CRFM Fishery Report – 2008
Volume 1

Report of Fourth Annual Scientific Meeting –
Kingstown, St. Vincent and the Grenadines, 10-20 June 2008

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Foreword

CRFM's Fourth Annual Scientific Meeting took place during 10-20 June, 2008. During this Meeting, CRFM Resource Working Groups examined data from nine fisheries: the crevalle jack (*Caranx hippos*) fishery of Trinidad and Tobago; the spiny lobster (*Panulirus argus*) fisheries of The Bahamas and Jamaica; the queen conch (*Strombus gigas*) fishery of St. Lucia; the reef and slope fisheries of the Turks and Caicos Islands and St. Kitts and Nevis; the whitemouth croaker (*Micropogonias furnieri*) fishery of Trinidad and Tobago; and the Atlantic Seabob (*Xiphopenaeus kroyeri*) fisheries of Guyana and Suriname. A plan of action was developed for strengthening the information base necessary to inform the establishment of management and conservation measures for small coastal pelagic fisheries. In addition, the Large Pelagic Working Group conducted a review of the region's fisheries in order to evaluate assessment priorities and to develop a workplan for addressing required assessments and improving collaboration with ICCAT. The Meeting reviewed and adopted the Report of the Third Meeting of the CRFM Ad Hoc Working Group on Methods. A proposal to establish a Working Group on Data, Methods and Training was considered and endorsed by the Meeting.

The Report of the Fourth Annual Scientific Meeting is published in two Volumes: Volume 1 contains the proceedings of the plenary sessions and the full reports of the CRFM Resource Working Groups for 2008. National reports, submitted for consideration by the Meeting, are published as Supplement 1 to Volume 1, while the Report of the Third Meeting of the Ad Hoc Working Group on Methods is published as Supplement 2 to Volume 1. Volume 2 contains the general reports of each Working Group and the fishery management advisory summaries for completed fishery assessments. These fishery management advisory summaries are the same as the first 7 sections (sections 1 to 1.7) of each of the fishery assessment reports that are provided in full (sections 1 to 1.8) in Volume 1.

Volume 1 is intended to serve as the primary reference for fishery assessment scientists, while Volume 2 is intended to serve as the main reference for managers and stakeholders. Sincere thanks to Mr. Greg Franklin for providing the photographs which appear on the covers of these two volumes.

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List of Acronyms and Abbreviations

ACP	-	African, Caribbean and Pacific states
ASPIC	-	Argumentation Service Platform with Integrated Components
CARICOM	-	Caribbean Community
CARIFIS	-	Caribbean Fisheries Information System
CERMES	-	Centre for Resource Management and Environmental Studies
CFRAMP	-	CARICOM Fisheries Resource Assessment and Management Programme
CFP&R	-	Common Fisheries Policy & Regime
CL	-	Carapace Length
CLME	-	Caribbean Large Marine Ecosystem
CLWG	-	Conch and Lobster Resource Working Group
CPUE	-	Catch Per Unit of Effort
CRFM	-	Caribbean Regional Fisheries Mechanism
DANIDA	-	Danish International Development Agency
DAS	-	Days at Sea
DMTWG	-	Data and Methods Working Group
EBM/EAF	-	Ecosystem-based Management/Ecosystem Approach to Fisheries
ECOST	-	Ecosystems, Societies, Consilience, Precautionary Principle
EEZ	-	Exclusive Economic Zone
ERAEF	-	Ecological Risk Assessment for the Effects of Fishing
EU	-	European Union
FAD	-	Fish Aggregating Device
FAO	-	Food and Agriculture Organization of the United Nations
FL	-	Fork Length
FLR	-	Fisheries Library in R
GCFI	-	Gulf and Caribbean Fisheries Institute
GDP	-	Gross Domestic Product
GRP	-	Glass- reinforced Plastic
GSI	-	Gonadosomatic Indices
ICCAT-STWG	-	International Commission for the Conservation of Atlantic Tunas – Small Tuna Working Group
ICLARM	**-**	International Center for Living Aquatic Resources Management
IFAD	-	International Fund for Agricultural Development
IMA	-	Institute of Marine Affairs
IUU	-	Illegal, Unreported and Unregulated fishing
JICA		Japan International Cooperation Agency
LAPE	-	Lesser Antilles Pelagic Ecosystem Project
LCCC	-	Length-converted-catch-curve
LJFL	-	(Lower Jaw Fork Length)
LOA	-	(Length Overall)
LPWG	-	Large Pelagic Fish Resource Working Group
MCMC		Monte Carlo Markov Chain Methods
MCS	-	Monitoring, Control and Surveillance
MSC	-	Marine Stewardship Council
MSY	-	Maximum Sustainable Yield
NGO	-	Non-Governmental Organization
NIS	-	National Insurance Services
NMFS-SEFSC	-	National Marine Fisheries Service – South East Fisheries Science Center

NOAA		National Oceanic and Atmospheric Administration
OECS	-	Organization of Eastern Caribbean States
OSPESCA	-	Organizacion del Sector Pesquero y Acuicola del Istmo Centroamericano (Organization of the Fisheries and Aquaculture Sector of Central America)
RFMO	-	Regional Fisheries Management Organization
RSWG	-	Reef and Slope Fish Resource Working Group
SCPWG	-	Small Coastal Pelagic Fish Resource Working Group
SCRS	-	Standing Committee on Research and Statistics
SGWG	-	Shrimp and Groundfish Resource Working Group
TAC	-	Total Allowable Catch
TCDC	-	Technical Cooperation among Developing Countries
TCI	-	Turks and Caicos Islands
TOR	-	Terms of Reference
UNDP	-	United Nations Development Programme
UNU-FTP	-	United Nations University – Fisheries Training Programme
USA	-	United States of America
UWI	-	University of the West Indies
VPA	-	Virtual Population Analysis
VMS	-	Vessel Monitoring System
WECAFC	-	Western Central Atlantic Fishery Commission

1. Opening of Meeting

The Meeting was formally opened by the Senior Fisheries Officer, Fisheries Division, Ministry of Agriculture, Forestry and Fisheries, St. Vincent and the Grenadines, Ms. Jennifer Cruickshank. The Honourable Minister of Agriculture, Forestry and Fisheries, Ministry of Agriculture, Forestry and Fisheries, St. Vincent and the Grenadines, Mr. Montgomery Daniel, delivered the feature address. The Acting Deputy Director of the CRFM Secretariat, Mr. Terrence Phillips, made remarks on behalf of the CRFM, and the Secretariat's Programme Manager for Research and Resource Assessment, Dr. Susan Singh-Renton, gave the vote of thanks.

2. Election of Chairperson

The Meeting was reminded that it was customary practice for the chief fisheries officer of the host country to be invited to chair the meeting. Given that the Chief Fisheries Officer of St. Vincent and the Grenadines was on duty abroad, CRFM's Acting Deputy Executive Director, Mr. Terrence Phillips, was elected to serve as Chairperson.

3. Adoption of Agenda

Regarding agenda item 6, the Chair of the CLWG advised the meeting that the CLWG and RSWG held a joint meeting in preparation for the plenary session. In consequence, a joint report was compiled for presentation. Also on agenda item 6, the Chair of the LPWG advised that he would be present only for the first day of the plenary meeting, and requested that the LPWG presentation be received first. The meeting adopted the agenda, taking these changes into account. The adopted annotated agenda is given in Appendix 1.

The Meeting Chairperson then established the working hours for each day of the meeting.

4. Introduction of participants

Participants were asked to introduce themselves. A list of participants is provided in Appendix 2.

5. Presentation of national (country) reports

National reports are provided in Supplement 1 to this report.

To facilitate Working Group reviews during the 2008 sessions, national reports were received from the following nine countries, listed in alphabetical order: The Bahamas; Guyana; Jamaica; St. Kitts and Nevis; St. Lucia; Suriname; St. Vincent and the Grenadines; Trinidad and Tobago; The Turks and Caicos Islands.

The representatives from Belize and Grenada indicated that they would like to submit their national reports shortly after the meeting. It was noted that these reports would be useful as references for future meetings. A deadline of 27 June 2008 was set for submission of the reports from Belize and Grenada.

6. Reports of the CRFM Fishery Resource Working Groups

6.1 LPWG

The Report of the Working Group is given in Appendix 3.

There were some queries regarding observed fishery trends, as reflected by the catch data reported to FAO. These data showed apparent inconsistencies in level of fishing activity from year to year. It was not possible to explain the inconsistencies based on information made available to the meeting. For the French Antilles, the meeting was informed that there has been a recent shift towards the harvest of yellowfin tuna and billfish resources, and that a monitoring programme commenced in 2007 should ensure improvement in catch data reported to FAO in the future. It was also pointed out that in the case of Venezuela, those fishing fleets that traditionally targeted blackfin tuna were still operating. Given the incompleteness of the FAO database, the meeting reinforced the need for countries to strive to complete the CRFM nominal data forms for large pelagic fisheries and to submit these to the Secretariat during the inter-sessional period.

Regarding the preparations for the proposed joint ICCAT STWG–CRFM LPWG meeting in 2010, the meeting acknowledged the necessity for those countries with major blackfin tuna harvests, such as Grenada, to advise about their state of readiness to undertake the required additional sampling of the fisheries concerned. The representative from NMFS SEFSC indicated preliminary interest in the proposal to analyze blackfin tuna data and the availability of data for the US fisheries. The representative from UWI CERMES confirmed that UWI would be willing to assist with genetic studies of blackfin tuna.

The Working Group developed a written proposal outlining the specific aims and activities of the proposed joint meeting, and this was included as one of the annexes to the full report.

6.1.1. Report of crevalle jack fishery of Trinidad

A question was raised about the allocation of the crevalle jack assessment to the LPWG, although the mixed nature of the fishery, similar to the dolphinfish-flyingfish fishery, was recognized. The meeting acknowledged the usefulness of applying definitions for allocation of assessment responsibilities to the various working groups, but highlighted the importance of taking into account significant fishery interactions even though these included resources examined by different working groups.

Working Groups were reminded about the advantage of prioritizing their recommendations and stating clearly the time period for implementation of these. Additionally, it was suggested that the recommendation to clean the Trinidad and Tobago database be extended to cover all species and not just crevalle jack.

A query was raised regarding the usefulness and feasibility of including examination of the oceanographic and physical data that are available. It was pointed out that the French had done extensive work in this area, and in French Guiana, some work on oceanographic dynamics and productivity had been in progress. Additionally, the meeting was informed about recent work completed on dolphinfish that attempted to link the position of fronts and frequency of fronts to the abundance of this species. The meeting noted the relevance of this type of work, and agreed on the need to improve linkages with research initiatives aimed at gathering data and information for informing development of ecosystem-based approaches.

6.2 CLWG

The report of this Working Group is given in Appendix 4.

Noting the overlap in interests of OSPESCA and the CRFM, the meeting acknowledged the need to improve collaboration between the two organizations. Given that Belize is a member of both CRFM and OSPESCA, it was agreed that such collaboration could be fostered through Belize’s participation or through the exchange of reports and publications. The importance of collaboration was further emphasized, with a general recommendation to link Working Group activities to related activities being undertaken by other initiatives in the Caribbean.

Concerning the recommendation dealing with obtaining funds for research projects and data collection, the meeting was reminded that donor funded projects usually had a long gestation period. Fisheries Departments/Divisions had their roles to play in highlighting the importance of this sector at the national level. Such actions would help to attract the attention of these funding agencies, as well as increase allocations from the national budgets by showing the sector's contribution to the GDP. The representative from Belize noted that his country had obtained training in project proposal preparations through collaboration with NGOs and foreign chain restaurants.

Concerning the recommendation for the transfer of knowledge between country representatives and their colleagues at the national level, it was pointed out that this was mainly an internal issue. National departments and divisions should therefore explore ways of improving communications to share information within their agencies and ministries, etc. in order to improve on institutional memories and influence the decision-making process. In this regard, the meeting acknowledged the importance of participants presenting the meeting's results when they returned home. Preparation of travel mission reports was also recommended as a good means of communicating the knowledge gained.

Regarding the recommendation to invite a MSC expert, the meeting noted that MSC dealt with trade related issues. Consequently, the MSC issues should be addressed at the Forum level prior to being addressed during the scientific meeting.

The meeting noted that the recommendation to shorten the length of the meeting seemed to be in conflict with the recommendation to re-introduce training. The meeting was also reminded that the final meeting of the Ad Hoc Working Group on Methods had recommended omission of training during the annual scientific meetings, so as not to divert attention away from the core business of the scientific meetings. Additionally, it was pointed out that some Working Groups required more time than others to complete their tasks, and so a general recommendation should not be made. There was a suggestion that the plenary meeting could be shortened to two days instead of three days and the report could be adopted by mail. The Working Group clarified that the aim of the recommendation was to ensure that the maximum possible time was allocated to assessment work, and that activities that diverted attention away from core tasks should be minimized.

With regard to the recommendation for a socio-economic consultant to attend the 2009 meeting, it was clarified that meeting consultants were recruited based on the relative priorities for the annual meetings and the state of data readiness, as determined from the information countries provide to the Secretariat prior to the annual meetings.

The Working Group was commended for the amount of inter-sessional work which they managed to complete and a query was made about how this was achieved. The Group indicated that the consultant had been successful in transferring knowledge to members of the group. Members of this Group also indicated that the training received during the CRFM Meetings had made them more competent in stock assessment methods.

6.2.1. The spiny lobster fishery of The Bahamas

Noting that the majority of the catch was taken in casitas set in shallow sea areas it was pointed out that the size frequency data would reflect both mortality and migration. The Working Group was aware of this as the migration problem had been identified during previous data reviews. The meeting considered and agreed that figure 3 should be omitted from the final report, as it was uninformative to those who did not fully understand the application of the depletion model. It was suggested to show that there was simply no clear pattern in recruitment. In response to a concern about the use of tail length data because of the known errors associated with tail measurements, it was explained that only the tail length data were consistently available for the fishery.

In respect of another concern regarding the interpretation of the CPUE trends, it was clarified that the CPUE index would still be useful for monitoring trends in relative abundance on fishing grounds. It was also pointed out that, in theory, the disappearance of lobsters from the casitas could be monitored and compared to offshore data so as to distinguish the losses due to mortality and migration. However, this aim would not be simple to achieve in practice.

6.2.2 The spiny lobster fishery of Jamaica

In response to a query regarding the use of tail length versus carapace length for regulatory purposes, it was clarified that it was possible to utilize both.

It was pointed out that the time series of catch suggested high variability in recruitment for this fishery. If that were indeed the case, a TAC measure would be difficult for fishers to accept because they would want to take advantage of high abundance years. In this situation, effort controls would be more acceptable. The practicality of this suggestion would have to be given consideration. It was also suggested that the impact of hurricanes be considered, as these environmental events were known to affect local abundance of lobsters.

Noting plans to evaluate the usefulness of a minimum size measure, the Working Group was reminded that the MSY value would differ if a minimum size had to be incorporated into the evaluation. It was clarified that production models did not take into account size information.

There was concern that implementation of two management restrictions would place pressure on fishers in respect of two separate aspects of their operations.

6.2.3 The queen conch fishery of St. Lucia

It was pointed out that the analysis gave high precision estimates of the performance indicators. Additionally, stock recovery appeared to be important given that fishing mortality was found to be in excess of that required to harvest MSY. It was suggested that the Working Group consider recommending a TAC that was consistent with the lower limit of replacement yield.

There was some discussion about the need to demonstrate to fishers that efforts were being made to determine the socio-economic implications of the fishery and proposed management measures. The meeting agreed that it was essential to highlight to fishers the longer term benefits of proposed management measures.

A query was made about the enforcement of the TAC proposed in 2007. It was explained that the Working Group's recommendation from last year was not carried out, as there was a problem primarily with monitoring, enforcement and surveillance.

6.2.4 The reef and slope fishery of the Turks and Caicos Islands

It was explained that the fishery utilized a range of gears, including longline, hook and line, traps and hand spears. In view of this, a concern was raised in respect of the proposed size restrictions that would only work for the spear fishers, because the other gears used kill fish before they are hauled. It was clarified that except for the longline gear, other gears were being used in shallow water.

In addition, it was suggested that the current versions of figures 1 and 2 be changed to reflect changes in catches by weight rather than by numbers, as the use of numbers tended to overemphasize the estimated catch reductions. However, this was not possible this year given the small quantity of weight data available.

6.2.5 The reef and slope fishery of St. Kitts and Nevis

The Working Group advised that there was some review of the data from St. Kitts and Nevis, but that no assessments were completed in 2008.

6.3 SGWG

The Report of this Working Group is given in Appendix 5.

