an estimated 1.4 million lbs. landed.



Historical catch landings of Spiny Lobster and Queen Conch, showing the trends and fluctuations in catch over the years.



Marine products exported from the Turks and Caicos Islands, categorized by product type (2002/2003).

CONCH AND LOBSTER DATA COLLECTION PROGRAM

Catch and effort data is still being collected by the D.E.C.R. Everyday the number of fishers per vessel and the catch data (number of pounds) are recorded at each of the processing plants. Effort is standardized and measured as man-days (number of days fished multiplied by the number of fishers in the boat). Catch per unit-effort (CPUE) is measured as weight of product per man-day (kg man-day^{-1}).

Currently the D.E.C.R. is creating and implementing a local consumption survey. This survey will improve the data collection of the D.E.C.R. The survey has been pre-tested to alleviate any uncertainties. By the end of May 2004, D.E.C.R. officers will be trained on how to conduct the surveys. The information collected from the surveys can provide the department with a consumption index. The survey includes information not only on conch, but also on lobster, scalefish and gamefish.

However, the D.E.C.R. has realized that this information is limited to a specific time period, so the survey will have to be conducted again within 2-3 years. The department has also developed a receipt form for local restaurants and hotels. This form includes information about how much and how often local TCI seafood goes through the restaurants and hotels. The forms are collects monthly and placed onto a database to provide more data on our local usage of TCI seafood.

OTHER RESEARCH

Bioeconomic Survey

As stated in the National Report on the Queen Conch Fishery in the Turks and Caicos Islands by Wesley Clerveaux, there has been very little economic data collected for the Queen Conch or lobster fishery in the TCI. However, the D.E.C.R. is making an effort to develop an internship program. Within this program, student researchers can assist the D.E.C.R. in data collection and monitoring.

FISHERY INDEPENDENT STUDIES

Conch Visual Assessment

As stated in the 2002/2003 National Report, a visual survey was conducted in 2001 by the D.E.C.R. Currently, we are conducting a conch visual survey of the Turks and Caicos Islands East Harbour Conch and Lobster Reserve.

Lobster Recruitment Index

The Department realized that the spiny lobster is fluxuating in catch. This could be attributed to a variety of reasons. The Department had decided to determine the rate at which spiny lobster are retained on the Banks of the Turks and Caicos Islands and are ultimately recruited into the fishery. The first step in this is to identify location of nursery areas and deploy casitas for juvenile recruits. After deployment, we intend to determine the recruitment of juvenile lobster in commercially important fishing grounds and possibly predict the sustainability of the resource and provide information to improve the management strategies for the DECR.

Spiny Lobster Morphometric Sampling

During lobster season, many lobster are landed at the plants. From a bio-economic study in 2001, approximately 41% of the lobster captured were undersize. The DECR implemented a sampling program that was conducted in the past 1998. Currently, the DECR will resume the study in the 2004-2005 lobster season. There will be a systematic sampling of the captured and landed catch at the processing plants. Prior to sorting at the scale, measurement of the morphometric parameters such as carapace length, total length, weight, maturity and sex will be recorded. After analysis, the DECR will be able to ascertain if the regulations of the country are adhered to and if the capture of juveniles has any bearing on recruitment.

LEGAL AND REGULATORY FRAMEWORK FOR MANAGEMENT

CONCH

- Minimum size restrictions based on shell length (7 inches or the equivalent meat weight of 8 ounces.)
- Closed season since (July 15-August 15)
- Gear restrictions; the use of SCUBA gear is prohibited

LOBSTER

- Minimum size restriction of 3.25 inches
- Closed season (April 1-August 1)
- Gear restrictions; the use of SCUBA gear is prohibited
- unlawful to be in possession of any egg-bearing spiny lobster or to strip or in any manner molest any egg-bearing spiny lobster in order to remove the eggs.
- Unlawful for restaurants and hotels to sell lobster during the closed season

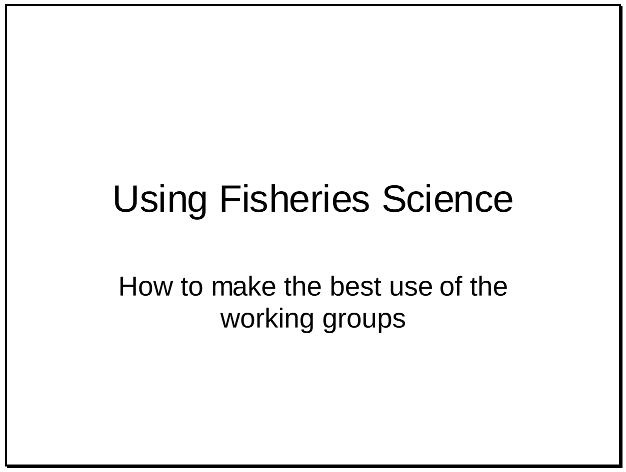
CONCLUSION AND RECOMMENDATIONS

- The TCI Government should conduct another conch visual survey within the next 2 years.
- A Conch Stunting Study should be conducted in the next 2 years.
- Establish a Limiting Reference Point and an Economic Reference Point. This will allow the highest economic value for the conch fishery.
- Continue to collect catch and effort data as well as the local consumption data.

PART IV – PRESENTATION SLIDES PERTAINING TO AGENDA ITEMS 9 AND 10

9.1 Using fisheries science – How to make the best use of working groups

Slide 1



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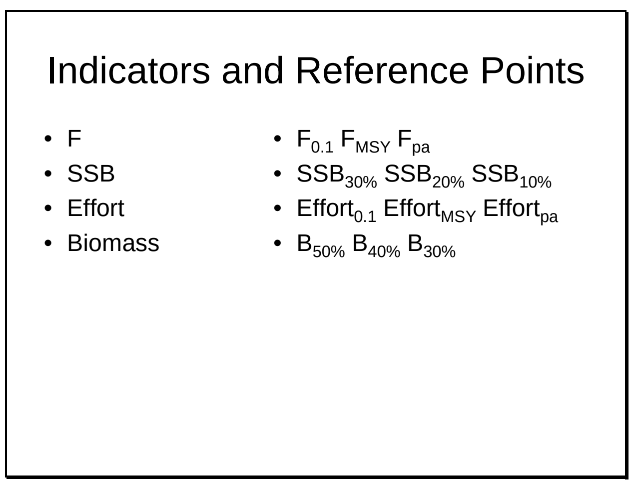

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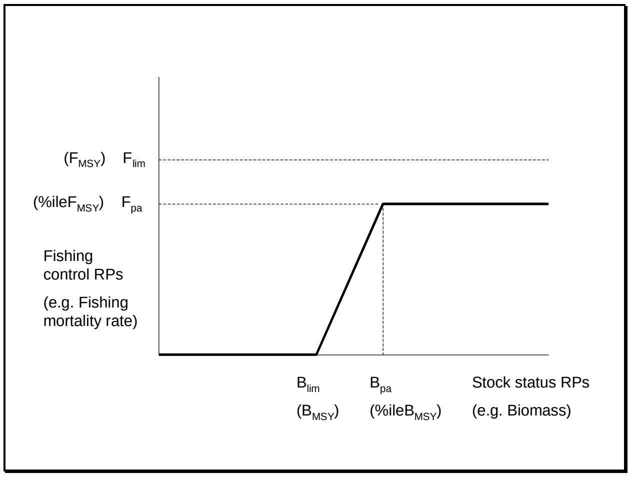