There was some discussion about the continued activity of the FAO WECAFC Ad Hoc Working Group on Shrimp and Groundfish. A query was raised regarding the attempt to coordinate this work with the FAO WECAFC working group, as its present link to the CLME project was an indication that the working group was shifting its attention to policy issues. The representative from FAO confirmed that the perceived indication was correct; he also indicated that FAO would generally respond to priority needs identified by Member States. The meeting was reminded that a number of projects were beginning in the region, e.g. the ACP FISH II project and CLME project, and that the scientific meeting should be conscious of these projects and the linkages with its work. It was noted that although the focus of CLME was on governance, the project recognized the need for technical contributions.

6.3.1 Report of the whitemouth croaker fishery of Trinidad and Tobago

There was some discussion about the possibility of strengthening the management advice, based on the precautionary approach and the best scientific evidence available. It was clarified that while the assessment suggests no cause for alarm, the present understanding of the status quo was uncertain. Further investigations were needed to determine if the status quo represented a safe position for the fishery.

In response to a query about the range of Z estimates obtained. It was clarified that the variation of Z with gear from year to year was random and showed no consistent pattern. Hence, there was no reason to believe that the gears had different selectivities. However, review of the variation in Z warranted further review of the data, as well as consideration of growth information if possible. Concerning a query regarding attempting to estimate F for each gear using length converted catch curves, this was not recommended.

6.3.2 Report of the seabob fishery of Guyana

There was considerable discussion about the recommended change in the placement of the closed season. The meeting recalled that the current closed season was determined by the trawler association, and was normally either September-October or August-September, depending on the industry’s decision. It was suggested that the current closed season was market-driven. In response to a query about inter-annual variation in the recruitment peak, it was confirmed that the peak appeared to be fairly consistent from year to year.

The meeting was informed of an intention by the trawler association to recommend 50% reduction in fishing effort in the near future. The meeting noted that if this dramatic reduction took place, detailed monitoring should be undertaken to evaluate the impact of this effect. There was some concern that the implementation of the reduction would not be executed in a controlled way, diminishing the quality of the information available to understand fully the impact of the reduction. To take full advantage of the opportunity as far as possible, the Working Group was asked to consider providing recommendations to the industry for implementing the intended 50% reduction in fishing effort. There was also acknowledgement that the trawler association was driving the management process rather than the government, and that this management model warranted some further consideration.

A query was raised regarding the impact of the closure on the activities of other fleets harvesting other shrimp fisheries and other fleets in other countries. It was clarified that Suriname had no closed season. The arrangements were worked out by the industry and there appeared to be no conflict with these other fleets.

Considering the industry's concern about the suitability of the most recent advice on shifting the closed season, the meeting emphasized the need for the industry to provide better data to the scientists, in order to improve management advice. There was some further discussion about the importance of quantifying the benefits of the current recommendation, and the fact that the industry may be worried about diminished profits with the shift in the time closure. It was confirmed that based on data available to the Working Group, May was not the month with highest economic returns and so the closure in May was not considered to be too severe. It was also noted that a reduction in the fishing effort may make seasonal closure unnecessary.

It was pointed out that a closure could be for biological as well as economic reasons. However, the Working group did not have economic data, and so should aim to provide the biological justification for the closure, and to quantify the amount of recruitment protected and the gains in yield to be obtained, i.e. focus on the biological gains. It was clarified that the recommended closure was intended to protect against recruitment overfishing primarily. The meeting concluded that the current result should be taken to the industry, as it was the best data that were made available to the Working Group. The meeting was also reminded that the fishery was export market driven and that this would influence the final decision. Given the heavy dependence on the industry for data, it was suggested that priority consideration be given to the recommendation for establishing an observer programme; although expensive, an observer programme would be essential for providing an independent evaluation of the quality of the data provided by the industry.

On a general note, the meeting recognized the importance of maintaining communications with target groups. The development of communication strategies was recommended, and the meeting was reminded of the current related UWI initiative in this regard. Such communication strategies should also try to obtain support for improving the quality of data supplied from the full range of companies in Guyana.

The meeting agreed that the biological sampling conducted in December 2007 provided useful information and emphasized the importance of having this type of sampling continued.

6.3.3 Report of seabob fishery of Suriname

It was agreed to develop a biological profile of seabob inter-sessionally.

6.4 SCPWG

The Report of this Working Group is given in Appendix 6.

The Working group was asked to document the overarching goal of its proposed action plan. Additionally, the rationale for establishing the ban in St. Vincent and the Grenadines should be documented. It was explained that the ban was established based on the fact that neighbouring countries within the eastern Caribbean had observed notable declines in the performance of their bait fisheries as a result of efforts to supply visiting longliners. This, together with a marked local decrease in the supply of fresh fish to local communities in the rural areas of St. Vincent and the Grenadines, elevated concerns about the capacity of the resource to satisfy the range of demands, and gave rise to the imposed ban.

There was some concern about the ability of the Working Group to be able to provide management advice in less than a year, given the lack of data from previous years. Despite this, and recognizing that management advice was being requested, it was clarified that efforts would be made to gain some understanding of the patterns and amounts of harvest (supply), some understanding of the biology of the resource, and the demands of the various markets (local and foreign) over the next few months. This preliminary dataset would have to be examined to develop at least some short-term management advice that could assist with reviewing the ban and the need for its continuity.

7. General Review and Discussion of Working Group recommendations to improve statistics and research inputs.

The recommendations from each Resource Working Group were compiled to facilitate discussion of this agenda item.

Noting the common problem of lack of data and participation from neighbouring non-CRFM States, an overall recommendation was made for CRFM to explore ways of addressing this issue. It was agreed that CRFM should continue to promote participation in the annual scientific meetings by the countries concerned. Meeting contribution and participation were limited by financial resources for some of the neighbouring States concerned, e.g. Venezuela. The meeting recalled that CRFM was sometimes asked by FAO to co-fund certain FAO meetings, and so perhaps in the future, FAO could be asked to consider funding the participation of some of these neighbouring non-CRFM States.

The meeting also reviewed the plans to resume regional fish age and growth research. The representative from IMA confirmed that the regional lab would work towards completing age and growth analyses of wahoo later in 2008, and of Serra Spanish mackerel in late 2009. Age and growth parameters developed by the IMA were used in the 2008 assessment of the crevalle jack fishery of Trinidad and Tobago. CRFM Working Group requests for age and growth information on whitemouth croaker would be addressed by 2010. In response to a query in respect of the proposed 2010 assessment of blackfin tuna, there was some concern about the difficulty with interpreting the otolith patterns. The meeting was reminded that for the tunas, vertebrae of dorsal fin spines were often used to age the species. An evaluation of the use of hard parts for ageing blackfin tuna had been completed during the early 1990s, and the report of this study should be reviewed by the regional lab.

The representative from IMA noted that assistance with data analyses would be required in the near future to facilitate completion of current outstanding reports. Additionally, countries were reminded about the need to resume regular collection of hard part samples to ensure the success of the regional age and growth research initiative.

8. Report of the Third Meeting of the CRFM Ad Hoc Working Group on Methods

The Report of the Meeting is provided in Supplement 2 to this report.

The meeting was updated on the progress of the inter-sessional activities to test the Parfish method for a fishery in Trinidad & Tobago. A number of fisheries division staff had received training to undertake the necessary sampling. Some interviews had been completed, but more interviews were planned. Data analysis was scheduled to take place later in 2008.

The meeting was also updated on the Parfish work being undertaken for the deep water snapper fishery in Puerto Rico. The interview stage was still in progress, and data analyses were expected to commence in about a month. The results should be available by November 2008. The meeting was also informed of the Parfish workshop session planned by GCFI during its annual meeting in 2008.

In response to a query about testing the ERAEF method, it was clarified that CRFM Secretariat staff could assist countries to undertake the ERAEF tests for preparation of a draft product that could then be reviewed by an ERAEF expert.

Regarding the proposal for re-establishment of the regional fish age and growth laboratory at IMA, the Meeting accepted the recommendations made by the Third Meeting of the Ad Hoc Working Group on Methods, and endorsed the proposal for implementation. It was recognized that the list of species provided in the proposal was a provisional one and would change depending on the countries' interest. In this regard, the Meeting was reminded of the whitemouth croaker recommendation for age and growth research. There were also a number of age and growth research recommendations noted in previous scientific meeting reports. In respect of the proposed financing arrangement for resumption of the IMA Regional Fish Age and Growth Laboratory, it was understood that this would have to be reviewed and formally accepted by the Caribbean Fisheries Forum.

9. Proposal to establish CRFM Working Group on Data and Methods

The meeting was advised of the changes proposed by the LPWG, which were documented in the report of that working group.

The meeting agreed to include the task of developing and implementing a communications plan and to change the name of the working group to reflect the importance of training activities. The revised proposal is given in Appendix 7.

10. Special lectures and presentations

10.1 FAO LAPE project review

A summary of the presentation is provided in Appendix 8.

In response to a query regarding the high risk ecosystem issues identified by the project, it was clarified that there were four aspects that were demonstrated to be vulnerable: (i) the sustainability of the bait fishery; (ii) the predator-prey relationship between dolphinfish and flyingfish that could impact on the fisheries targeting these resources; (iii) factors affecting the health of the marine mammal population; (iv) the impact of environmental changes on the ecosystem as a whole.

The meeting acknowledged the usefulness and importance of the project results to the work of the scientific meetings, particularly the approaches to be adopted. These project results should therefore be considered carefully during the inter-sessional period, especially by the LPWG and the SCPWG.

While discussing the need for follow-up activities and closer collaboration between the CRFM and FAO in this regard, the representative from UWI CERMES informed the meeting of a symposium scheduled to take place in December 2008. This symposium on 'Marine EBM/EAF in the Wider Caribbean', is aimed at reviewing the available information on EBM/EAF within the Caribbean, and should include review of the FAO LAPE project outputs.

10.2 The application of the ECOST model to Caribbean fisheries

A summary of the presentation is provided in Appendix 9.

In response to a query about the conclusions of the studies completed for other regions, it was explained that these still needed to be assimilated and summarized. The meeting recognized the importance of the ECOST model, noted its direct and immediate relevance to CRFM management situations, and recommended the importance of continued exchange of information and reports between ECOST and the CRFM.

11. 2008-09 partnership activities

11.1 UNU-FTP stock assessment training course

A status update and summary of the arrangements for development of the stock assessment training course is provided in Appendix 10.

The meeting noted that the item was discussed by the LPWG, which had made specific recommendations that included, *inter alia*: (i) delivery of course materials in modular format; (ii) provision of basic and advanced training modules to address range of needs within fisheries departments and divisions; 1-2 year cycle for repetition of the course modules. These recommendations were supported by the other working groups. The details of the LPWG discussion of this item are given in the LPWG report, provided in Appendix 3.

11.2 ICCAT-CARICOM/CRFM training workshop

The meeting was informed of plans to deliver this training workshop early in 2009. A summary of the training workshop format proposed by ICCAT is provided in Appendix 11.

The LPWG had primary responsibility for addressing this agenda item, and its specific recommendations are provided in Appendix 3. In general, the LPWG supported the format and content, as proposed by ICCAT.

11.3 FLR

A summary prepared for the meeting noted the development of FLR, and its potential widespread application in the future. As it was an open source product, much software was being written for it. In view of this, the meeting recognized the importance of investing time in learning R. There was a steep learning curve, but once mastered, analyses in R were often facilitated more easily than in excel. It was pointed out that FLR would provide a range of possibilities for use within the CRFM situation, as outputs could vary with data inputs and identified needs. Another advantage of FLR was that it allowed management advice to be transparent, compared to excel where it was often more difficult to follow spreadsheet analyses.

Following a very limited exploratory practice session, it was agreed that the CRFM should consider options for further exploration of FLR and for facilitating training in the near future. The summary is provided in Appendix 12.

12. Identification of assessment needs for 2009

Several assessments to be addressed in 2009 were identified by the Working Groups, and are given in the table below. The list provided is tentative, pending confirmation of the type and quality of available data, as well as of the management questions of concern.

Working Group	Fisheries
CLWG	Spiny lobster fisheries of Jamaica, Belize, TCI, The Bahamas and St. Vincent and the Grenadines Queen conch fisheries of Jamaica, Belize, TCI, The Bahamas, and St. Lucia
LPWG	Dolphinfish fishery
RSWG	Mutton snapper fishery of Belize Red hind and queen triggerfish fisheries of Montserrat Parrotfish fishery of St. Kitts and Nevis Reef fisheries of St. Lucia (species to be identified)
SGWG	Atlantic seabob fisheries of Guyana and Suriname Shrimp fishery of Trinidad and Tobago (species to be identified) Acoupa weakfish fishery of Guyana Groundfish fisheries of Suriname and Trinidad and Tobago (species to be identified)
SCPWG	Four-winged flyingfish fishery (review of 2008 WECAFC assessment report)

13. Election of Working Group Chairpersons for 2009.

CLWG - Anginette Murray, nominated by the Lester Gittens, seconded by Ramon Carcamo
LPWG – Christopher Parker, nominated by Cheryl Jardine-Jackson, and seconded by Ramon Carcamo
RSWG – John Jeffers, nominated by Kathy Lockhart and seconded by Anginette Murray
SGWG – Lara Ferreira, nominated (tentatively) by Suzuette Soomai, and seconded by Ramon Carcamo.
SCPWG – Elizabeth Mohammed, nominated by Ramon Carcamo and seconded by Crafton Isaac.
DMTWG – Lester Gittens, nominated by Ramon Carcamo, and seconded by Crafton Isaac.

14. Any other business

14.1 Data Policy Outline

No further changes were made to the content of the outline.

15. Review and adoption of meeting report.

It was agreed to adopt the report by email.

16. Adjournment

The Chairman thanked the organizers and participants for their efforts to ensure a successful meeting, as well as those experts and consultants who worked with the officers to complete assessments. The Chairman also reiterated the need for CRFM fisheries officers to share the meeting's results with their respective departments and divisions, and recognizing the use that was made of FAO data, to ensure that good quality data were always provided to FAO. He took the opportunity to remind participants of their responsibility to monitor and to provide inputs into the development of regional projects and other initiatives, such as CLME and ACP Fish II, thereby ensuring the national relevance and usefulness of the outputs from such projects and initiatives.

The meeting was then adjourned at 1730h.

Appendices

Appendix 1

CRFM's FOURTH ANNUAL SCIENTIFIC MEETING
AGENDA
(0900h-1700h, Fisheries Division, Kingstown, St. Vincent and the Grenadines)

I. Individual Resource Working Group Sessions: 10– 17 June 2008

Completion of selected fisheries analyses and assessments and Working Group reports.

II. Formal plenary sessions: 18 – 20 June 2008

1. Opening of the meeting.
2. Election of chairperson.
3. Adoption of meeting agenda and meeting arrangements.
4. Introduction of participants.
5. Presentation of national (country) reports.
6. 2008 reports of the CRFM Fishery Resource Working Groups (listed in alphabetical order):
Conch and Lobster Resource Working Group (CLWG);
Large Pelagic Fish Resource Working Group (LPWG);
Reef and Slope Fish Resource Working Group (RSWG);
Shrimp and Groundfish Resource Working Group (SGWG);
Small Coastal Pelagic Fish Resource Working Group (SCPWG).
7. General review and discussion of Working Group recommendations to improve statistics and research inputs.
8. Review of Report of the Third Meeting of the CRFM Ad Hoc Working Group on Methods.
9. Proposal to establish CRFM Working Group on Data and Methods
10. Special lectures and presentations
FAO LAPE project review
The application of the ECOST model to Caribbean fisheries
11. 2008-09 partnership activities
11.1 UNU-FTP stock assessment training course
11.2 ICCAT-CARICOM/CRFM training workshop
11.3 Training seminars in FLR and Bayesian techniques (half-day session), titled respectively
'FLR (Fisheries Library in R) - a flexible open source modeling framework for management strategy evaluation', and
'Using Bayesian models in data poor fisheries management'.
12. Identification of assessment needs for 2009.
13. Election of Working Group Chairpersons for 2009.
14. Any other business
15. Review and adoption of meeting report.
16. Adjournment.

CRFM's FOURTH ANNUAL SCIENTIFIC MEETING
ANNOTATED AGENDA
(0900h-1700h, Fisheries Division, Kingstown, St. Vincent and the Grenadines)

I. Individual Resource Working Group Sessions: 10– 17 June 2008

Completion of selected fisheries analyses and assessments and Working Group reports.

II. Formal plenary sessions: 18 – 20 June 2008

1. Opening of the meeting.
- The meeting will be formally opened by a senior official of the government of St. Vincent and the Grenadines during a short ceremony commencing at 0900h on 18 June 2008.

2. Election of chairperson.
- Representatives of the Member States will be invited to elect a Meeting Chairperson and Vice-Chairperson.

3. Adoption of meeting agenda and meeting arrangements.
- The elected Chairperson will review the agenda and request that it be adopted by the Meeting. The Chairperson will also confirm general meeting arrangements, including the appointment of rapporteurs for the plenary meeting.

4. Introduction of participants.
- Each participant will be invited to introduce him/herself, and to state his/her interest in the Meeting.

5. Presentation of national (country) reports.
- The Secretariat will be asked to list those national reports that have been submitted for consideration by the 2008 Meeting.

6. 2008 reports of the CRFM Fishery Resource Working Groups (listed in alphabetical order):
Conch and Lobster Resource Working Group (CLWG);
Large Pelagic Fish Resource Working Group (LPWG);
Reef and Slope Fish Resource Working Group (RSWG);
Shrimp and Groundfish Resource Working Group (SGWG);
Small Coastal Pelagic Fish Resource Working Group (SCPWG).
- Each Working Group Chairperson will present an overall report of the Working Group's 2008 meeting, including overall findings, recommendations and conclusions.
- Each species rapporteur will also present his/her fishery assessment report for 2008.
- Following each presentation, the Meeting will be invited to review, discuss, and endorse each report's findings and recommendations.

7. General review and discussion of Working Group recommendations to improve statistics and research inputs.
- Following presentation and endorsement of fishery reports, participants can give further consideration to the options for realizing recommendations, especially those that require implementation by several countries.

8. Review of Report of the Third Meeting of the CRFM Ad Hoc Working Group on Methods.
- The Working Group Chairperson will present the Working Group's final report for review and endorsement, including the proposal for the Continued Collaboration between the Regional Fish Age And Growth Laboratory at the Institute of Marine Affairs (IMA) and the Caribbean Regional Fisheries Mechanism (CRFM) for the period 2008-2013.

9. Proposal to establish CRFM Working Group on Data and Methods
- The Meeting will be invited to consider and endorse the establishment of a permanent CRFM Working Group on Data and Methods.

10. Special lectures and presentations
  10.1 FAO LAPE project review
  10.2 The application of the ECOST model to Caribbean fisheries
- The FAO representative will deliver lecture 10.1, highlighting key conclusions and recommendations
- The ECOST representative will deliver lecture 10.2, highlighting key conclusions and recommendations

11. 2008-09 partnership activities
  11.1 UNU-FTP stock assessment training course
  11.2 ICCAT-CARICOM/CRFM training workshop
  11.3 Training seminars in FLR and Bayesian techniques (half-day session), titled respectively 'FLR (Fisheries Library in R) - a flexible open source modeling framework for management strategy evaluation', and
  'Using Bayesian models in data poor fisheries management'.
- At 11.1, the Secretariat will provide an update on plans to develop a training course in stock assessment, in collaboration with UNU-FTP and regional partners, and the Meeting will be invited to make relevant recommendations.
- At 11.2, the Secretariat will provide an update on the progress of collaboration between CARICOM/CRFM and ICCAT to hold a training workshop early in 2009, and the Meeting will be invited to make relevant recommendations.
- At 11.3, representatives from CEFAS and the University of Helsinki will deliver a half-day training session, covering topics listed.

12. Identification of assessment needs for 2009.
- A draft list of assessment needs will be compiled, based on priorities identified in Working Group reports and by representatives of CRFM Member States.

13. Election of Working Group Chairpersons for 2009.

- The Meeting will be invited to elect Working Group Chairpersons and Vice-Chairpersons for 2008-09.

14. Any other business
- Further development of data policy outline

15. Review and adoption of meeting report.
- The text of the report is reviewed and adopted. If time is limited, the report is to be adopted by email.

16. Adjournment.
- Following completion of Agenda items 1 to 14, the meeting Chairperson will make any necessary closing remarks, and move to adjourn the Meeting.

Brief informal Joint Meeting of WGs on 10 June
(CLWG; LPWG; RSWG; SGWG; SCPWG)
(0830-0900h – Fisheries Division Conference Room)

1. Working Group participation and organization.
2. Review of session schedule, including working hours, facilities and secretariat support.
3. Review of WG agenda and expected outputs.
4. Any other business.

Resource Working Group Meeting Agenda
(CLWG; LPWG; RSWG; SGWG; SCPWG)
(Fisheries Division Conference Room and Library)

1. Review of Inter-sessional activities, including management developments since last meeting.
2. General review of fisheries trends throughout the region.
3. Review of fisheries to be assessed - i.e. Review available new data and information related to the species proposed for assessment during the present meeting, including review of national reports, fisheries trends and issues.
4. Review of management objectives and possible management strategies – i.e. review of fisheries management plans, stated management objectives and agreed, practical management strategies in order to agree on the approaches to data analyses and assessments for the present meeting.
5. Fishery data analyses and assessments.
6. Preparation of fishery and working group reports for 2008.
7. Review and adoption of working group report, including species/ fisheries reports for 2008.
8. Any other business

– Proposal to establish CRFM Working Group on Data and Methods
– Recommendations for development of stock assessment training course by UNU-FTP
– Recommendations for ICCAT-CARICOM/CRFM training workshop (LPWG item)
– Recommendations for further development and elaboration of CRFM Data Policy Outline.

9. Adjournment.

Timetable of deadlines for CRFM's Third Annual Scientific Meeting

1) Deadline for rapporteurs to advise the Secretariat and Working Group Chairpersons on the progress of inter-sessional activities, including preparations for the 2008 Scientific meeting sessions – 15 March 2008.

2) Deadline for submission of cleaned datasets to the Secretariat for review by consultants – 30 April 2008.

3) Deadline for submission of national reports – 15 May 2008.

4) Deadline for submission of completed CRFM Nominal Catch and Fleet Data Reporting Form – 15 May 2008.

5) Deadline for submission of complete first drafts of Working Group Reports – 17 June 2008.

6) Deadline for submission of approved revisions to Working Group Reports – 20 June 2008.

Appendix 2

Fourth Annual CRFM Scientific Meeting
10-20 June 2008, Kingstown, St. Vincent & the Grenadines

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Appendix 3

REPORT FOR THE CRFM LARGE PELAGIC FISHERIES RESOURCE WORKING GROUP

A. OVERVIEW

1. General Introduction

As agreed at the plenary session of the 3rd Annual CRFM Scientific meeting held in St. Vincent and the Grenadines in 2007, the Large Pelagic Fish Resource Working Group for this the 4th Scientific meeting consisted of Christopher Parker (Barbados) as Chairman, Ms. Louanna Martin (Trinidad and Tobago), Ms. Cheryl Jardine (St. Vincent and the Grenadines), Ms. Elizabeth Mohammed (Trinidad and Tobago), species rapporteur for Crevalle Jack, Dr. David Die, consultant assigned to work with the LPWG, Ms. Nancie Cummings and Dr. Todd Gedamke, both scientists from the National Marine Fisheries Service (NMFS) of the USA. Dr. Susan Singh-Renton also contributed significantly to the work of the group.

The group adopted and followed the agenda as recommended by the CRFM secretariat (Appendix 1). This report will document the discussions and recommendations for the relevant items as per the agenda. This year's meeting focused heavily on charting the directions for the LPWG, specifically in the context of identifying which large pelagic species should be assessed and identifying the most appropriate fora for such assessments.

2. Review of the progress of proposed inter-sessional activities to gather additional data and information

<u>2.1 King and Spanish Mackerel Data</u>

The Working Group was informed about some additional data on king mackerel from Venezuela that had been presented at a recent ICCAT meeting (Arocha *et al*., 2008) and which provided observer data coverage for several areas. The Working Group identified several neighbouring countries that also fished the mackerels, including Grenada, and Guyana. Although data on total catch and/or landings may be available, it was desirable to obtain CPUE data and size data, when available. It was also pointed out that data collected during the FAO LAPE project, including size data, could be useful and should be examined. The Working Group also noted that the ICCAT database was a valuable source of at least Task I nominal fleet and catch data, as all countries that reported their data to ICCAT would appear in the ICCAT database. Some Task II data were also known to be available, but these had not yet been processed within the ICCAT database.

<u>2.2 Crevalle Jack</u>

The Working Group noted that this species was carried over as proposed, and the fishery was evaluated during the 2008 meeting.

<u>2.3 Evaluation of Management Priorities for the Large Pelagic Fisheries of CRFM States</u>

Instead of a letter dispatched to Member States during the inter-sessional period, a data reporting form was developed for completion by countries. This data form was aimed at gathering data on fleet size and annual catches of large pelagic fish species to facilitate evaluation of fisheries and priorities. Few countries had responded to the request for data, and so it was agreed to examine different data sources to help in the identification of important fisheries and associated management issues.

3. Review of implementation of general recommendations made in 2007

3.1 Participation of non-CRFM countries in CRFM scientific meetings.

The CRFM continued its efforts to promote participation in scientific meetings by non-CRFM States, which, during the inter-sessional period, included informing the 2007 ICCAT SCRS meeting of current CRFM efforts with regard to assessment of small tuna species. ICCAT's SCRS recommended that scientists from the ICCAT Working Group on Small Tunas should participate in CRFM scientific meetings in order to build the collaboration required for advancing research and assessment of small tuna species. Despite these efforts, ICCAT small tuna scientists were not in attendance at this year's scientific meeting.

The Working Group considered and recommended that a joint meeting of the CRFM LPWG and ICCAT Small Tunas Working Group should take place in the near future and that it would be best to hold it at the same time as the annual on-site meeting of the CRFM LPWG. There was considerable discussion about timing of the joint CRFM LPWG –ICCAT Small Tuna Working Group meeting, the need for preparatory work by CRFM scientists, and the need for acceptance of the strategy/proposal by the Caribbean Fisheries Forum. The LPWG also acknowledged that there was competition for ICCAT resources and the timing would be dependent on the scheduling of ICCAT inter-sessional meetings. In consequence, it was agreed that it would be more prudent to aim for a joint CRFM LPWG – ICCAT Small Tuna WG meeting in 2010, and focus in 2009 on preparations of data for the joint meeting. There was some concern about national level understanding about ICCAT data reporting requirements, in preparation for this type of meeting. It was noted that the CRFM-ICCAT training workshop should address this to a large extent.

3.2 Development of Bilateral Agreements

At the technical level, the Working Group noted that FAO WECAFC had been successful at facilitating collaboration with Venezuela in the assessment of shrimp fisheries that were shared by countries located along the Brazil-Guiana shelf. Generally speaking, no formal bilateral agreement, involving neighbouring non-CRFM countries, had been established by the CRFM. The Working Group acknowledged that such agreements would require support at very senior levels of government and would depend on the priority that the Caribbean Fisheries Forum attached to these agreements.

3.3 Promotion of assessment of large pelagic resources by other regional organizations

WECAFC currently does not undertake assessment of large pelagic fish resources. At present, ICCAT is the only RFMO that undertakes assessment of several large tuna and billfish resources. During the 2007 annual meeting of ICCAT SCRS, CRFM had informed ICCAT of the analyses being undertaken during the CRFM scientific meetings.

3.4 Regional Database

The Working Group was reminded of the proposed JICA-funded project to develop a regional database for CRFM. This project had not yet begun. However, the Working Group noted that JICA was interested in examining the CARIFIS database so as to ensure that the regional database followed a similar structure.

4. Management Developments

Developments based on management advice and other developments pertaining to these fisheries (include management plans, fisheries monitoring, database management, diversifications, regulations, MCS, legislation).

4.1 National developments

4.1.1 Trinidad and Tobago – A draft fisheries policy was developed in 2007.

4.1.2 Barbados – Draft high seas and fish handling legislation were still awaiting finalization and enactment. A new Fisheries Management Plan was being drafted, but there were no anticipated changes to the section referring to large pelagic fisheries. A review of past and existing methodologies for sampling and raising catches had recently been undertaken.

4.1.3 St. Vincent and the Grenadines – A national fleet expansion program was being implemented, sponsored by the government, the National Insurance Scheme and the National Commercial Bank. The Working Group noted that applicants had to satisfy a range of criteria in order to be considered, e.g. owners and operators were to be contributors to the National Insurance Scheme (NIS) and vessels had to be registered with the Fisheries Division. To date, mostly longline fishing vessels had been registered, although gears other than longline gear were possible. These vessels were about 40 ft in length. There were about 3-5 longline vessels included in the program so far. Vessels were being sourced from Mexico and the USA. Joint ventures were being facilitated, and licensees were obliged to report data. A Vessel Monitoring System (VMS) was in effect for these vessels. Regarding its High Seas fleet, St. Vincent and the Grenadines noted that 31 vessels had been in operation during 2007, 13 of which were over 24 m LOA.

4.2 Regional developments in management – CARICOM's Common Fisheries Policy & Regime

The CARICOM Fisheries Policy and Regime (CFP&R) is being formulated to complement the Agreement establishing the CARICOM Single Market and Economy as it relates to the management of the fishing industry in CARICOM Member States. To date, a draft legislation framework had been developed, based on consultations, both national and regional. The regional consultations have been coordinated by the CRFM Secretariat, and have included legal and socio-economic reviews. The CFP&R is expected to facilitate regional collaboration in all aspects of fisheries management, including statistics, research, harvest and post-harvest technology, and monitoring, control and surveillance. The establishment of a common fishing zone and regional fishing register are also included in the present framework. CRFM Member States are still in the process of reviewing and finalizing the framework.

5. General review of fisheries trends throughout the region.

It was noted that many of the national reports submitted by countries during the course of the 4 scientific assessments did not include any reference to large pelagic fisheries. As such, little information could be garnered about the present characteristics and trends of the large pelagic fisheries for much of the region from the cadre of national reports. The group was forced to rely on more dated reports that offered some pertinent information and fleet statistics from the ICCAT database. Based on this information, a summary of trends in the development of the region's pelagic fleet was written (see Annex 1 to this report).

The group also discussed the importance of the region's recreational fleets in harvesting large pelagics. It was noted that ICCAT was becoming increasingly interested in the activities of these fleets and as such, efforts should be made to assess this component of the fishery and to monitor these fishing activities. The CRFM secretariat had distributed a questionnaire to countries earlier in the year as a first attempt at characterizing recreational fisheries. Response was again very poor and the questionnaire was submitted for review by the group before recirculation to member countries. This activity was not completed during the course of the meeting but will be undertaken again early in the inter-sessional period.

6. Review of fisheries to be assessed.

This agenda item was of particular relevance to planning for the future work and direction of the LPWG. As noted before, most national reports did not provide enough information on the large pelagic fisheries to allow determination of catch trends. In addition to this, because of the poor response, the results of the questionnaire submitted earlier in 2008 to garner information on national catch rates could not be used primarily in prioritizing the pelagic species to be assessed. As such, the group had to resort to generating other selection criteria to suggest a regional prioritized list of species to be assessed. Based on this list, the group also offered suggestions regarding the appropriate forums and timetable for stock assessments for each species identified. A detailed report of this exercise is provided in Annex 2 to this report.

7. Review of management objectives and possible management strategies.

Most national management plans and policies were not available for review at the time of the meeting. However, this topic was touched on in the first agenda item through personal communication with country representatives within the working group. It was therefore agreed that the focus would instead be on enunciating existing relevant management recommendations by ICCAT. This was summarized in Annex 3 to this report.

8. Fishery data analysis and assessments.

Given the unavailability of significant new information for the species assessed at previous meetings (viz. dolphinfish, serra Spanish mackerel, king mackerel and wahoo), no assessments of these species were attempted at this meeting.

Ms. Mohammed, with the assistance primarily of Dr. Gedamke and Ms. Cummings attempted an assessment of Crevalle jack (*Caranx hippos*). The results of this assessment are detailed in section B of this report.

Reviews of existing scientific knowledge of large pelagic species currently harvested by CRFM countries, but which are not currently assessed by ICCAT, were conducted. Summary reports were produced for Atlantic bonito (*Sarda Sarda*), frigate tuna (Auxis sp.) and blackfin tuna (*Thunnus atlanticus*) (see Annex 4). It should be noted that similar summaries for other species were provided in the reports of the previous assessments of wahoo (*Acanthocybium solandri*), dolphinfish (*Coryphaena hippurus*), serra Spanish mackerel (*Scomberomorus brasilensis*) and king mackerel (*S. cavalla*).