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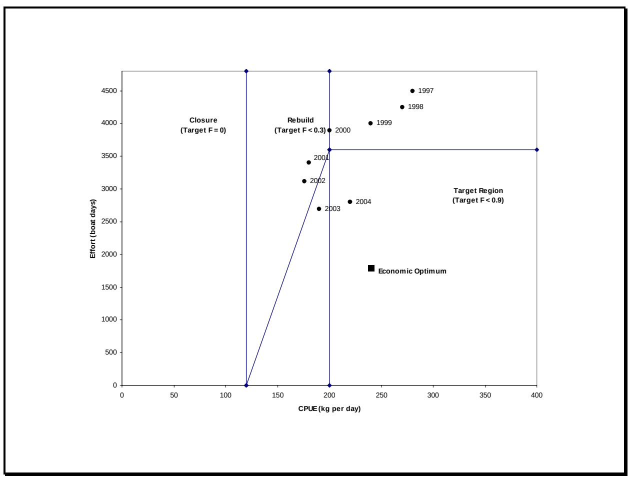

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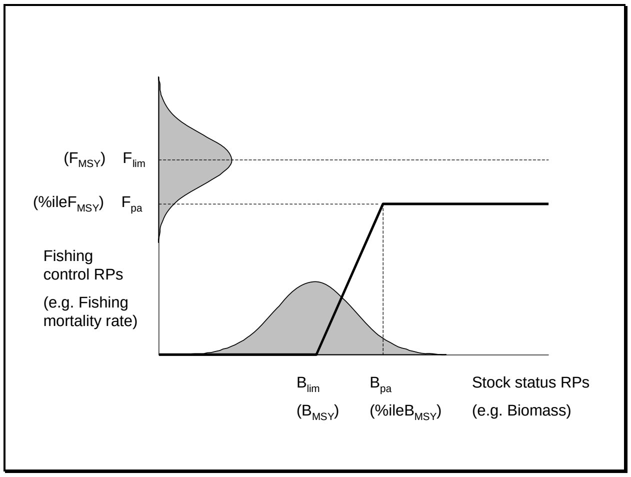

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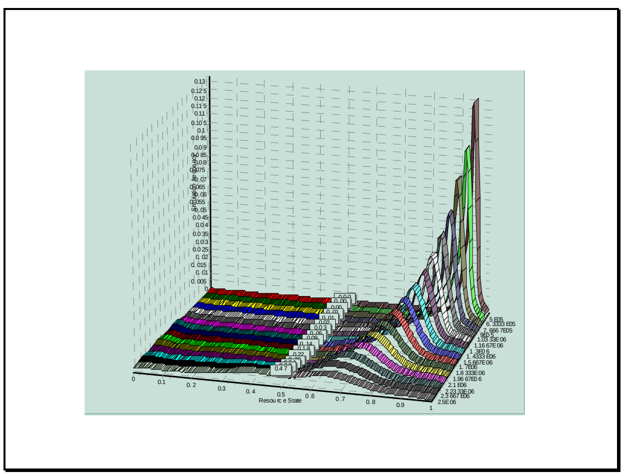


Slide 7

Decision Table

	Recovery Plan	Normal
$B_{now} > B_{lim}$	5% 1000	80% 0
$B_{now} < B_{lim}$	95% 0	20% 2000

Slide 8

New Approaches

- New types of data
- Address new management approaches
- New types of analyses
- Alternative types of working group outputs
- Appropriate

Slide 9

The Need

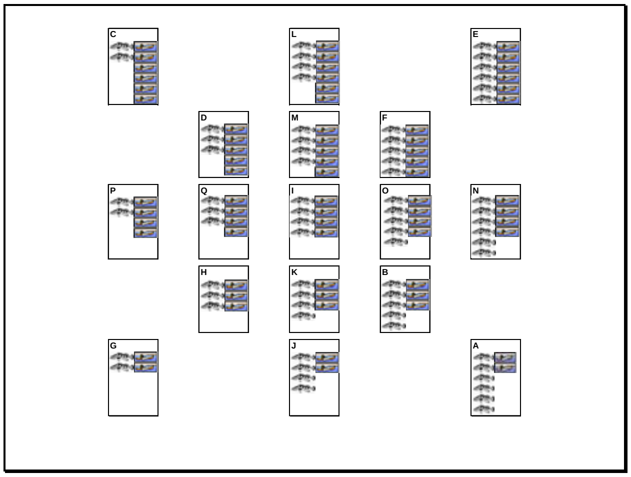
- Little scientific data and information
- Little statistical expertise
- Poor uptake on advice

The Solution

- Decision Analysis
- Robust methods (e.g. non-parametric)
- Fisher participation
- Potential to use all information
- Initiate adaptive management

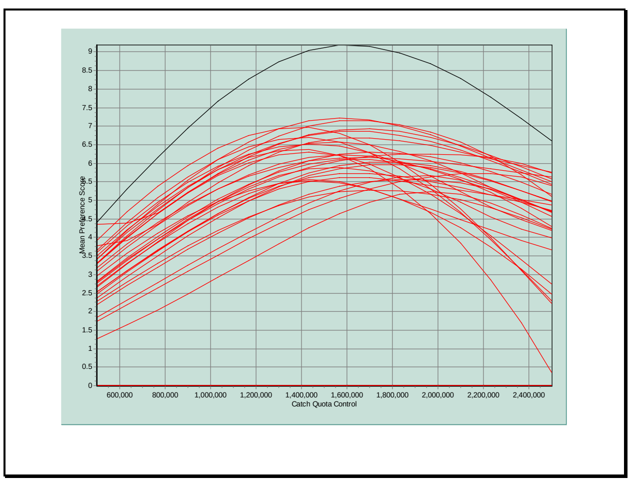
In developing countries, there is very little data. It is difficult to keep routine data collection programmes going. There are few statisticians and scientists and those that there are, are usually employed in other sectors. This suggests a method is required which deals with uncertainty, is robust and can be encapsulated into software which requires the minimum amount of training to use.
Decision analysis deals with uncertainty and potentially and decisions for which there is little information.
Robust non-parametric methods derive the shape and patterns from the data themselves. These methods will reduce errors associated with fitting a poor model, but do not allow information implied by choosing a correct model to be applied.
Involving fishers in the stock assessment so that their view is represented should lead to a better response to management advice.
As usual, given the low data availability, simpler biological models are preferable.
Finally, the method should be able to use data which can be collected rapidly to initiate management. Interviews, fishing experiments and so on.

Slide 10



Relative change for each fisher from present in relation to catch (income) and effort (work done) represent outcomes. 4-4 represents current practice – that is what the fisher currently catches and how much they fish in a month. Variation around this point up to +/-50% for each variable. Lines of dominance allows many options to be ranked automatically. Other comparisons (left to right e.g. H and J) must be ranked by the fisher.

Slide 11



Target reference point

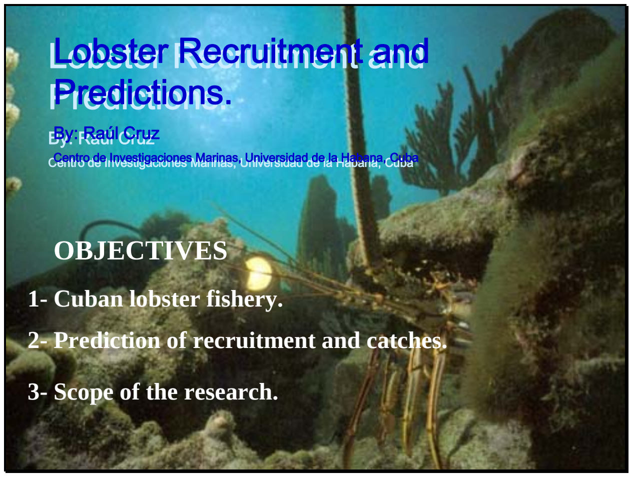
Slide 12

TCI Conch

	Probability Bnow < Blim	Quota (Million lbs)	Limit (Million lbs)
All Data	31%	1.53	1.58
Interviews Only	62%	1.68	0.79
Catch Effort Only	53%	1.38	1.43

9.2 Variability in recruitment of multiple life stages of the Caribbean lobster Panulirus argus, in the Gulf of Batabanao, Cuba

Slide 1



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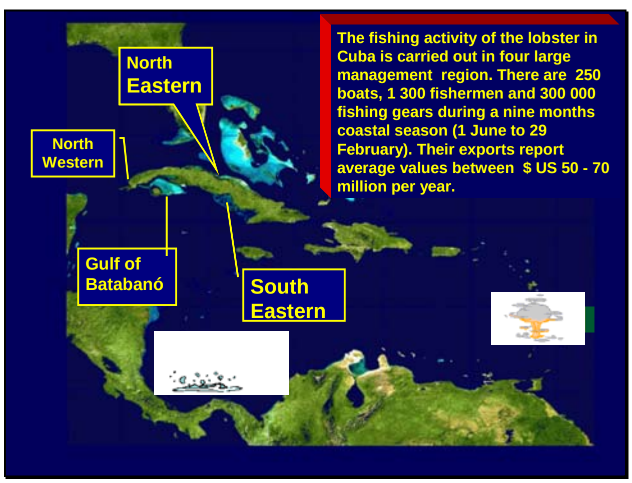

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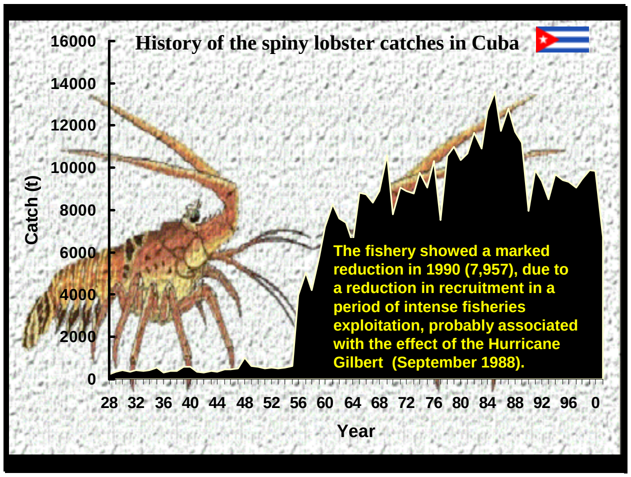

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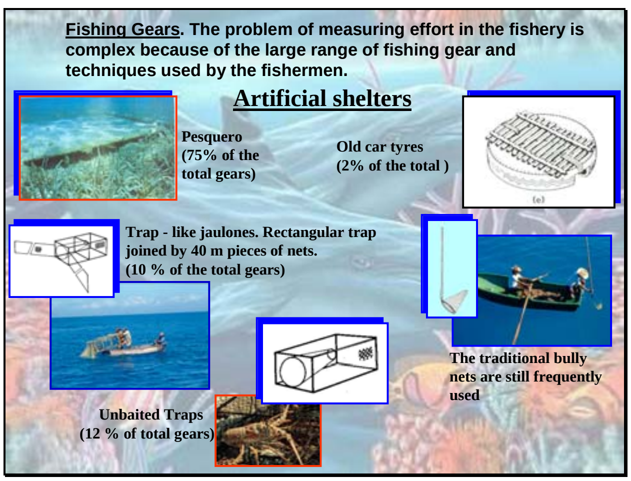
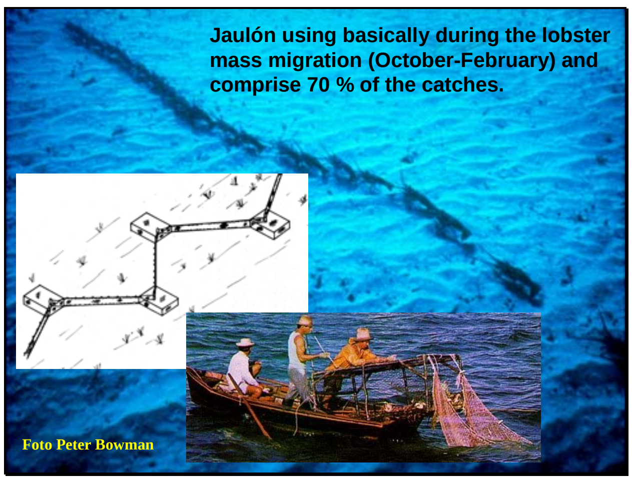


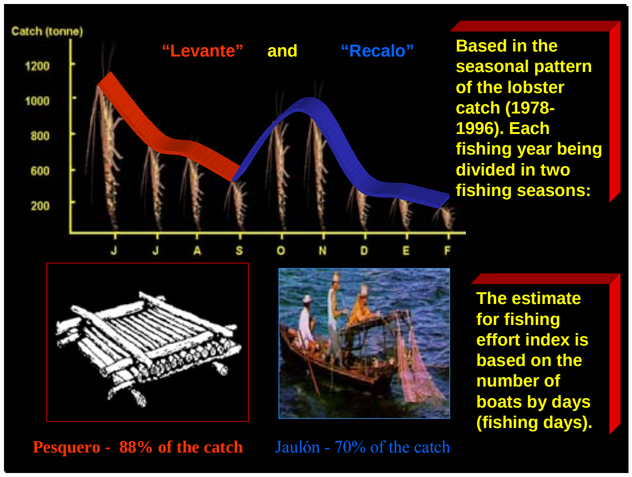
Slide 5


The original type of shelter was made by Cuban fishermen with the objective of increasing lobster concentration and increasing catch, in areas lacking natural shelters. They have been used since World War II.
The artificial shelter (pesqueros or casitas) are made from coast palm trunks or with fibrocement sheets. Was the predominant fishing gear since middle of the 1970s. Catches comprise 50% of total harvest and 88 % of the catches comes during season June - September

Slide 6


Jaulón using basically during the lobster mass migration (October-February) and comprise 70 % of the catches.
Foto Peter Bowman