9. Any other business

9.1 CRFM Working Group on Data and Methods

The LPWG acknowledged that the establishment of a permanent CRFM Working Group on Data and Methods would offer the advantage of formal recognition of the role and functions of the Working Group within the overall CRFM structure. It was agreed that the Working Group on Data and Methods should have on-site meetings only when requested to do so in order to address specific tasks assigned to it by the Annual Scientific Meetings. This arrangement would make the best use of the available resources and also guarantee quality outputs.

Despite the ongoing challenge of limited work progress during the inter-sessional period, the LPWG believed that inter-sessional data preparatory tasks should, in general, not be assigned to the Working Group on Data and Methods. This was not considered feasible, as such tasks were best undertaken by national representatives who could access and study their national databases in country over a longer time period. Nevertheless, it was agreed that the Working Group on Data and Methods could be asked to resolve specific issues pertaining to data and assessment preparations.

In its review of the Terms of Reference (TORs), the LPWG recommended the omission of the first TOR and modifications to other TORS, in order to address the following concerns.

(i) Confusion of the role of the Working Group on Data and Methods with the role of the Annual Scientific Meetings in respect of primary responsibility for the interpretation of management advice needs and the provision of management advice.

(ii) Repetition of TORS covering similar tasks for data management and assessment methodologies.

9.2 UNU-FTP stock assessment course

In discussing this item, the LPWG assumed that the target audience for the short course would be the fisheries officers in CRFM countries, as this would address a more immediate need. The delivery format, duration, content, and timing of the course would depend on the target audience.

9.2.1 Target audience, delivery format and duration

Fisheries officers would be the preferred target audience. In this case, it would be more appropriate to offer a short course with a modular delivery format: this would address the need to offer a range of training, depending on the needs of officers, e.g. basic and advanced. It was pointed out that the basic training module could run for a longer period of time without negative impact on the work commitments of junior fisheries officers. There was also some discussion about the period for repeating the training modules; it was suggested that the full set of modules could be delivered either over a 1 or 2 year period, after which time the course would then be repeated.

To ensure that trainees were able to benefit from the short course, it was agreed that prerequisites would be necessary. Moreover, if UWI was to be involved, consideration should be given to agreed forms of UWI accreditation.

9.2.2 Course Content

It was suggested that a basic training module should include topics such as: data management; data handling and standardization, including how to have variables set up; fisheries CPUE standardization; and stock parameter estimation. If possible, data managers should also be given the opportunity to receive this basic training.

The LPWG recognized that a wide range of topics could be covered in an advanced training module, for example, advanced statistics, production models, VPA (length and age-based), and multi-species approaches. Given the range of possible topics, the LPWG recommended that a priority list be developed, based on immediate application needs across the region.

It was further noted that training needs could change over time, and so course planning should include periodic review and revision. Consideration should also be given to the possibility of linking the UNU-FTP training course with additional training opportunities offered by other institutions and agencies.

9.2.3 Timing

There were no suggestions about the timing of the course, although the LPWG recognized that it should not conflict with the Annual Scientific Meetings.

9.3 ICCAT-CARICOM/CRFM Training Workshop

The LPWG recalled that the goals of the workshop, as proposed by ICCAT, were to improve the data reported to ICCAT by CARICOM Member States and to improve the participation of these countries in the technical activities of ICCAT. It was also pointed out that the training workshop format was similar to that successfully used by ICCAT for such training in West Africa.

The LPWG reviewed the format and content proposed by ICCAT and found it to be acceptable. As such, there were no modifications.

9.4. Data Policy Outline

The LPWG made no further additions to the Data Policy Outline, but noted that the policy should not impose additional burdens on countries in respect of data collection and data management activities.

10. Recommendations

Specific recommendations have been included in each of the detailed agenda item reports included as annexes to this report. Following is a summary of these recommendations.

- CRFM countries are encouraged to monitor the activities of their recreational fleets with the aim of collecting sound landings records that can contribute to future stock assessments.

- Historical fleet statistics are important data necessary for understanding landings trends. Neither the FAO nor ICCAT databases provide sound records of national fleet statistics. CRFM countries are therefore urged to gather whatever historic data they can on their fleets and provide these to the CRFM secretariat to advise future fishery and stock assessment work.

- Based on the prioritization exercise as explained in Annex 2, the Working Group recommends that:
    - A dolphinfish assessment be conducted in 2009, and;
    - Assessments of serra Spanish mackerel and blackfin tuna be conducted in 2010 at a joint meeting of the CRFM LPWG and the ICCAT Small Tunas Working Group.

- In relation to ICCAT, it is recommended that CRFM countries continue to cooperate with ICCAT at all levels possible at least in the collection and provision of relevant data of species of interest. To this end, the group was supportive of the proposed regional training workshop in data collection and reporting being offered by the ICCAT secretariat.

- For blackfin tuna, although no solid information is available on stock structure, it is suggested that assessments proceed based on a Western Central Atlantic stock hypothesis. In this case, collaboration of CRFM with the French Antilles islands and the US should at least be sought. Ideally, collaboration with other countries that land large quantities of blackfin tuna such as Venezuela and Cuba in this regard would be much preferred. It should also be noted that a significant proportion of scientific studies of this species has been conducted in the French Antilles and Cuba.

- A genetic study, specifically intended to assess the stock structure of blackfin tuna across the region should be conducted. The UWI should be approached in this regard and CRFM should consider seeking funding for the study.

- CRFM countries, particularly Grenada, involved in the blackfin tuna fishery, should encourage assessment of the status of this species and to this end, it is suggested that the following data and information be collected:
  - Collection of new catch and effort data and collation of any other historically available records that may allow for the estimation of relative abundance indices.
  - Focused morphometric studies that would include collection of data such as length, weight, gonadosomatic indices (GSI) and reproductive state covering a period of at least one year.
  - All historic catch and effort data should be supplied to the CRFM Secretariat for consideration during future stock assessments.

- Before assessments of frigate tuna (Auxis sp.) or bonito (*Sarda sarda*) could proceed; accurate estimates of total harvest for the stocks need to be obtained; it is therefore urgently needed to review landings of this species for the entire Caribbean area. In this regard, it is important that species be properly identified and catches appropriately reported.

- Reconstruction of historical landings has been carried out by Mohammed and national scientists for Barbados, St. Lucia, Trinidad and Tobago, St. Vincent and the Grenadines and Grenada. Although these authors have not provided landings by species in their publications, these are available and could be made available to the CRFM and ICCAT.

ANNEX 1

THE LARGE PELAGIC FISHERIES OF THE CRFM

General description of regional large pelagic fisheries

The region's fishing fleets have traditionally harvested large pelagic fish resources for centuries. The small, undecked vessels that comprised the majority of the island fleets primarily caught these species opportunistically on single-hook trolling gear on fishing trips for small coastal pelagics. Dolphinfish, wahoo and the smaller shelf-associated tuna species such as skipjack and blackfin tuna were usually caught in this manner by most of the regions fleets. In contrast to the other Caribbean Islands, Barbadian fishing fleets have always focused more on the pelagic fisheries, particularly flying fish and the associated large pelagics, principally dolphinfish and wahoo. These species were targeted initially by sail powered vessels, followed by small decked fishing launches (dayboats) from the latter half of the 1950's and finally by slightly larger ice-carrying decked launches known simply as "iceboats" from the late 1970's.

With these fleet improvements, which afforded expanded fishing ranges and periods, landings of these large pelagic species would have increased. However, it was primarily with the introduction of surface longline gear that it may be said that there was a concerted effort to increase landings of the tuna and billfish species. Records indicate that the Barbados Fisheries Division first experimented with longline gear from as early as the late 1950's. The feasibility of using longline gear in the region was further tested during a 1969-1973 joint UNDP/FAO fisheries project. Ironically that study concluded that the gear would be uneconomical due to small catches of the more valuable species. Development of the region's longline fishery followed a number of different paths peculiar to each of the islands. Some examples of these development paths are detailed in the next section.

Recent fleet statistics on vessels that target large pelagics for most of the CRFM countries were not available at the time of the meeting. However, Mahon (2004) provides a "snapshot" view of the characteristics of the pelagic fishing fleets and the fisheries in general for the region as of 2001 and the working group updated these figures for some of the major fleet types (Table 1). The Taiwanese longliners that operate out of Trinidad are not included as these vessels are not locally owned and only use Trinidad as a transshipment port. Based on this information it can clearly be seen that the region's present-day large pelagic fishing fleet is heterogeneous in vessel and gear design and fishing techniques. There is incomplete knowledge on how the major fleets have developed. However, it seems that the total number of longliners and the number of countries with longline fleets have progressively increased since the late 1980s, when there were only two countries with local longline fleets, to now, when the presence of longliners is confirmed for eight countries.

National indigenous fleet development

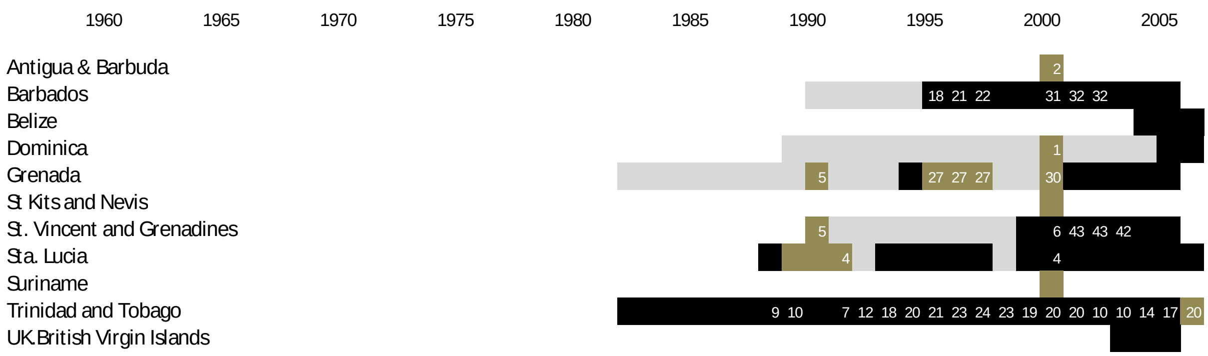
Grenada

The general concept of longline fishing appears to have been introduced to Grenada through the donation by Cuba in 1980 of 4 ferro-cement longline vessels. A non-mechanized technique with the gear being stored in boxes rather than on a reel was employed on these vessels. From 1982 longline fishing was further promoted through the Artisanal Fisheries Development Project funded by the International Fund for Agricultural Development (IFAD) and technical support from the Venezuelan investment fund (Mohammed and Rennie, 2003). Additional interest in longline fishing was generated by the operation of a few US longline fishing vessels in Grenada (Weidner *et al.*, 2001). Recognizing the potential value of the longline fishing techniques, local fishers eventually adopted a cost-efficient arrangement whereby they attached two short longlines stored on reels to the back of their pirogues. Given the narrow shelf on the leeward side the island, the vessels need not travel for long to reach deep-water large pelagic fishing grounds and as such, need not carry ice. Thus this unique artisanal longline fleet has grown rapidly in Grenada. In addition to the somewhat unique artisanal longline fleet, in 1991 JICA donated to the

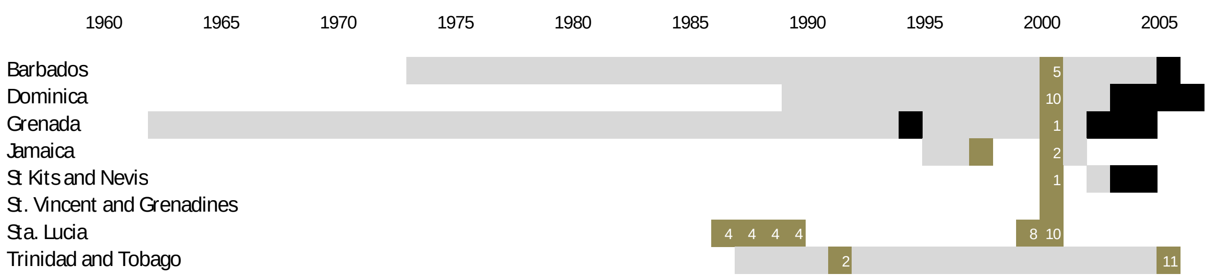
Government eight 36ft custom-built GRP fiberglass longliners with ice-holds for the catch (Samlalsingh *et al*., 1995; Finlay and Rennie, 1998). In 1992 these vessels started actively fishing thus commencing the development of the more conventional longliner fleet for the island.

Table 1: Evolution of longline and handline/trolling fleets that target large pelagic in CRFM countries. Black cells correspond to years when countries have reported the presence of vessels to ICCAT, dark grey when reports of the presence of vessels have been made elsewhere in other documents. Light grey cells correspond to reports of catches of large pelagics to ICCAT for either unclassified gear or surface gear, possibly indicating the start of pelagic longlining or handline/trolling. Numbers in cells correspond to numbers of longline vessels or 100s of vessels for the handline and troll fleet.

Longliners



Handline and troll



Barbados

From 1983 US longliners started successful operations in the region, effectively disproving the implied non-viability of such a fishery as previously opined by the 1967-1973 UNDP/FAO fisheries project. The successes of these vessels peaked interest in this fishing method and a large number of requests for loans to finance longliners prompted the Barbados Development Bank to commission a feasibility study for development of this fishery. The study concluded that the fishery could be economically viable provided that vessels of between 40' to 50' LOA were used. In 1990 the feasibility of a number of fishing techniques including longline gear was examined through a comprehensive institutional strengthening project for the fishing industry undertaken by Crown Agents. The vessel used in the project became the first long liner in the Barbados fishing fleet.

St. Vincent and the Grenadines

In 1991 a JICA project to develop the fishing industry of St. Vincent and the Grenadines included the donation of five 42 ft longliners. The St. Vincent Fisheries Division retained one vessel and the other 4 vessels were leased to local fishers. In addition to this truly local level development, the registration and thus flagging of foreign vessels under its open-registry effectively ascribed a large longliner fleet to St. Vincent and the Grenadines.

St. Lucia

The fleet targeting pelagic fish developed in earnest by the late 1980s and early 1990s when longliners of 9~15 m length were introduced in the fishery with the support of the Japanese Government (Mohammed and Joseph, 2003). Later, smaller pirogues and fiberglass boats started targeting pelagic fish by using sub-surface tuna longlines, bottom horizontal and vertical longlines (Mohammed and Joseph, 2003).

Trinidad and Tobago

Large pelagic fish are caught by a number of different fleets. In Tobago, flying fish vessels will use trolling on the way to their flying fish fishing grounds to target large pelagic fish. These vessels were fiberglass pirogues in the late 1970s but since the late 1980s have been replaced by larger iceboats. All use gillnets for targeting flying fish that have aggregated around FADs (Mohammed and Chang A Shing, 2003). In Trinidad, mackerel are primarily landed by the artisanal multigear fleet that uses 7-10 m pirogues with outboard engines and the semi-industrial multigear fleet that uses vessels of 14-20 m, powered by inboard diesel engines. Larger tunas are mainly landed by the semi-industrial longline fleet, a fleet of 20 longliners ranging in size between 14-23 m.

Recommendations

Historical fleet statistics are important data necessary for understanding landings trends. Neither the FAO nor ICCAT databases provide sound records of national fleet statistics. CRFM countries are therefore urged to gather whatever historic data they can on their fleets and provide to the CRFM secretariat to advise future fishery and stock assessment work.

ANNEX 2

Identification of most important pelagic resources for CRFM assessments

In order to review the assessment priorities for the working group, several indicators were developed.

Aggregate landings
The first indicator was the aggregate landings of CRFM countries for each pelagic species in the period 1990-2008. The species considered were further divided into two groups, those regularly assessed by ICCAT (viz. albacore, yellowfin tuna, bigeye tuna, skipjack, bluefin tuna, swordfish, blue marlin, white marlin, sailfish, blue shark and mako shark) and those species that have not been assessed by ICCAT either because of their low priority (viz. small tunas, spearfishes, mackerels and other sharks) or because they are not under ICCAT's management (eg. dolphinfish, carangidae). An additional indicator used was the evenness index of Pielou applied to landings by country instead of species counts. Landing estimates were obtained from the ICCAT, FAO and World Around Us databases.

Landing trends
Estimates of the historical landings from CRFM countries were obtained from ICCAT reports, and examined to see the trends in CRFM landings and of landings from individual countries.

Previous regional assessments
Another indicator was whether a stock had been previously assessed at the regional level, the nature of that assessment and its conclusions regarding future assessment needs.

Country priorities
Scientists from countries participating in the meeting were asked to rank the three pelagic species (among those not regularly assessed by ICCAT) that they would consider to have greater priority for assessment. Given these ranks, species were given an overall rank on the basis of how many number 1 rankings, number 2 rankings and number 3 rankings they were given.