Slide 7



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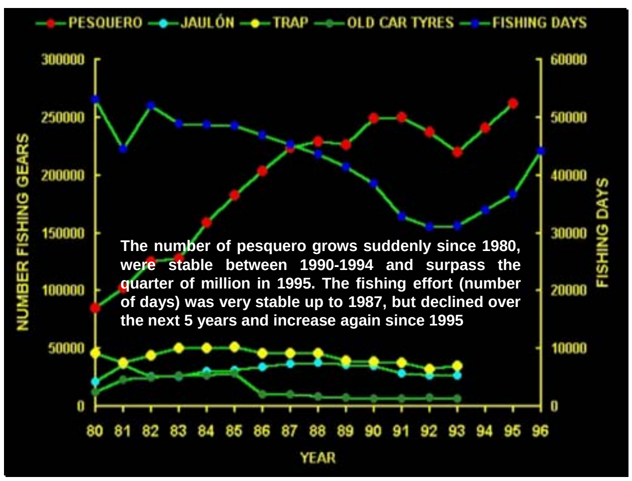

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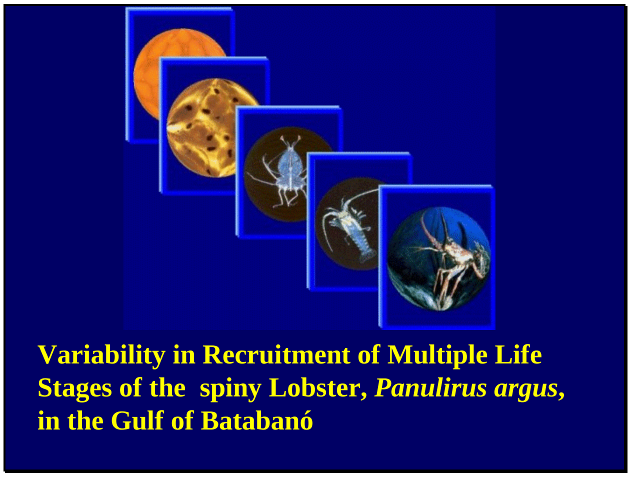

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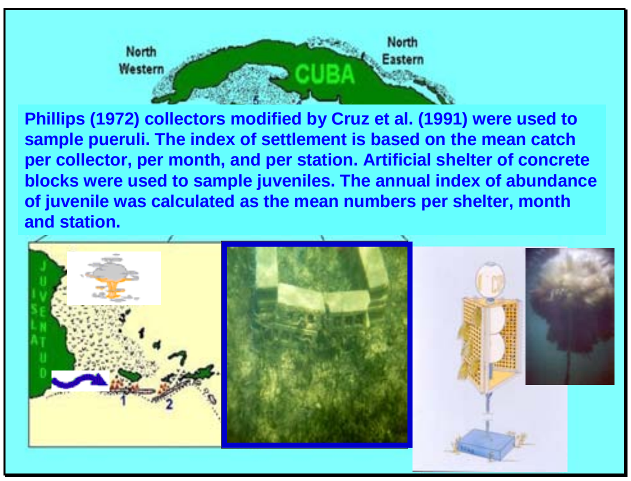

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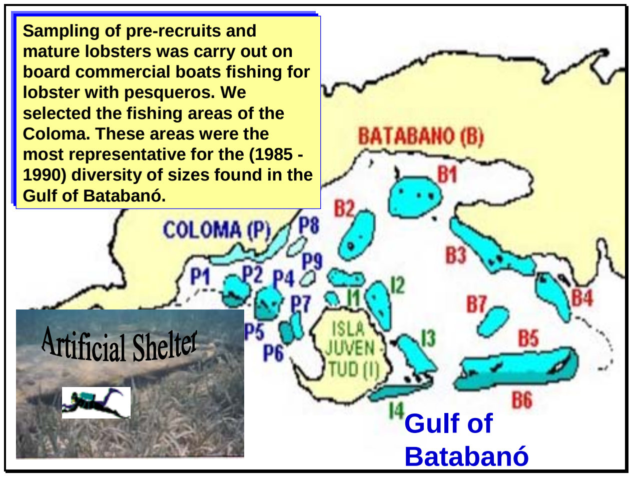
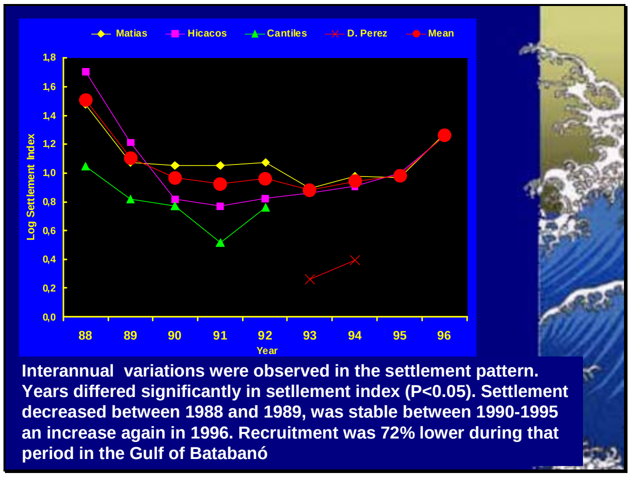


Slide 12

Terms for life-history stages of the spiny lobster (Panulirus argus), showing the source of the data for each recruitment index

Terms	Size range (CL) mm	Source data	Recruitment index
Puerulus	4 - 6	Collectors	Settlement Index
Postpuerulus	6 – 16	Collectors	
Juvenile	16 – 50	Concrete blocks	Juvenile index
Pre-recruit	50 – 69	Artificial shelters	Pre-recruit index
Recruit	2 years old	Cohort analysis	Recruit index

Slide 13



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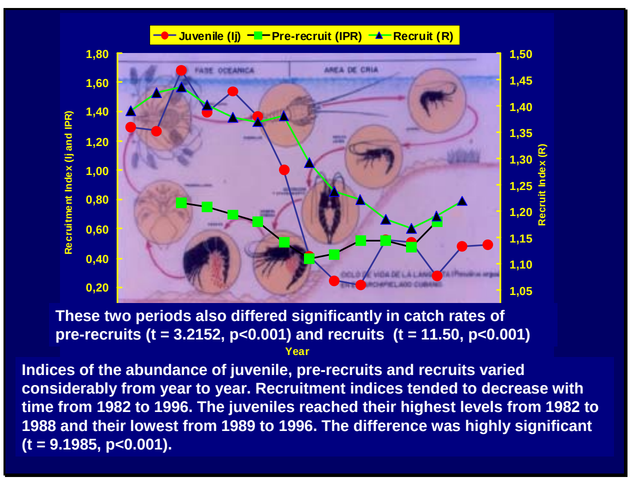

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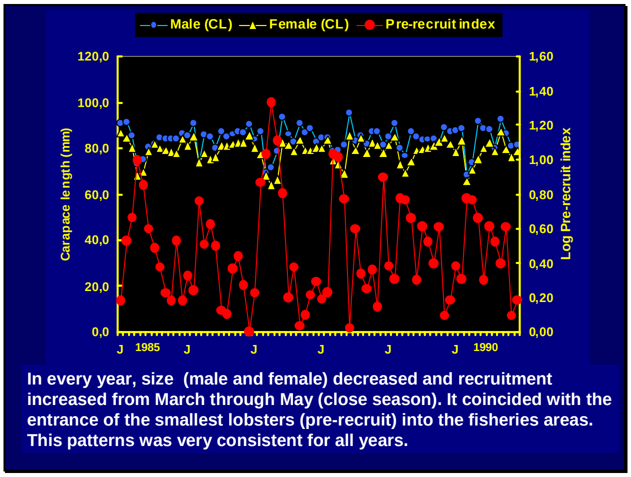