Results
Of the species regularly assessed by ICCAT those species with the largest landings are yellowfin tuna, albacore tuna, skipjack and sailfish (Figure 1, Table 1). Of the species not regularly assessed by ICCAT, the largest landings come from Serra Spanish mackerel, dolphinfish, king mackerel and wahoo (Figure 2, Table 1).

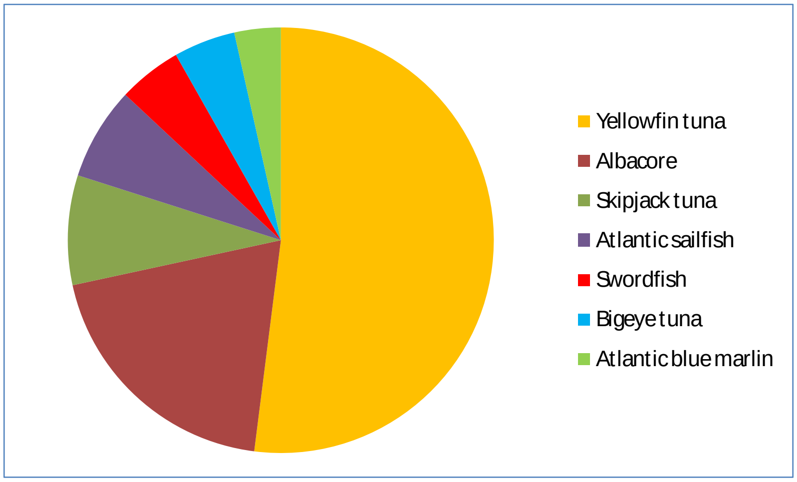


Figure 1: Species regularly assessed by ICCAT landed by CRFM countries with the highest reported landings for the period 1990-2006. Landings estimates are from ICCAT Task I.

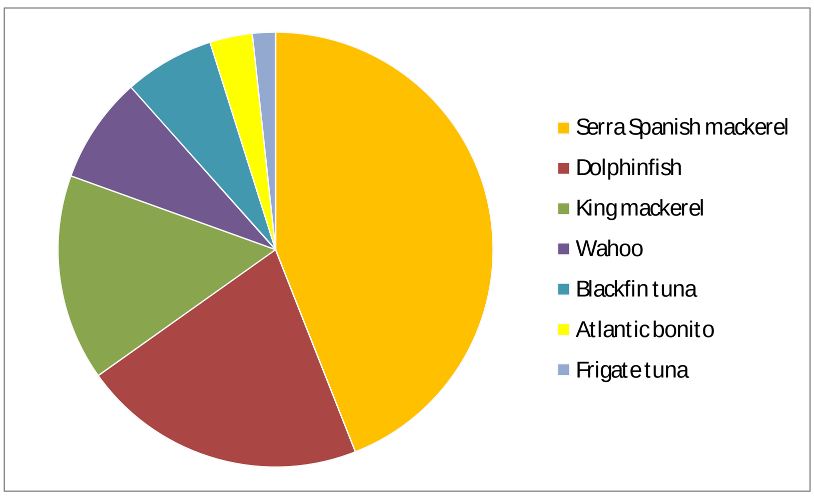


Figure 2: Species landed by CRFM countries with the highest reported landings that are not regularly assessed by ICCAT for the period 1990-2006. Landing estimates are from ICCAT Task I but dolphinfish landings are estimates from FAO.

Table 1 ICCAT Task I reported catch for all CRFM countries for the period 1990-2006 (tons). Species codes in bold type are those that are regularly assessed by ICCAT, and those that are underlined correspond to species groups where many species are reported together.

40,432	*Scomberomorus brasiliensis*	Serra Spanish mackerel
32,055	*Thunnus albacares*	Yellowfin tuna
21,176	Squaliformes	Dogfish sharks, etc. nei
15,664	Thunnini	Tunas nei
14,089	*Scomberomorus cavalla*	King mackerel
12,091	*Thunnus alalunga*	Albacore
7,282	*Acanthocybium solandri*	Wahoo
6,153	*Thunnus atlanticus*	Blackfin tuna
5,223	Selachimorpha (Pleurotremata)	Various sharks nei
5,130	*Katsuwonus pelamis*	Skipjack tuna
4,345	*Istiophorus albicans*	Atlantic sailfish
2,979	*Xiphias gladius*	Swordfish
2,906	*Sarda sarda*	Atlantic bonito
2,889	*Thunnus obesus*	Bigeye tuna
2,162	*Makaira nigricans*	Atlantic blue marlin
1,565	*Auxis thazard*	Frigate tuna

According to reported landings (Table 2) for 1990-2006, a few species are landed by a large number of countries, namely wahoo, blackfin tuna and dolphinfish and have large evenness indices. Mackerels (*S. cavalla* and *S. brasiliensis*) are mainly landed by Trinidad and Tobago and Guyana, whereas bonito (*Sarda sarda*) and frigate tuna (*Auxis thazard*) are mainly landed in Trinidad and Tobago. These other species therefore have lower evenness indices.

According to the opinions of scientists at the meeting the highest priority species for assessment would be in the following order of priority: dolphinfish, serra Spanish mackerel, wahoo, king mackerel and blackfin tuna (Tables 3 and 4).

Table 2: For each species percentage of the 1990-2006 CRFM landings reported by each country. All landings are those reported to ICCAT except for those for dolphinfish that are from Kleisner (2008). BRS (Scomberomorus brasiliensis), KGM (*Scomberomorus cavalla*), WAH (*Acanthocybium solandri*), BLF (*Thunnus atlanticus*), BON (*Sarda sarda*), FRI (*Auxis thazard*), DOL (*Coryphaena hippurus*). Evenness index is derived from Pielou's index, the greater the index the more catches are spread among countries, therefore the more "shared" is the species.

	BRS	KGM	WAH	BLF	BON	FRI	DOL
EVENESS INDEX	0.13	0.23	0.54	0.33	0.13	0.01	0.39
Anguilla							
Antigua and Barbuda		<1	<1				<1
Barbados			21		<1		58
Bahamas							
Belize							
Dominica		1	8	7	1		4
Grenada		<1	17	70	3	<1	13
Guyana	13	21					
Haiti							
Jamaica		<1		2	<1		
Montserrat							
Saint Kitts and Nevis			<1				1
Suriname							
St. Vincent and Grenadines		<1	12	4	2		
Sta. Lucia		<1	34	16	1		24
Trinidad and Tobago	87	71	2	<1	93	99	
Turks and Caicos			<1				
UK Virgin Islands		<1	<1	<1			

Table 3. Rankings given by scientists participating at the meeting and representing CRFM countries. Scientists were asked to rank the three most important pelagic species for their country to be assessed by the LPWG, disregarding those species regularly assessed by ICCAT.

	BRS	KGM	WAH	BLF	BON	FRI	DOL
Anguilla							
Antigua and Barbuda							
Barbados			2				1
Bahamas			2				1
Belize		2	1				3
Dominica							
Grenada			2	3			1
Guyana	1	2					
Haiti							
Jamaica							
Montserrat							
Saint Kitts and Nevis							
Suriname	1	2					
St. Vincent and Grenadines			3	2			1
St. Lucia			2				1
Trinidad and Tobago	1	2					3
Turks and Caicos			1				
UK Virgin islands							

Table 4: Overall rankings obtained from those provided by scientists and frequency of #1, #2 and #3 ranks provided by scientists (see table 3).

		Frequency of ranks		
Species	Overall rank	#1	#2	# 3
DOL	1	4		2
BRS	2	3		
WAH	3	2	3	1
KGM	4		4	
BLF	5		1	1
BON	Not ranked			
FRI	Not ranked			

Regional assessments have been conducted on these stocks as part of the work conducted by CRFM for dolphinfish, wahoo, serra Spanish mackerel and king mackerel (Table 5). All assessments concluded that significant improvements in the evaluation of stock status are constrained by the need to extend the data available to other fleets that harvest the same stock but for which data were not available at the assessment meeting. Exclusively on the basis of whether stocks have been already assessed these species can be given ranks of 1 (never assessed), 4 (assessed once) or 6 (assessed more than once).

Table 5: Summary of assessments conducted by CRFM, including the year when assessments were conducted, the countries that provided most of the data for the assessment, the years of data available for the abundance index, the assessment method used and the most recent recommendation regarding the desired course of action for future assessments.

Species	Year	Data sources	Years of data	Assessment methods	Recommended Assessment need
DOL	2006	St. Lucia, St. Vincent, Barbados	95-04	Relative Abundance trends	Relative abundance indices from other fleets
BRS	2004	T&T	77-03	ASPIC	Relative abundance indices from other fleets
WAH	2004 2007	Dominica, Barbados, St. Lucia, St. Vincent, Grenada Barbados, St. Lucia	94-03	Relative Abundance trends	Extend relative abundance trends to other fleets and further back in time
KGM	2006 2007	T&T T&T	96-98, 04 06-07	Yield/Recruit Yield/Recruit	Data on size structure from other fleets

The group summarized all these indicators to provide some guidance regarding the assessment workplan for the LPWG (Table 6).

Table 6. Indicators (ranks) used to prioritize the species with the greatest priorities for the workplan of the LPWG.

Species	Landings	Evenness	Scientists	Already Assessed
DOL	2	2	1	4
BRS	1	5	2	4
WAH	4	1	3	6
KGM	3	4	4	6
BLF	5	3	5	1
BON	6	6	6	1
FRI	7	7	6	1

Recommendations

Given the collection of indicators, the working group recommended that:

- a dolphinfish assessment be conducted in 2009, during the CRFM annual scientific meeting and;
- assessments of Serra Spanish mackerel and blackfin tuna in 2010 at a joint meeting of the CRFM LPWG and the ICCAT Working Group on Small Tunas.

ANNEX 3

Review of status of and management recommendations for species actively managed by ICCAT

Yellowfin tuna

Based on its assessment of yellowfin tuna conducted in 2003, the SCRS inferred that effective effort may have been either slightly below or above (up to 46%) the Maximum Sustainable Yield (MSY) level, depending on the assumptions. It was also found that an increase in effort would likely decrease the yield-per-recruit, while reductions in fishing mortality on fish less than 3.2 kg could result in substantial gains in yield-per-recruit and modest gains in spawning biomass-per-recruit. Reductions in catches since 2001 were recognized. However, the SCRS cannot confirm the cause of the decline (e.g. stock level declines, reductions in effort or other factors) until a full stock assessment is completed. The next full stock assessment is scheduled for 2008. The management measure in force for the species states that fishing effort on yellowfin tuna should not exceed the 1992 level [Rec. 93-04]. Additionally, recommendation 04-01, which was intended to reduce small bigeye catches by the implementation of a closure for surface fishing in the area 0º - 5º N, 10º W- 20º W during November in the Gulf of Guinea, is expected to impact catches of yellowfin and of other tropical tunas.

Northern Albacore

A stock assessment was conducted in 2007. It was determined that the stock was overfished. Northern albacore spawning stock is believed to have declined to a size that is currently about one quarter of the peak spawning stock levels estimated for the late 1940s, although the spawning stock biomass recently rebuilt to levels near the biomass at MSY (SSB is approximately 20% below the SSB_{MSY}). The current fishing mortality is approximately 50% larger than F_{MSY}. Total annual albacore average catch was 50,000 t during 30 years (1956-1986), which is higher than the current MSY estimated at about 30,200 t. A Total Allowable Catch (TAC) of 34,500 t was in place until 2007. It was noted that the reported 2001-2004 catches were below the TAC, but that 2005 and 2006 catches were above TAC. The assessment also indicated that the stock will not recover from the overfished conditions if catch levels remain over 30,000 t. The implementation of a reduced TAC is recommended to allow the stock to recover. The management measure currently in force limits fishing capacity to the average of 1993-1995 levels.

Southern Albacore

The stock was assessed in 2007. It was concluded that the spawning stock has declined to about 25% of its unfished level and that it is likely that the stock biomass is currently below the level at MSY; Biomass (B) is estimated to be at about 90% of B_{MSY}. Fishing mortality (F) was estimated at about 60% of F_{MSY} in 2005. MSY was estimated to be around 33,300 t. A TAC of 29,200 t was in place until 2004; the catches reported for 2005 (also 2006) did not exceed the TAC. It was determined that catches around the 2006 level (24,460 t) will recover the stock.

Skipjack tuna

The last stock assessment was carried out in 1999. There have been, since then, some signs of local over-exploitation. Maximum sustainable yield, biomass and fishing mortality rates have not been estimated for either the east or west stocks. There are no management measures in force for the species.

North Atlantic Swordfish

The 2006 assessment of North Atlantic swordfish showed an increase in biomass. It was surmised that this increase may have resulted from strong recruitment in the 1990s in combination with lower reported catches since that time. Biomass analyses show that the status of North Atlantic swordfish is close to the Convention objectives. A TAC of 14,000 t is currently in place for the species. It is recommended that this TAC be continued in order to maintain the northern Atlantic swordfish stock close to a level that would produce MSY. Additionally it is indicated that this TAC should be sustainable into the future, and it reflects the maximum yield that could be harvested from the population under existing environmental and fishery conditions. The management measures currently in effect for North Atlantic Swordfish also indicate country-specific catch limits [Rec. 02-02]; and prescribe a minimum size of 125/119 cm LJFL.

South Atlantic Swordfish
After the 2006 assessment it was concluded that the stock is in good condition. However it is pointed out that further research is required to better utilize the available data. The biomass was likely above B_{MSY} and the estimated MSY was 33% higher than current reported landings. It was recommended that the annual catch should not exceed the estimated MSY (17,000 t). A minimum size of 125/119 cm LJFL [Rec. 02-02] is in force for the stock.

Bigeye tuna
Bigeye tuna was last assessed in 2007. At the beginning of 2006 the biomass was estimated to be slightly lower than the biomass at MSY (92% of B_{MSY}) and the fishing mortality rate was estimated to be slightly (13%) below the fishing mortality rate at MSY. The stock appeared to have declined during the 1990s and to have stabilized in recent years at around or below the level that produces MSY. This was as a result of a large reduction in reported catches. There is a concern, however, relating to unreported catches from the Atlantic. Illegal, Unreported, and Unregulated (IUU) longline catches were estimated from Japanese import statistics but these statistics are considered uncertain. A TAC for 2005 was set at 81,400 t for major fishing countries and entities. The number of fishing vessels should be less than the average of 1991 and 1992. There are limits on the number of longline vessels for China (45), Chinese Taipei (98) and the Philippines (8), and limits on the number of purse seine boats for Panama (3). Additionally, fishing is prohibited during the month of November for purse seine and baitboats within the area encompassed by 0º-5ºN and10º-20º W.

Blue/White marlin
The stocks were most recently assessed in 2006. For both stocks, both the biomass and fishing mortality rates were estimated to be at unfavourable levels, i.e. biomass was estimated to be below B_{MSY} and fishing mortality rate was estimated to be above F_{MSY}. Abundance appears to have continued to decline, though confirmation of these trends will require at least an additional four or five years of data. ICCAT Recommendations [Rec. 00-13], [Rec. 01-10] and [Rec. 02-13] establish catch restrictions for both blue marlin and white marlin. The annual amounts that can be landed by pelagic longline and purse seine vessels "must be no more than 33% (for white marlin) and 50% (for blue marlin) of the 1996 or 1999 landing levels, whichever is greater". Recommendation 02-13 also prescribes that, "All blue marlin and white marlin brought to pelagic longline and purse seine vessels alive shall be released in a manner that maximizes their survival".

ANNEX 4

REVIEW OF KNOWLEDGE ON SELECTED LARGE PELAGIC SPECIES FOUND IN THE CRFM AREA

1. Auxis sp.

Auxis sp. is widespread in the western Atlantic with an uninterrupted distribution from the Rio de la Plata in Argentina to the northern US coast, including the entire Caribbean and the Gulf of Mexico (Valeiras and Abad, 2006a). Surprisingly, many more CRFM countries report catches of *Sarda sarda* to ICCAT than of Auxis sp., the exception are T&T and Grenada that report and separate catches of both species (Figure 1). Jardine and Straker (2003) do not report catches of Auxis sp. in their review of landings for (1998-2002) from St. Vincent and the Grenadines.

A number of non-CRFM countries in the Western Atlantic report catches of frigate tuna to ICCAT. These include Venezuela (1950-2006), USA (1968-69), Panama (1991-97 and 2004-2007), Netherland Antilles (1996-2007), Brazil (1982-2006) and Argentina (1967-68). Reports from Panama, Netherland Antilles and part of the reports from Brazil and Venezuela are from purse seiners, so some of these catches may have been made in the Eastern Central Atlantic.