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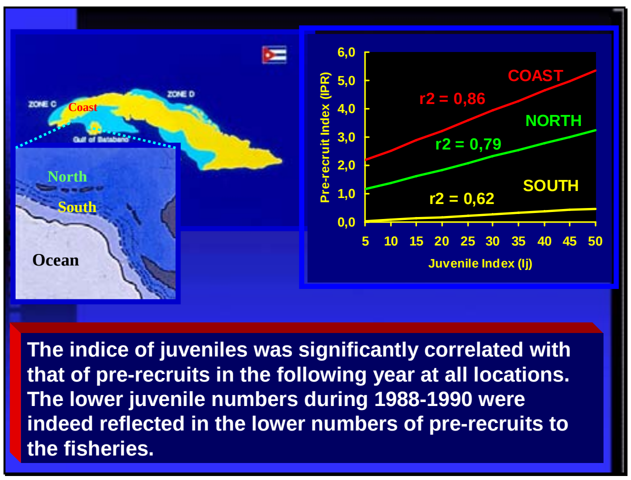

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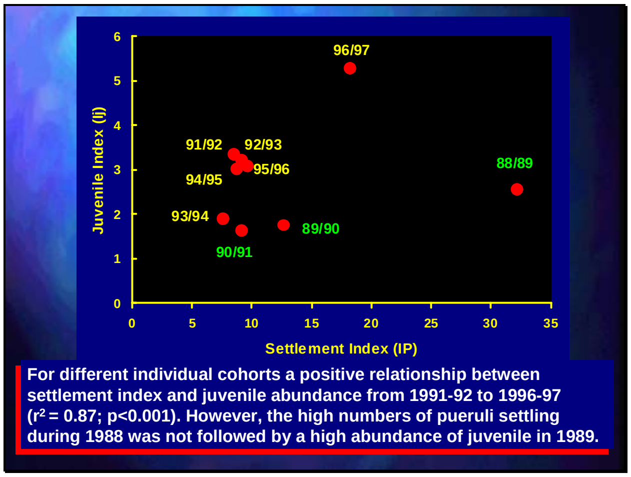

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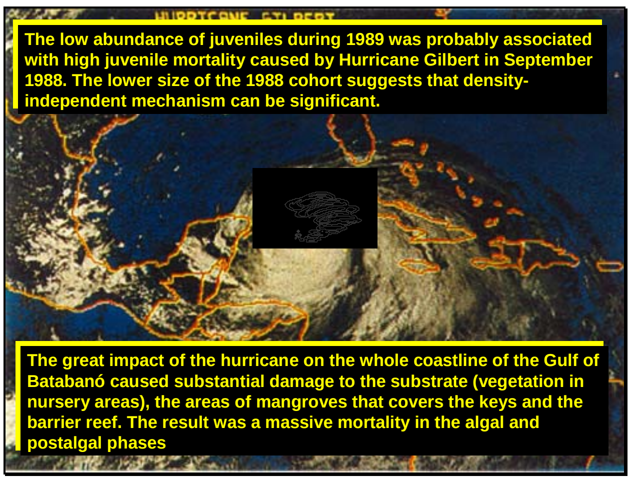

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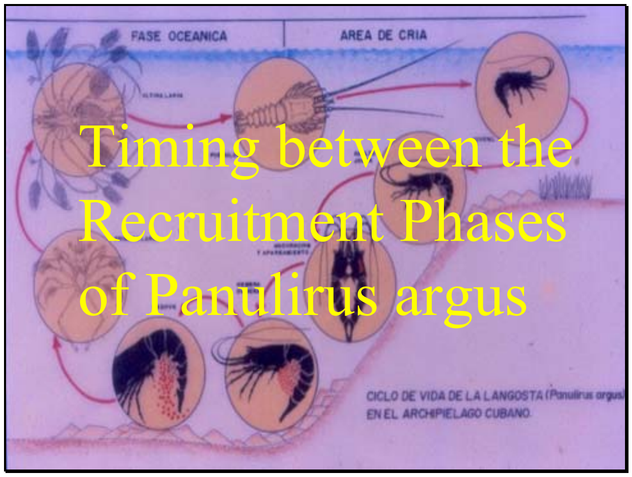

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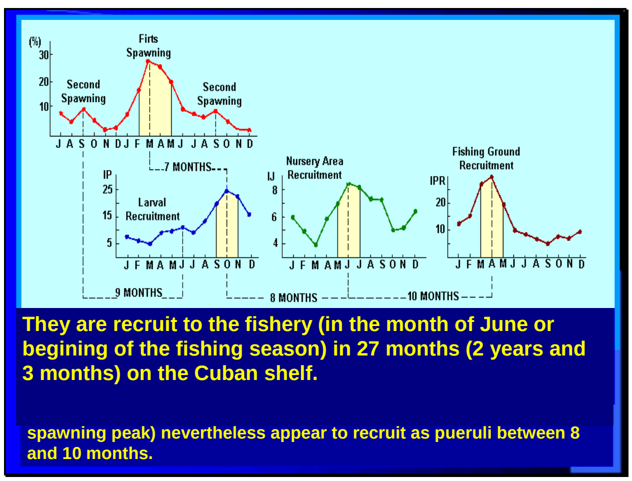

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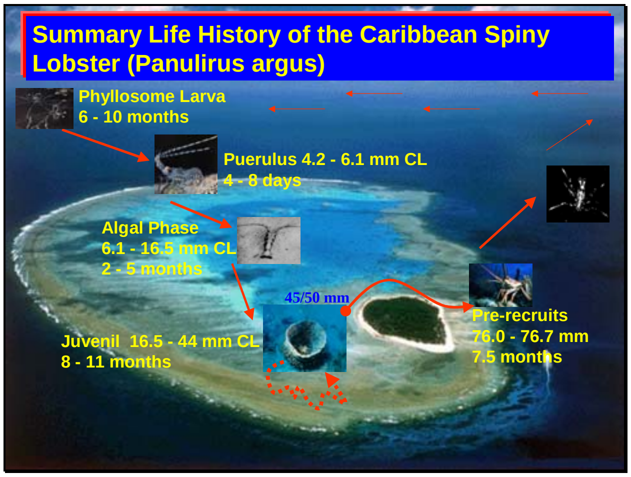

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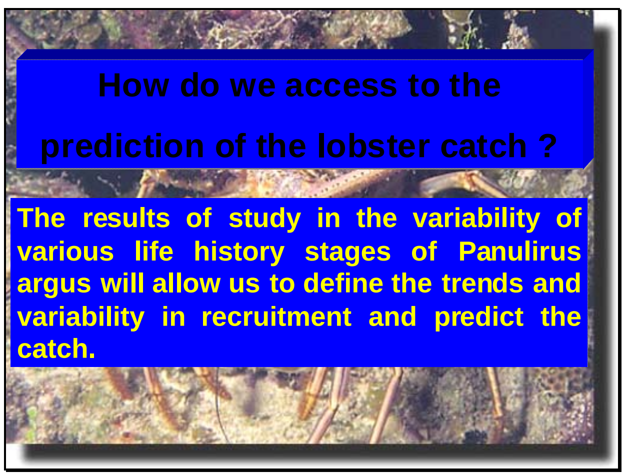

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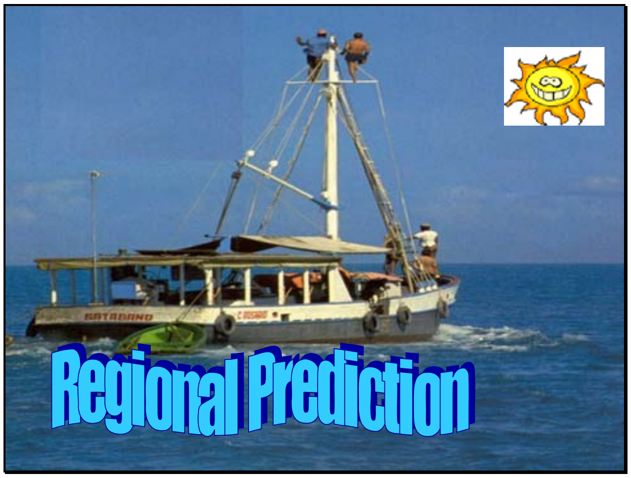

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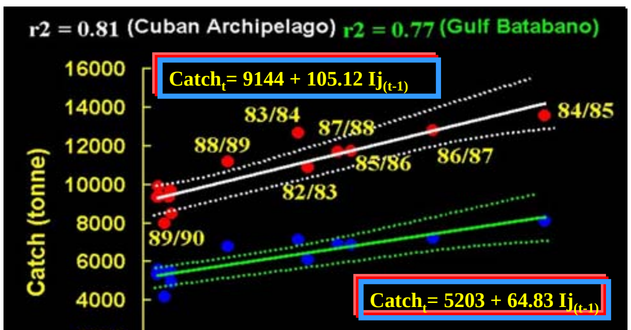
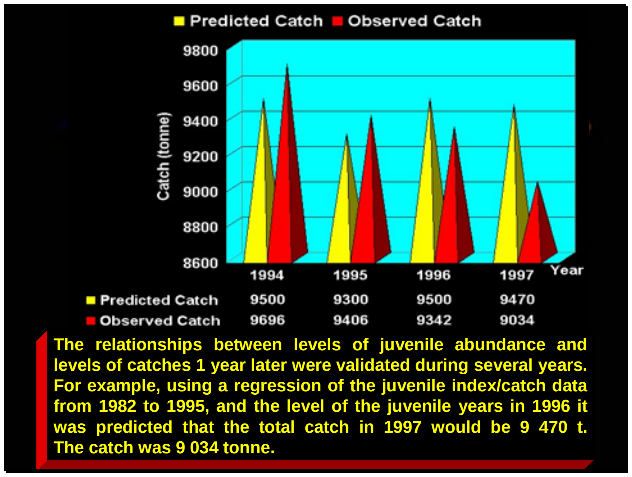


The indexes of abundance of juvenile among the years 1982-1987 sustained a catch that oscillated between 7000t (GB) and 11600t (Cuban shelf). In 1984 the maximum observed recruitment took place that gave place to a catch record of 8125t (GB) and 12584 (Cuban shelf). With the descent of the abundance of the juvenile after 1988, the catch declined 5500t (GB) and to 9500t (Cuban shelf).

Slide 25



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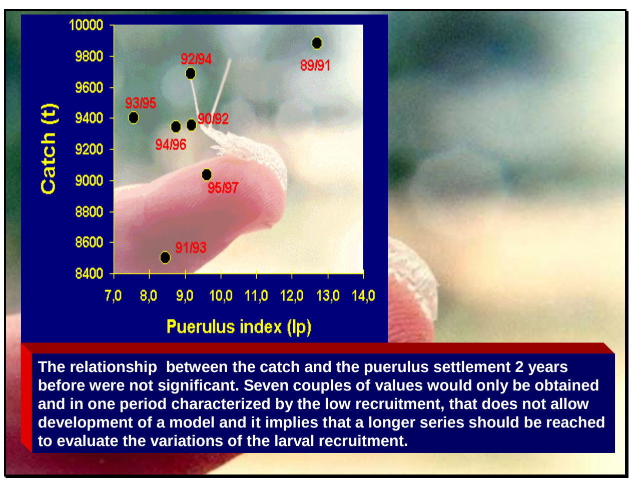

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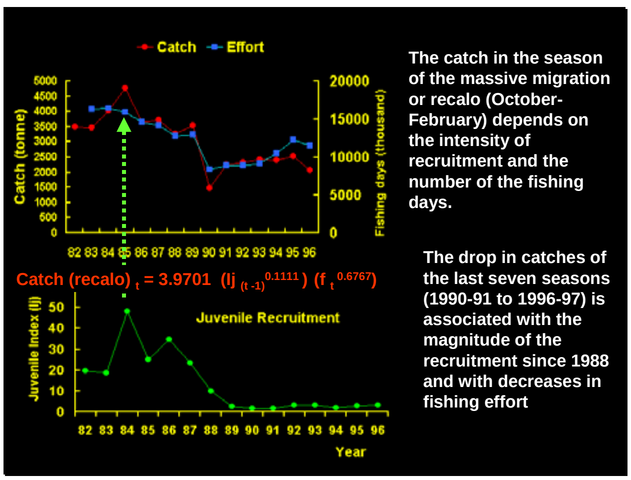

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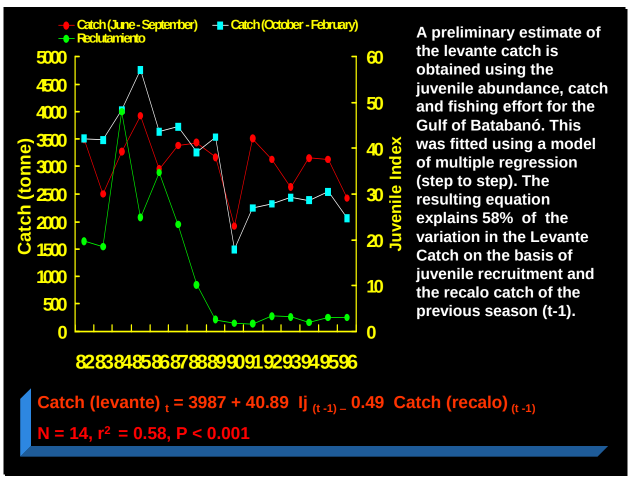