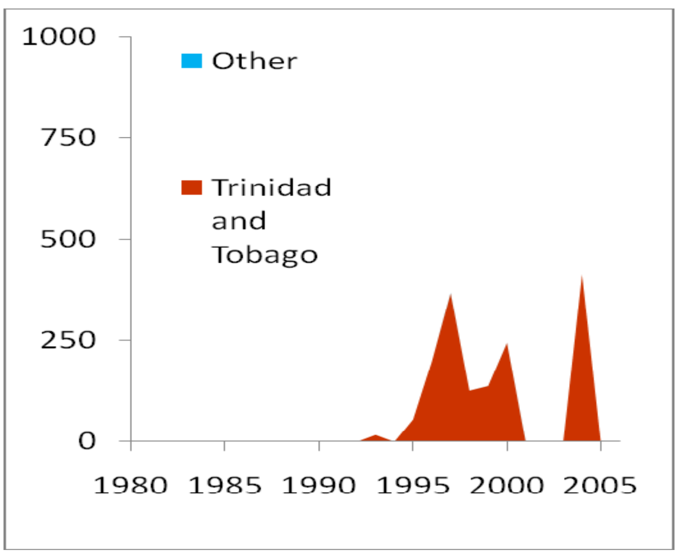


Figure 1. Catches of Auxis sp. (FRI) by CRFM countries reported to ICCAT as task I data.

No reports exist of landings of Auxis sp. by CRFM countries in the Sea Around Us project database. However, *Auxis thazard* is caught around FADs in Martinique and used as bait in drifting handlines that target large tuna and marlins (Reynal *et al*., 2006) but is also often landed and sold (Reynal pers. comm.).

Marcano *et al*. (1994) does not mention catches of Auxis sp. in their review of the pelagic fleet from Margarita Island, that otherwise catches all other pelagic species, including large tunas, sharks, billfish, mackerels, dolphinfish, and wahoo. On the other hand, there are reports of small catches of frigate tuna made during 1989-1995 on board Venezuelan baitboats (Salazar *et al*., 1997) and purse seiners (Marcano *et al*. 1997a) that target yellowfin tuna. Frigate tuna caught on board these purse seiners were between 28 and 58 cm long with a mode of 40 cm and represented between 1 and 4% of the total purse seine catch (Marcano *et al*., 1997a). During the same period an analysis of the catches of Venezuelan longliners showed no catch of frigate tuna (Marcano *et al*. 1997b). Frigate tuna are regularly caught by the gillnet fleet of north central Venezuela (Marcano *et al*., 2001) and during 1988-1995 the species represented 9% (FRI) of the overall landings from this fleet. FAO statistics do contain reports of frigate tuna catches for Venezuela.

Table 1: Species associated with the vernacular name frigate (tuna or mackerel), melva or Auxide in the wider Caribbean region. Data obtained from FAO, Fishbase and ICCAT.

Scientific name	CRFM Country	Other Caribbean countries
Auxis thazard		Cuba, Mexico, Puerto Rico, USA
Auxis rochei	Barbados, Trinidad and Tobago	Cuba, Mexico

Biological notes

Larvae of Auxis sp., although uncommon, were found in the Northern Caribbean in February, March, May, July and August but were not found in November and December (Richards, 1984; Hare *et al*., 2001). Nishikawa and Kikawa (1983) report finding in June-September, 37 and 76 frigate tunas inside the stomachs of 27 yellowfin tunas and 42 white marlin respectively caught by longliners in the Northwestern Atlantic (30 N and 41 N and 60 W and 78 W). The range of lengths (SL) of these tuna was 7- 29 cm with a mode at 12 cm. No frigate tuna were found in bluefin tuna stomachs from fish caught in the Gulf of Mexico during March.

Discussion and recommendations

Although the FAO and ICCAT accepted names for *Auxis thazard* are frigate tuna, Auxide and Melva, and often is referred as bonito, there are also a variety of vernacular names including in Brazil (Albacora-bandolim, Bonito-cachorro, Cachorro, cachorinha Cadelo, Cavala, Judeu, Serra), Colombia (cachorra), Mexico (barrilete negro), Martinique (Bonite queue raide), USA (frigate mackerel, bullet mackerel) and Venezuela (Cabana negra). In the Caribbean region, the vernacular denominations frigate tuna, frigate mackerel, melva are rather specific and only refer to species of Auxis (Table 1). Unfortunately several countries do use the vernacular name "bonito" to refer to Auxis sp, therefore possibly creating reporting problems. Additionally, it is clear that some frigate tuna are likely to be reported as unclassified tuna.

Before assessments of frigate tuna can proceed; accurate estimates of total harvest for the stock need to be obtained. Consequently, there is an urgent need to review landings of this species for the entire Caribbean area. Reconstructions of historical landings have been carried out for Barbados (Mohammed *et al*., 2003a), St. Lucia (Mohammed and Joseph 2003), Trinidad and Tobago (Mohammed and Chang A Shing 2003), St. Vincent and the Grenadines (Mohammed *et al*., 2003b) and Grenada (Mohamed and Rennie 2003). Although these authors have not provided landings by species in their publications, these are available (Mohammed E. pers. comm.) and could be made available to the CRFM and ICCAT.

2. Blackfin tuna (*Thunnus atlanticus*)

The fishery

The landings of blackfin tuna differ markedly among countries within the known geographic range of the species (Figure 2). The highest quantities of the species are landed by Venezuelan fishing fleets. The southeastern coast of Cuba is known to be one of the richest fishing grounds for the species. Among the Eastern Caribbean countries, by far the largest recorded quantities of blackfin tuna are traditionally landed in the French Islands of Martinique and Guadeloupe followed by Grenada, with Grenada taking the most blackfin tuna amongst the CRFM member countries (Figure 3). The species is often taken along with skipjack tunas (*Katsuwonus pelamis*) with which it often forms mixed schools.

The species is caught by a number of gears. In Cuba, blackfin tuna are mainly taken by live bait and jackpole. In Venezuela, in addition to baitboat fishing, blackfin tuna are taken on long lines and in purse seines (Cabello *et al*., 2003). In the Eastern Caribbean the species is mainly taken by trolling over coastal shelf areas. The animals are also found around sea mounts, drifting objects and moored-FADs; facilitating their capture by simple trolling gear in these deeper waters as well (Taquet *et al*., 2000). In fact, Laurans *et al*., (2000) report that the blackfin tuna landed at Martinique are mainly taken by trolling around FADs or over seamounts. Blackfin tuna are also an important species for the sports fisheries of the Bahamas and Florida.

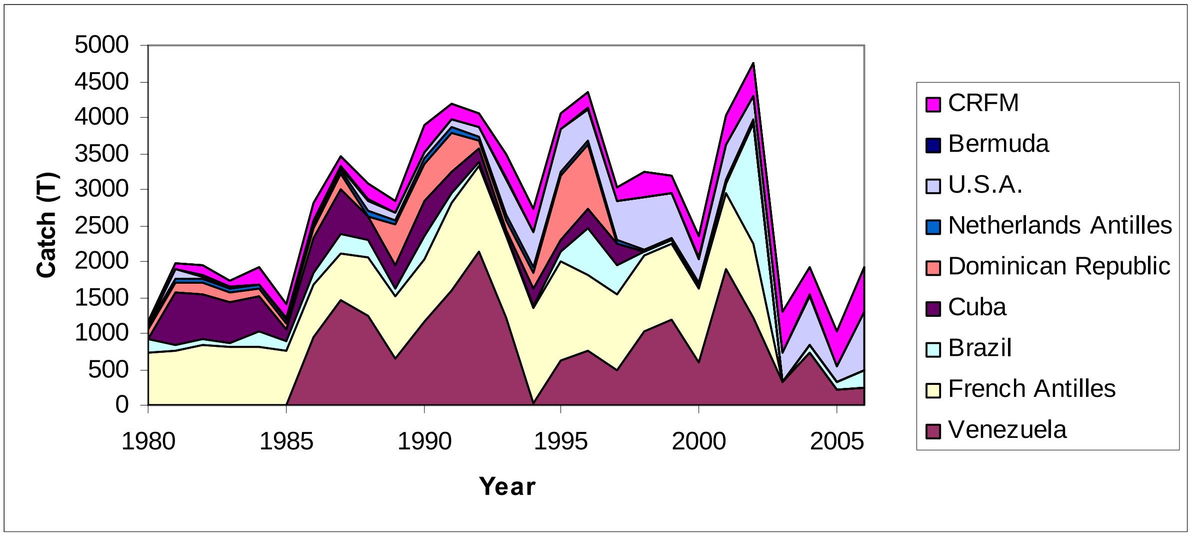


Figure 2 Cumulative nominal landings of *Thunnus atlanticus* reported to ICCAT (1980-2006)

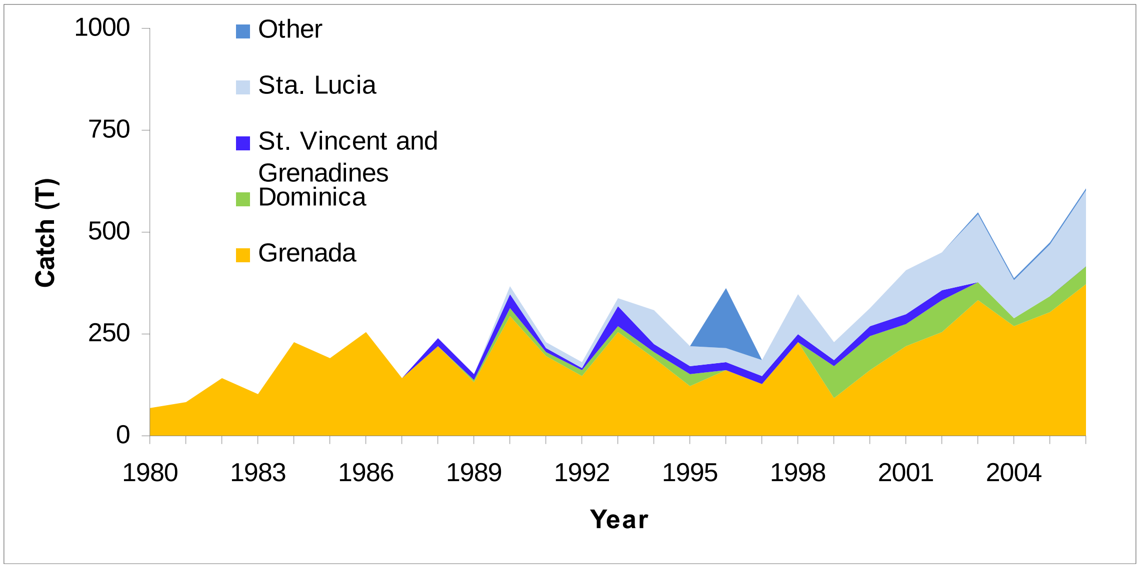


Figure 3 Cumulative nominal landings of blackfin tuna of CRFM member countries reported to ICCAT for the period 1980 to 2006.

<u>Biology</u>
Blackfin tuna reach a maximum size of around 108 cm (FL) and 20.6 kg in weight. However, most are taken at an average size of approximately 50 cm (FL) and a weight of about 3.2 kg. Maturity is reached at around 40-50 cm (FL). The blackfin tuna may live past 5 years of age. Growth rates have been reported at 1-1.5 cm per month.

Blackfin tuna are known to consume a varied diet including surface and deep-sea fishes, squids, amphipods, shrimps, crabs and Stomatopods and Decapod larvae. Dolphinfish, blue marlin and skipjack tuna are known predators of blackfin tuna. Spawning is believed to occur offshore in oceanic waters.

Distribution and Stock Structure

Blackfin tuna is a highly migratory, warm-water species known to migrate into more temperate waters during the summer months. It is believed that the species is confined to coastal waters warmer than 20ºC (Collette and Nauen, 1983). Blackfin tuna are commonly believed to occur only in the western Atlantic Ocean from Massachusetts (USA) (Mather and Shuck, 1952) south to Rio de Janeiro (Brazil) (Mather and Day, 1954), including the Caribbean (Bullis and Mather, 1956, Boobe and Tee-Van, 1936) and the Gulf of Mexico. However, one report indicates the presence of the species off the Canary Islands (Laboratorio Oceanografico de Canarias, 1974).

No clear information could be found on the stock structure of blackfin tuna. By default, without clear information to the contrary, a single unit stock of the entire Caribbean basin and Gulf of Mexico i.e. the species known geographic range would be ordinarily assumed.

Although the evidence may not be strong, there is enough circumstantial information to indicate that separate intra-regional stocks of blackfin tuna may exist. The existence or level of mixing between the stocks is unknown. Given the known current patterns through the Caribbean, it seems reasonable to envisage that larvae produced off Brazil would become entrained in the South Equatorial current and taken more along the South American coast and away from most of the Caribbean islands. As such the source point or points of larvae for the Caribbean must be located further northwards. With no clear additional information it may seem appropriate to presume the existence of at least two stocks viz. a north and south stock defined by using the 5ºN latitude as a possible separation line, similar to the one recently proposed by ICCAT for Atlantic sailfish.

Reproduction

Vieira *et al*. (2005) reported that the coastal waters off Northeast Brazil probably serve as a breeding ground for blackfin tuna. The animals are found in highest abundances in that area during the second half of the year when spawning occurs with peak activity around December. This contrasts with the reported spawning periods for blackfin tuna off Florida (April to November), notably with a peak in May (Collette and Nauen, 1983). The spawning period in the Gulf of Mexico is given as between June to September (Collete and Nauen, 1983). Vieira *et al*. (2004) also note that the animals are total spawners i.e. reproducing once per spawning period. Battaglia (1993) suggests that spawning in the Caribbean occurs between April and September. The presence of numerous mature males and females around FADs off Martinique during May and June led Taquet *et al*. (2000) to postulate that there was a blackfin tuna breeding ground within the Lesser Antilles. The spawning period implied falls within the period defined for off Florida (Collette and Nauen, 1983) and for the Caribbean (Battaglia, 1993).

These studies therefore collectively suggest that distinct spawning grounds occur throughout the animals' geographic range. However, this information does not address if the animals are faithful to specific spawning grounds, which would be a more solid basis for stock differentiation at the genetic level. While it seems unlikely that the animals would move from one extreme of their range to the other to spawn, it is quite possible that they may move through portions of their ranges and move to the nearest spawning ground when the time arises.

Migration

Very little solid information is available on site faithfulness of blackfin tuna. Doray *et al*. (2004) report the presence of all age groups around FADs off Martinique, albeit at different water depths. The authors further report the presence of 4 month-old juveniles in the area which coincide well with recruit cohorts produced from March to October spawning events. As such the data support a Caribbean recruit source. Singh-Renton and Renton (2007) reports the recapture, two years later, of 2 blackfin tuna tagged off the same area off St. Vincent. Although by no means a good sample size, the capture of these two fish close to their points of release two years afterwards may be an indication that blackfin tuna exhibit some level of site faithfulness.

Existing management

No management regulations specifically for blackfin tuna have been found for any of the harvesting nations.

Summary of previous stock assessment work

No records of stock assessment for this species have been found.

Available data for stock assessment

The only data available to the meeting for this species were nominal national total catch estimates as stored in the FAO and ICCAT Task I databases. Of course these datasets do not accurately reflect real temporal catch trends per se as the periodicity and consistency of national reporting to the databases varied over the period. However, some crude trends can be deduced at the individual national levels. For example, the dataset for Grenada is quite long. A very preliminary and crude index of the stability of the stock over this period could potentially be obtained by simply dividing the recorded total landings by the fleet size and comparing over the time period. This effectively retroactively calculates the catch per trip, the simplest level of catch per unit effort traditionally available to the scientific working group. However, detailed data on fleet over time was not available at the time of the meeting.

Given the lack of information on stock structure two alternatives are proposed for future CRFM assessments: first a Western Central Atlantic stock assessment, extending from the Eastern US to the Guyanas, including all the Caribbean and Gulf of Mexico, and second an Eastern Caribbean assessment, including only the Antillean islands southeast of Puerto Rico, and the waters offshore of Venezuela, Trinidad and Tobago and the Guyanas. Either option would have to include, at a minimum, harvest estimates for all countries landing blackfin tuna in each of these areas, not just the CRFM landings.

Recommendations

- Although no solid information is available on stock structure, it is suggested that assessments proceed based on a Western Central Atlantic hypothesis. In this case, collaboration of CRFM with the French Antilles islands and the US should at least be sought. However, ideally collaboration with other countries that land large quantities of blackfin tuna such as Venezuela and Cuba in this regard would be much preferred. It should also be noted that a significant proportion of scientific studies of this species has been conducted in the French Antilles and Cuba.

- A genetic study specifically intended to assess the stock structure of the species across the region should be conducted. The UWI should be approached in this regard and CRFM should consider funding the study.

- CRFM countries, particularly Grenada, involved in the fishery should encourage assessment of the status of this species and to this end it is suggested that the following data and information be collected:
  - Collection of new catch and effort data and collation of any other historically available records that may allow for the estimation of relative abundance indices.

- Focused morphometric studies that would include collection of data such as length, weight, gonadosomatic indices (GSI) and reproductive state covering a period of at least one year.
- All historic catch and effort data should be supplied to the CRFM Secretariat for consideration during future stock assessments.

3. Atlantic Bonito (*Sarda sarda*)

According to Colette and Nauen (1983), cited by Valeiras and Abad (2006b), *Sarda sarda* is uncommon in the Caribbean, but present from Nova Scotia to the Yucatan peninsula, including the Gulf of Mexico (Boschung 1966; Ortiz and Phares 2002). In the Caribbean it is present in the large Antilles islands and the coasts of Colombia and Venezuela and Trinidad and Tobago, but not in Central America or the Lesser Antilles. In the Central coast of Venezuela, *S. sarda* is one of the species commonly caught by the artisanal gillnet fishery (Marcano *et al*., 2001). According to these authors it is also neither present in the Guyanas nor from the northern and equatorial Brazilian coasts and only reappears in southern Brazil, Uruguay and Argentina. FAO, on the other hand, suggest that the species is present in the Brazilian coasts south of the Amazon but absent between the mouths of the Amazon and the Orinoco. The absence from this area is consistent with the lack of reports of catches of *Sarda sarda* from the Venezuelan fleets based in Margarita Island that fishes pelagic fish east of Trinidad all the way to French Guiana (Marcano *et al*., 1994). FAO also suggests this species is absent from the Caribbean islands.

Trinidad and Tobago, Barbados, Dominica, Grenada, Jamaica, St. Vincent and Grenadines, St. Lucia Turks and Caicos Islands and the British Virgin Islands all report landings of *Sarda sarda* to ICCAT but the majority of these landings are from Trinidad and Tobago (Figure 4). A number of non-CRFM countries in the Western Atlantic report catches of *Sarda sarda* to ICCAT. These include Argentina from (1964-2001), Brazil (1959-68, 1984-95, 1998 and 2005), Cuba (1987-90 and 1998), Guatemala (2006), Mexico (1969-2006), Panama (2000), USA (1950-2006), Uruguay (1975-86, and 1991) and Venezuela (1968-2006). Unlike frigate tuna, few catches are reported to come from purse seines, the exception being Argentina where most of the reports are from purse seine or unclassified gear (but most likely purse seine as well).

The only reports of CRFM catches of *Sarda sarda* contained in the Sea Around Us project database are for Grenada (1950-81, 1996-99, 2004). FAO statistics for 1970-1999 however do contain reports of landings of *Sarda sarda* for other islands and mainland countries in area 31 (Guadeloupe, Martinique, US, Mexico, Venezuela). Dominica recently has started separating catches by gear, and from 2005-2007 reports that *Sarda sarda* was caught from hand lines and troll gear.

Reports from FAD fisheries in Guadeloupe (Diaz 2002, Diaz *et al*. 2002) suggest that neither Sarda nor Auxis are caught around such devices. However, FAO statistics report catches of Sarda in both islands, indicating that these must come from gear not associated with FADs.

Marcano *et al*., (1994) do not mention catches of Sarda in their review of the pelagic fleet from Margarita Island, that otherwise catches all other pelagic species, including large tunas, sharks, billfish, mackerels, dolphinfish, and wahoo. During the same period an analysis of the catches of Venezuelan longliners showed no catch of bonito (Marcano *et al.*, 1997b). Sarda is regularly caught by the gillnet fleet of north central Venezuela (Marcano *et al*., 2001) and during 1988-1995 catches of this species represented 4% (BON) of the overall landings from this fleet. Off Louisiana, Gulf of Mexico, anglers target *Sarda sarda* in sport fishing tournaments (Daley *et al*., 2007).

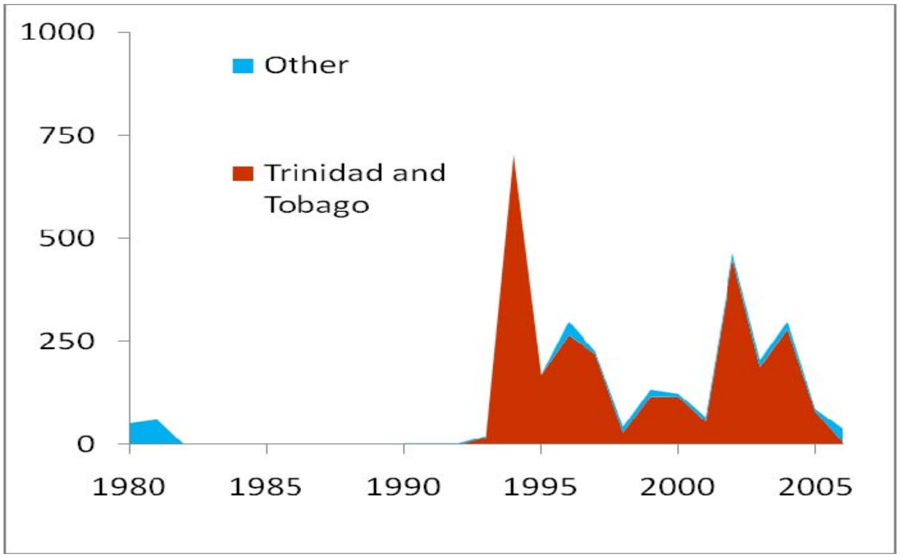


Figure 4: Catches of Sarda sarda (BON) by CRFM countries reported to ICCAT as task I data.

Biological notes

According to Collette and Nauen (1983), *Sarda sarda* spawns in June and July in the Northwestern Atlantic, as in the Mediterranean and Northeast Atlantic. In the central coast of Venezuela, *Sarda sarda* are caught in the gillnet fishery between November and February, at the same time as skipjack tuna (Marcano *et al*., 2001). In the Northern Caribbean, *Sarda sarda* is rarely seen in larval collections, except for a few individuals identified by Richards (1984) in February and March. The only other area where spawning has been reported so early in the year is Senegal (Valeiras and Abad, 2006b). Neither Richards (1984) nor Hare *et al*. (2001) found Sarda larvae in the months of July, August, November, December or May.

Discussion and recommendations

Atlantic Bonito is the English name for *Sarda sarda* accepted by ICCAT and FAO. However, bonito or bonite is a vernacular name given to several different species of tuna in the region (Table 2). According to Mohammed and Rennie (2003) the use of "bonito" as a local name may have caused species misidentification in the reporting of catches of tunas in St. Lucia and St Vincent and the Grenadines.

Table 2: Species associated with the vernacular name bonito or bonite, in the wider Caribbean region. Data obtained from FAO, Fishbase and ICCAT.

Scientific name	CRFM Country	Other Caribbean countries
Auxis thazard	Trinidad and Tobago	Brazil, Dominican Rep., Mexico
Euthynnus alletteratus	Trinidad and Tobago	Brazil, Colombia, Cuba, Dominican Rep., Martinique, Puerto Rico, Venezuela
Katsuwonus pelamis	Barbados, Suriname, Trinidad and Tobago	Brazil, Colombia, Cuba, Dominican Rep., Martinique, USA, Venezuela
Sarda sarda	Grenada, St. Lucia, St. Vincent & Grenadines, Trinidad and Tobago	Brazil, Colombia, Cuba, Mexico, USA
Scomberomorus	French Guiana	

brasiliensis		
Thunnus alalunga	Barbados	
Thunnus atlanticus	Grenada, St. Lucia, St. Vincent & Grenadines	

Sarda sarda has a variety of other vernacular names in Venezuela (cabana blanca, cabana cariba, cabana de dientes) and Brazil (cavala, sarda, serrajao, serra sarda, serra comun, serra de escama). It is therefore possible that the lack of reports of *Sarda sarda* from many CRFM countries may be the result of species misidentification. Additionally it is clear that some Atlantic bonito are likely to be reported as unclassified tuna.

Before assessments of bonito can proceed, accurate estimates of total harvest for the stock need to be obtained. There is therefore an urgent need to review landings of this species for the entire Caribbean area. Reconstruction of historical landings has been carried out for Barbados (Mohammed *et al*., 2003), St. Lucia (Mohammed and Joseph 2003), Trinidad and Tobago (Mohammed and Chang A Shing, 2003), St. Vincent and the Grenadines (Mohammed *et al*. 2003) and Grenada (Mohamed and Rennie, 2003). Although these authors have not provided landings by species in their publications, these are available (Mohammed E. pers. comm.) and could be made available to the CRFM and ICCAT.

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B. FISHERY REPORTS

1. Assessment of the Crevalle Jack (*Caranx hippos*) fishery of Trinidad and Tobago

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Consultants: Dr. Todd Gedamke (US National Marine Fisheries Service, Miami Laboratory)
Dr. Nancie Cummings (US National Marine Fisheries Service, Miami Laboratory)

1.1 Management Objectives

Crevalle jack (*Caranx hippos*) is a coastal pelagic species caught mainly in the multi-fleet, multi-gear fisheries that target mackerels in Trinidad and Tobago. The general policy goal for the fisheries sector of Trinidad and Tobago is to promote sustainable management and growth of the sector within a diversified economy, by improving conservation outcomes, increasing industry self-reliance, creating systems that allow for efficient access to and allocation of resources, facilitating transparent decision-making and promoting shared stewardship (Fisheries Division, 2007).

The management objectives for the coastal, pelagic fishery are to maintain biological diversity and to ensure that the exploitation of the fisheries resources and conduct of related activities are consistent with ecological sustainability (i.e. for target and non-target species as well as marine environments), (Fisheries Division, 1992, 2007).

1.2 Status of Stocks

Although the distribution of the species has been reported, the specifics of stock delineation have not been addressed. Therefore, this working group assumed that information from the fisheries in Trinidad and Tobago was representative of the entire stock.

In our analysis of the Trinidad fisheries data for recent years (since 1995), there is no obvious trend in either the CPUE (landings per trip) or length-frequency data. The lack of contrast in CPUE prevented fitting of a non-equilibrium production model to standardized CPUE and estimated landings data for 1995 to 2007. Hence, the results were inconclusive. There is no strong evidence to suggest that the population size has changed. However, without contrast in the data, it is also difficult to fully assess the stock status.

Between 1995 and 2006, the average annual landing of *Caranx hippos* in Trinidad was 245 tonnes from the artisanal multi-gear and trawl fleets. Annual landings varied between 153 and 400 tonnes (Figure 1a). Point estimates of landings for 1963 and 1975 were 135 and 189 tonnes respectively. Although no clear long-termed trends in landings are apparent, higher landings have been observed in recent years compared to 1963. Landings of Crevalles 'nei', reported by Caribbean countries in the Western Central Atlantic Region (FAO FishStat Database), have increased since 1950, but in recent years appear to have stabilized (Figure 1b). At this time there is no evidence of overfishing of this group.

1.3 Management Advice

The Working Group noted that limitations in available data and uncertainties in parameter estimates influenced the quality of the assessment results. The management advice is therefore precautionary in nature and considers the recommendations from previously assessed, more important commercial species (Serra Spanish mackerel and King mackerel) in this multi-species fishery. It is therefore recommended that fishing pressure not be allowed to increase until the dynamics of the stock are better understood.

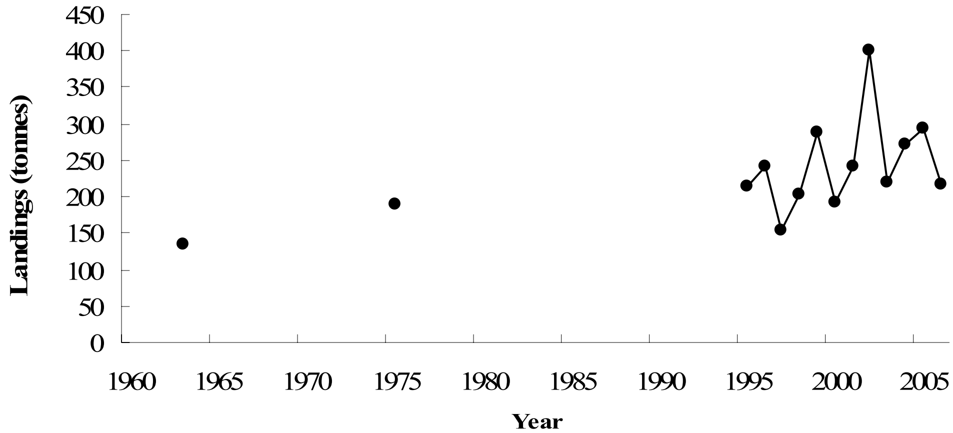


Figure 1a. Annual landings of *Caranx hippos* in Trinidad. Recorded catches are available for additional years, however, these data are not included as the corresponding total catches have not yet been estimated.

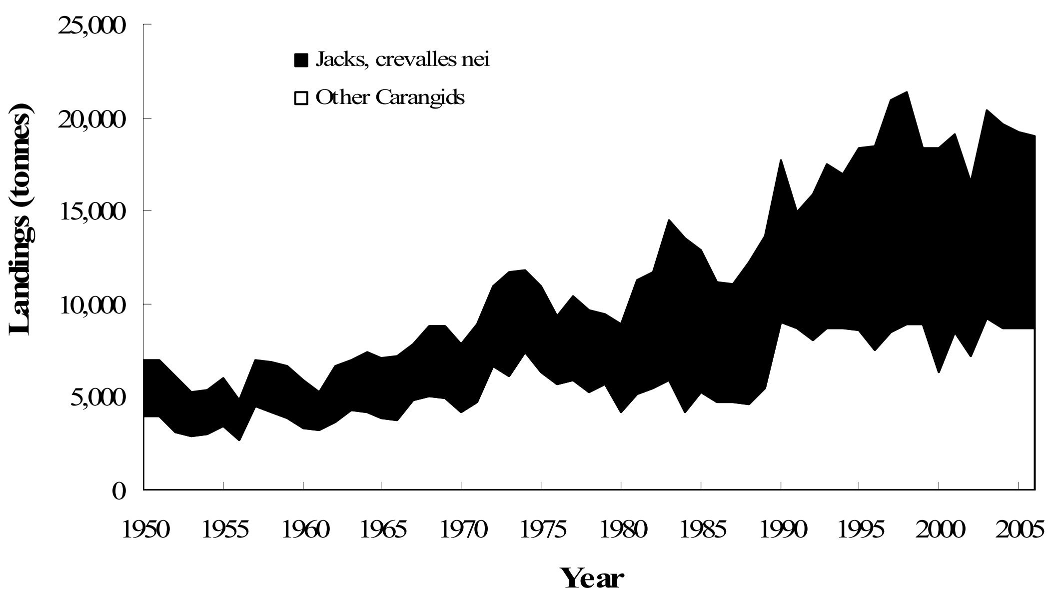


Figure 1b. Annual landings of 'Jacks, crevalles nei' by Caribbean countries in the Western Central Atlantic Region.

1.4 Statistics and Research Recommendations

Due to data limitations, resulting uncertainties in parameter estimates and inconclusive results, the following are recommended:

1.4.1 Data quality

<u>Specific to *Caranx hippos*</u>

1. The sampling strategy for collection of length frequency data should be evaluated to maximize the benefit of data collected given the limited resources. The goal of the sampling strategy should be to investigate selectivity of the gears and provide a reliable estimate for the mean length of the population. Sub-sampling strategies which account for temporal and spatial distribution of effort within the different fisheries will increase the likelihood of successful sampling trips and therefore minimize the work necessary to provide reliable results. An alternative approach may be to generate estimates of mean length from a single, consistent, annual sampling event (e.g. large number of samples taken from the same locations and gears at the same time of year). Collection of length frequency data should commence in 2009.

2. The time series of CPUE data should be extended prior to 1995 (at least ten years back or corresponding to about one life span) as this information could be useful in explaining trends in local abundance of the stock. This activity should commence within the next three months.

3. Catch and effort data collection in Trinidad and Tobago should be expanded to include the semi-industrial multi-gear fleet, trawl fleets (by-catch) and recreational fleets, as well as artisanal fleets in Tobago. In addition, catch and effort data from other countries in the Eastern Caribbean should be obtained. Current data in the FAO FishStat database for the Western Central Atlantic Region should be disaggregated to the species level to facilitate better estimation of total removals of *Caranx hippos* due to fishing.