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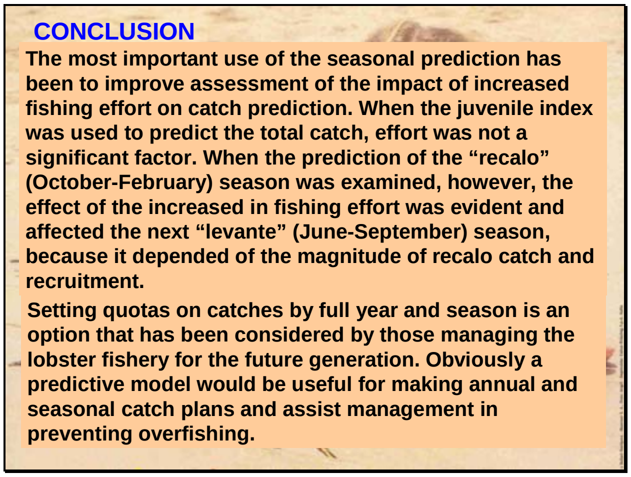

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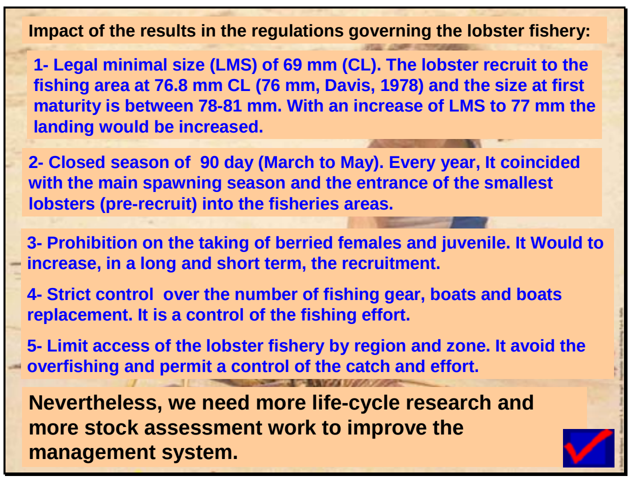
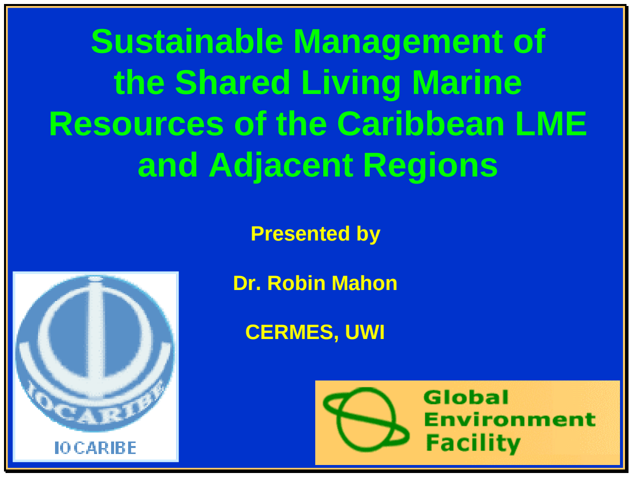


10. Review and status update of proposed LME (Large Marine Ecosystem) project

Slide 1



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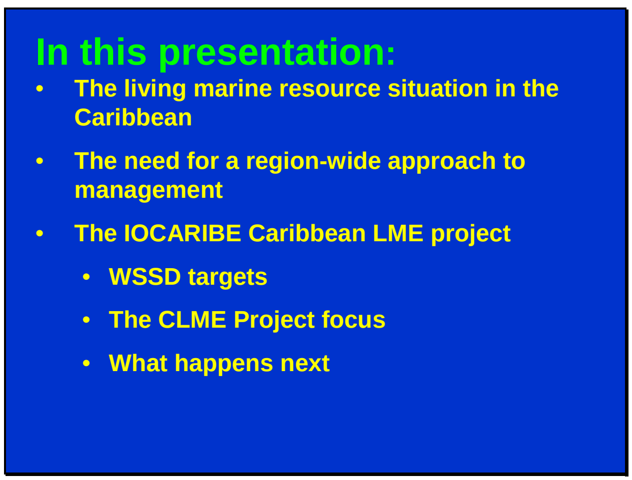

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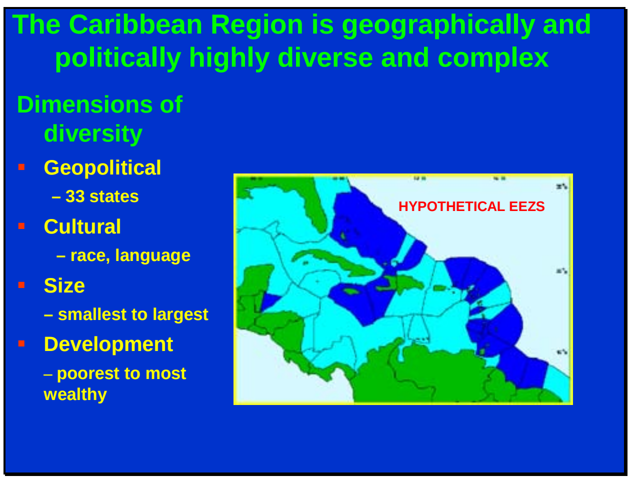

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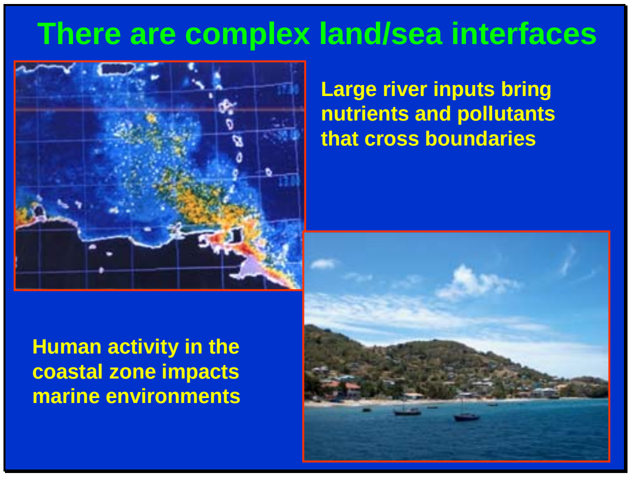

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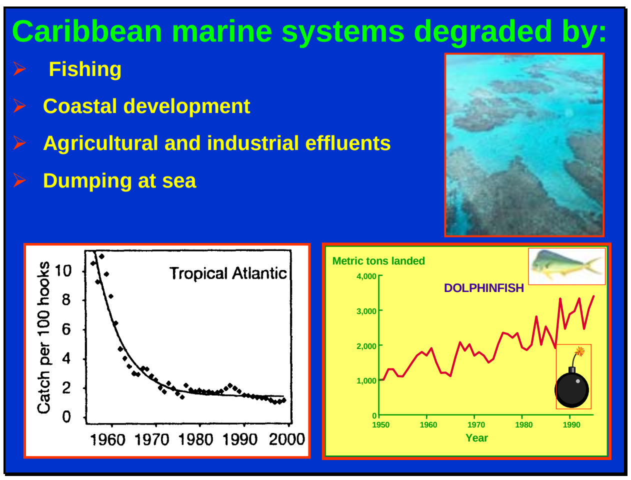

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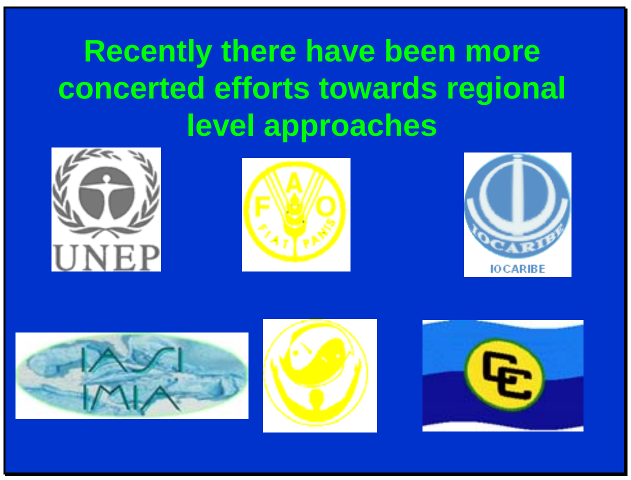


Slide 9

IOCARIBE's
Caribbean Large Marine Ecosystem Project
aims to strengthen regional cooperation
to
reverse degradation
of living marine resources

Slide 10

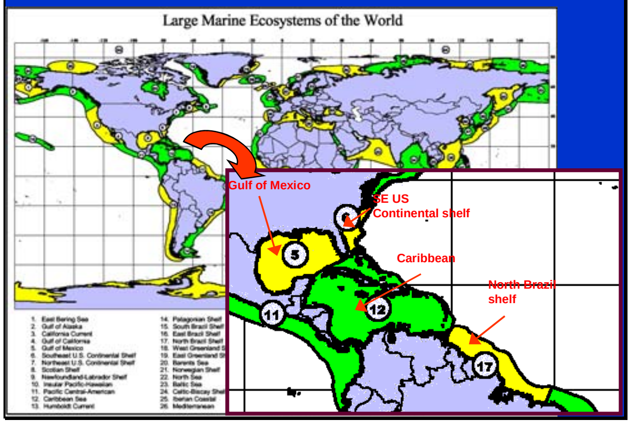
The Caribbean LME Project
What is it?

Overall objective

Sustainable management of the shared living marine resources of the Caribbean LME and adjacent regions through an integrated management approach that will meet WSSD targets for sustainable fisheries

Slide 11

The Caribbean LME and adjacent regions



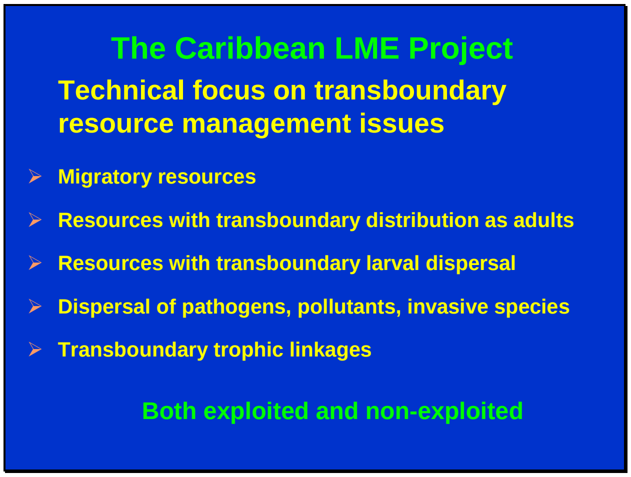
Slide 12

What are the WSSD targets?

- Encourage application of the ecosystem approach for the sustainable development of the oceans by 2010
- Maintain or restore depleted fish stocks to levels that can produce MSY by 2015
- Put into effect FAO IPAs for the management of fishing capacity by 2005; and IUU fishing by 2004
- Use diverse approaches and tools to eliminate destructive fishing and to establishment MPAs

JOHANNESBURG SUMMIT 2002

Slide 13



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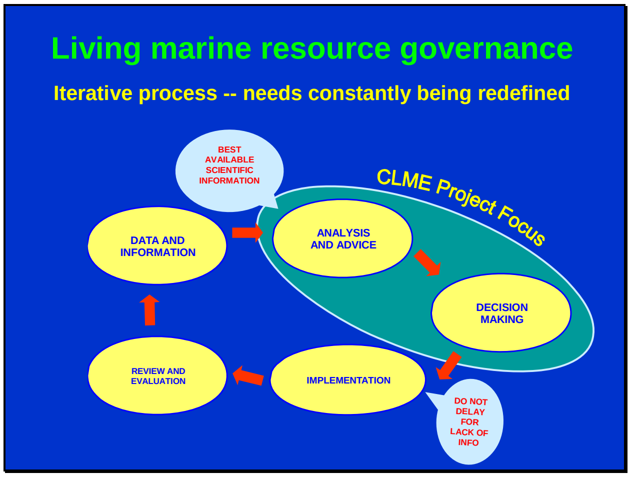

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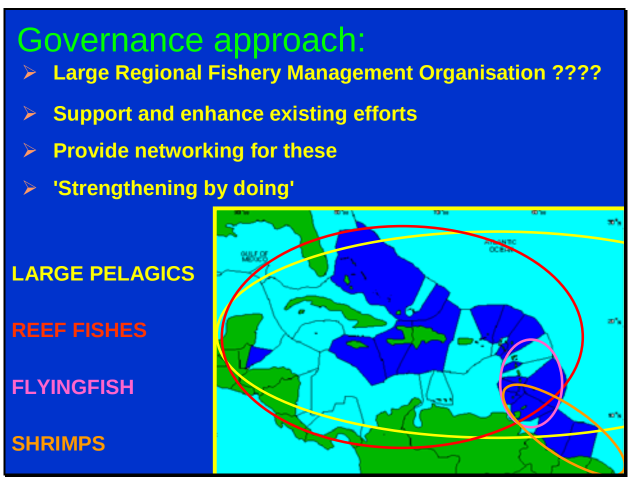
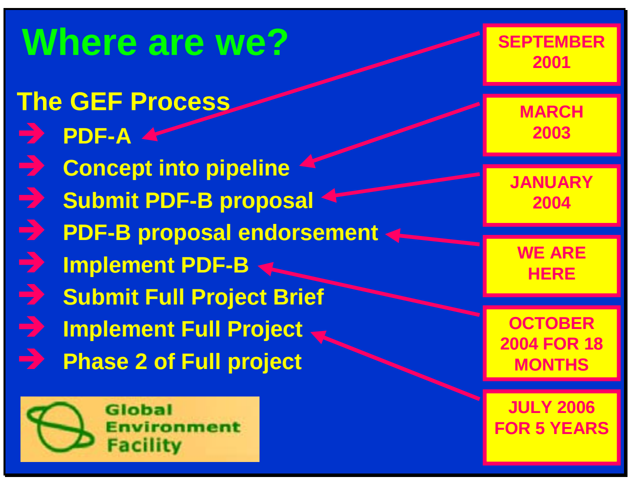


Slide 19

Emphasis on governance

- Is a demand driven approach
- Emphasises learning by doing
- Requires partners with cofinancing for science inputs

Slide 20



Slide 21

Financing

PDF-B 18 months

- GEF -- US$ 700 K
- Co -- about US$ 200 K

Full Project first 5 years

- GEF -- US$ 9 M
- Co -- about US$ 10 M

Slide 22

The PDF-B Process

- Establish Steering Committee
- Consultative activities
- Task groups review
  - Transboundary issues
  - Science needs
  - Governance mechanisms
- Prepare full project proposal

Slide 23