<u>General</u>

1. A number of errors were identified in the Trinidad catch and effort database. Efforts should be undertaken to audit the current database and protocols should be developed for future data collection and computerization to facilitate analysis of data for all species. This activity should commence at the soonest possible time.

1.4.2 Research

1. Continued analyses of the CPUE data should be conducted in the intercessional period to investigate possible causes for the overestimation of CPUE by the model. More work is needed to identify fishing trips that provide a representative sample of the catch and effort for evaluating the local abundance of the stock.

2. Physical and ecological indices related to productivity and mortality should be compiled to investigate whether fluctuations in local abundance can be explained. Since indices are already available this activity can provide an inexpensive and potentially useful alternative to prediction of future catches and more specific management advice.

3. Due to the multi-species nature of the fisheries in Trinidad and Tobago it is recommended that future analyses take into account the impacts of proposed management measures for the coastal pelagic fishery on *Caranx hippos*.

1.5 Stock Assessment Summary

The analyses utilized estimated total landings from 1963, 1975 and 1995 to 2006 for the artisanal multi-gear fleets and trawl fleets (excluding by-catch), catch per trip data from 1995 to 2007 for fishing trips utilizing monofilament and multifilament gillnets; a-la-vive; trolling; switchering; beach seines; banking; fishpots and trawl nets. Biological data comprised length data for 2,294 fish collected between July 1995 and June 1998 and March to December 2004. Growth parameters were taken from a modified report of Kishore and Solomon (2004).

The length weight parameters estimated for *Caranx hippos* in Trinidad are: a = 0.025 ± 0.00139; b = 2.805 ± 0.01502 for the sexes combined. There was no significant difference in the relationship between length and weight for males and females.

Total mortality (Z) was estimated from length frequency data and ranged between 0.441 and 0.959 $year^{-1}$. Although the estimates of Z varied depending on parameter inputs, the analysis evaluated both the upper and lower bounds of total mortality.

Natural mortality was estimated to be between 0.12 and 0.33 $year^{-1}$ using six different methodologies. Growth parameters from a study in Trinidad (Kishore and Solomon, 2004) were the most reliable life history information available and therefore used to estimate a natural mortality of 0.23 $year^{-1}$ from the Pauly (1980) model.

Fishing mortality was calculated as the difference between total and natural mortality and ranged between 0.211 $year^{-1}$ and 0.708 $year^{-1}$ for the lower and upper bound estimates of total mortality respectively.

The catch per unit of effort (CPUE) data from the commercial landings between 1995 and 2007 were used to generate a standardized index of local abundance using a general linear model (Figure 2). Although the observed data suggest a slight increase in CPUE may have occurred, standardized CPUE's remained noisy over the time series. The confidence intervals around the standardized estimates were large and no strong evidence for changes in CPUE exists.

1.6 Special Comments

None.

1.7 Policy summary

The Working Group agrees with the Trinidad and Tobago Government (Fisheries Division, 1992) that management for the coastal, large pelagic species should be coordinated among neighbouring countries sharing these sub-stocks. More information and guidance from the CRFM Forum is required on the regional policies for management of the *Caranx hippos* resources.

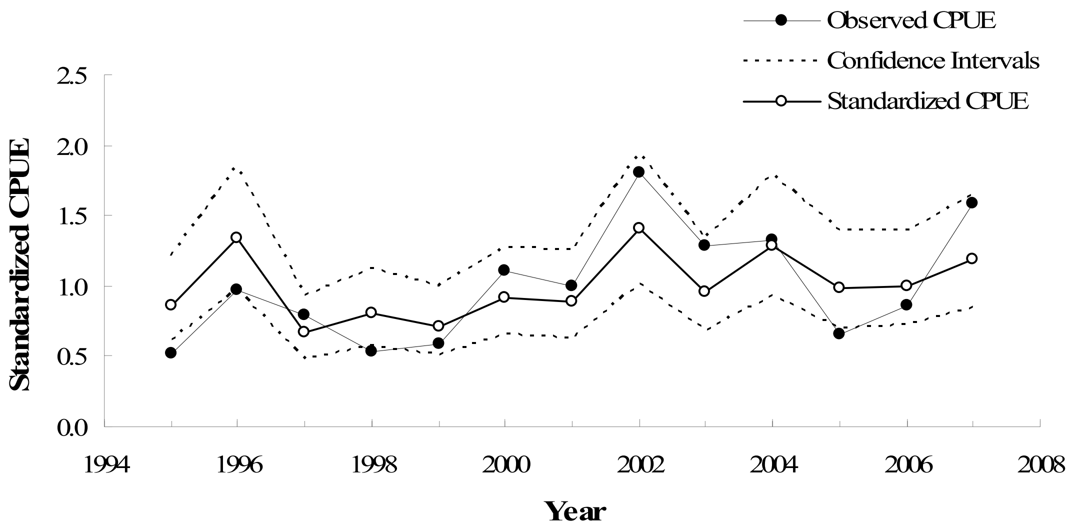


Figure 2. Standardized CPUE (catch per trip) trends for *Caranx hippos* in Trinidad.

1.8 Scientific Assessments

1.8.1 Background

<u>1.8.1.1 Fishery Description</u>

This study is the first attempt at assessing the status of resources of Crevalle Jack (*Caranx hippos*) off Trinidad and Tobago. Crevalle Jack (*Caranx hippos*) is a coastal pelagic species caught mainly in the multi-fleet, multi-gear fisheries that target mackerels in Trinidad and Tobago. When aggregated in large schools in coastal waters the species is targeted using beach or land seines. The species is also caught in the recreational fishery.

In Trinidad *Caranx hippos* is caught mainly by the artisanal multi-gear fleet. Average annual landings between 2002 and 2006 was 281 t, valued at TT$2.83 million. The associated vessels are of the pirogue design, ranging between seven and ten metres with outboard engines of 40 to 75 Hp. There are about 947 of these vessels and about 1,894 fishers (assuming an average crew of two persons per vessel). The species is also abundant in the by-catch of the soft-bottom demersal fishery, which utilizes trawl gear as well as gillnets. There are about 102 artisanal trawlers (6.7 to 10.4 m; 56 Hp outboard engine or 48 – 100 Hp inboard engine), 10 semi-industrial trawlers (9.3 – 12.1 m; 165 – 250 Hp inboard engine) and 25 industrial trawlers (10.9 – 23.6 m; 365 – 425 Hp inboard engine). An estimated 312 fishers utilize trawl gear.

Landings data are available only for the artisanal fleet and trawlers operating from Trinidad. A biomass of 36,000 tonnes was estimated for Carangids, Scombrids and Sphyraenids combined from hydro-acoustic surveys off the coasts of Trinidad in the late 1980s (Institute of Marine Research, 1988).

<u>1.8.1.2 Species biology</u>

Crevalle jack is a subtropical species, distributed between 45° N and 33° S and 98° W and 14° E. Its distribution in the Western Atlantic extends from Nova Scotia, Canada and the northern Gulf of Mexico to Uruguay, including the Greater Antilles. The species is common in neritic waters over the continental shelf (e.g., shallow flats and reefs) but larger fish may be found in offshore waters at depths of 350 m.

Juveniles can be found in brackish water near estuaries with muddy substrate, near sandy beaches and on seagrass beds. Although *C. hippos* may form fast moving schools larger fish may also be solitary.

The diet of *Caranx hippos* varies depending on location, season and area, but generally comprises fish, shrimp and other invertebrates. Diet of the species caught off Puerto Rico comprised solely of shrimps and prawns (Austin and Austin, 1971), while off Cuba the diet comprised 57.7% shrimp/prawns; 39.8% bony fish and 2.5% crabs (Sierra *et al*., 1994). In the coastal zone of the Gulf of Mexico and the southern U.S. Atlantic coast the species feeds mainly on small schooling fishes: small jacks eat mainly clupeids; medium-sized jacks eat clupeids and sparids and large jacks eat various clupeids, carangids and sparids (Saloman and Naughton, 1984). Other food items of *Caranx hippos* include gulf menhaden, scaled sardine, anchovies, Spanish sardine, Atlantic bumper, pinfish, Atlantic thread herring, crevalle jack and Atlantic cutlassfish. In Trinidad several species were observed in a qualitative stomach content analysis of *Caranx hippos* (Fisheries Division, unpublished data) Food items included: herrings (Clupeidae, *Opisthonema oglinum*, *Sardinella brasiliensis, Etrumeus teres*); anchovies (Engraulidae, *Anchoviella* spp., *Cetengraulis edentulus, Chirocentrodon* sp.); other jacks (Carangidae, *Caranx chryso,*; *Hemicaranx amblyrhynchus, Selene brownii, Chloroscombrus chrysus*); shrimp (Penaeidae, *Penaeus subtilis*); croakers (Sciaenidae, *Cynoscion* sp., *Stellifer* sp.); Crabs (Portunidae); squids (Lologinidae, *Loligo plei*); butterfishes (Stromateidae, *Peprilus paru*); toadfishes (Batrachoididae); cutlassfishes (Trichiuridae); lizardfishes (Synodontidae); cusk-eels (Ophididae, *Lepophidium* sp.) and searobins (Triglidae, *Prionotus* sp.). *Caranx hippos* is a top predator species with trophic level of between 3.83 and 3.96 (Sierra *et al*., 1994). Studies off the USA and Mexico indicate that *C. hippos* is eaten by bony fish (Istiophoridae – *Tetrapturus audax* and Sciaenidae – *Cynoscion regalis*) as well as seabirds (Laridae – *Anous stolidus*; *Sterna fuscata*), (Hensley and Hensley, 1995; Abitia-Cardenas *et al*., 1997; Bowman *et al*., 2000).

*Caranx hippos a*ttains a maximum age of 13 years in Trinidad (Kishore and Solomon, 2004). In Jamaica *C. hippos* matures at between 55 and 66 cm FL (Thompson and Munro, 1974) and spawning occurs between April and May in Cuba (García-Cagide *et al*., 1994). Off Florida, females mature at five or six years and males at four or five years while spawning occurs from April to June (Florida Fish and Wildlife Conservation Committee, 2005).

Although the distribution of the species has been reported, the specifics of stock delineation have not been addressed. Therefore this working group utilized information from the fisheries in Trinidad and Tobago as representative of the entire stock.

1.8.2 Overall Assessment Objectives

The assessment objectives were to determine the status of the resources of *Caranx hippos* in the waters off Trinidad and to propose management measures to sustain the yields from the fishery.

1.8.3 Morphometric relationships

1.8.3.1 Objective

The objective was to estimate morphometric parameters in the relationship between length and weight; total length and fork length of *Caranx hippos*.

1.8.3.2 Data used

Fork length, total length and weight data were collected for 312 fish obtained from the commercial catch.

1.8.3.3 Method/Models/Data

A regression analysis (power curve) was conducted on length and weight data for 312 fish to estimate the parameters in the length-weight relationship ($W = aL^b$; where W = total weight in grams, L is total length in cm). Females examined ranged between 18.5 and 106.2 cm TL, and males ranged between 17.5 and

100 cm TL. The smallest fish examined was 6.8 cm, however this specimen was unsexed. A linear regression analysis was conducted on fork and total length to estimate the parameters of the relationship.

1.8.3.4 Results and Discussion

Of the 312 fish examined, females ranged between 18.5 and 106.2 cm TL, and males ranged between 17.5 and 100 cm TL. The smallest fish examined was 6.8 cm, however this specimen was unsexed. Parameters of the relationship between length and weight are provided in Table 1 and Figure 1. A comparison of these parameters with similar studies in other regions is given in Table 2. The equations derived for conversion of length measurements for the sexes combined were: TL = 1.2394 x FL – 4.7082 (r^2 = 0.9985); FL = 0.8057 x TL+ 4.3226 (r^2 = 0.9985).

Table 1. Length-weight parameters for *Caranx hippos* in Trinidad

Group	Constant a ± S.E.	b ± S.E.	N	Adjusted r^2
All (males and females)	0.025 ± 0.00139	2.805 ± 0.01502	312	0.9912
Males	0.0295 ± 0.00323	2.763 ± 0.02909	140	0.9848
Females	0.0266 ± 0.00245	2.789 ± 0.02423	146	0.9892

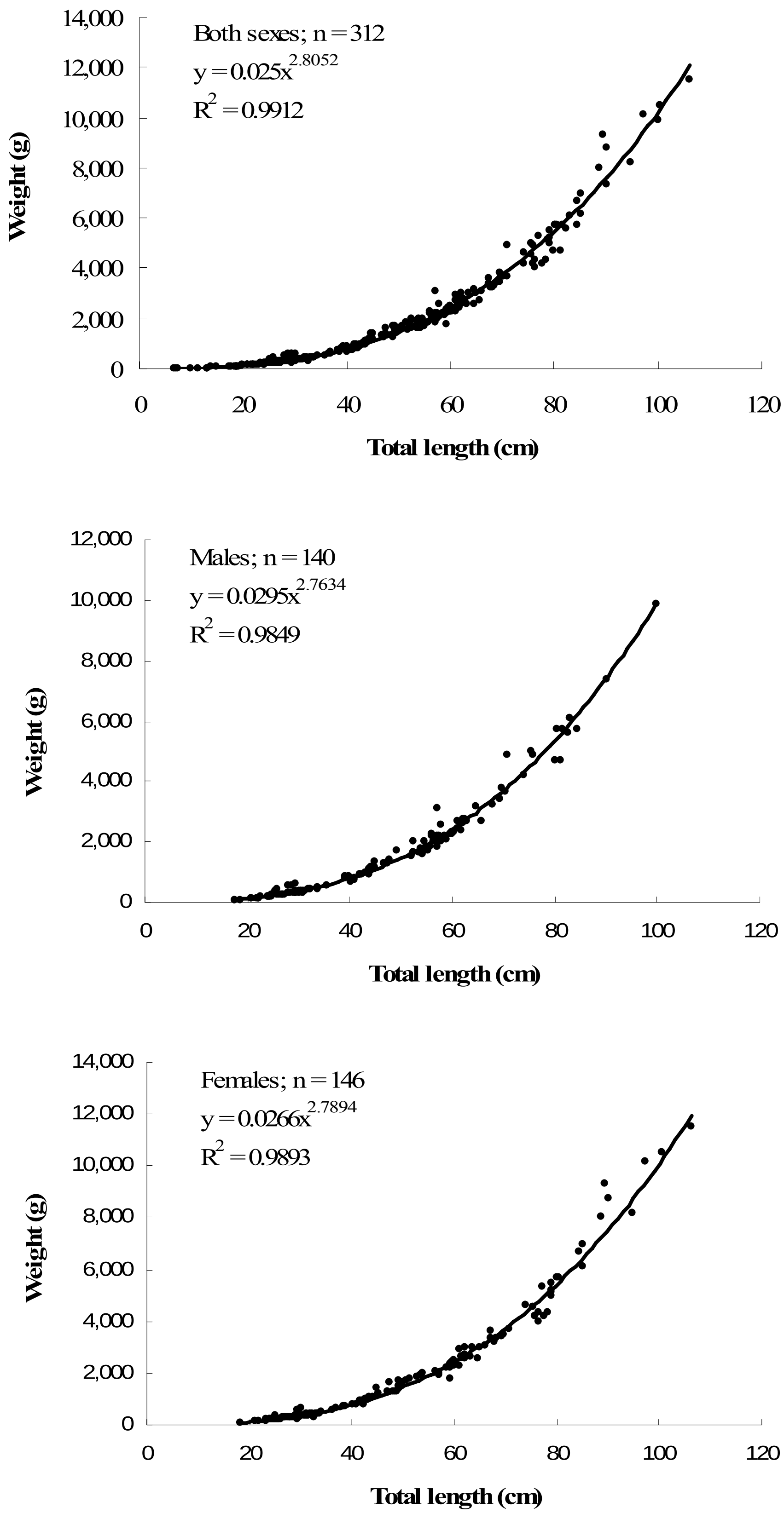


Figure 1. Length-weight relationship for *Caranx hippos* in Trinidad (a) sexes combined; (b) males and (c) females.

Table 2. Comparison of length weight parameters for *Caranx hippos*.

Parameters	Length range/ Sex	N	Location	Reference
a = 0.058 b = 2.734	26 – 65 cm FL	18	Southern Florida, USA	Bohnsack and Harper, 1988
a = 0.0329 b = 2.8550			Tamil Nadu & Pondicherry, India	Reuben *et al*., 1992
a = 0.0404 b = 2.91	15 -345 cm SL	19	Gulf of Salamanca, Caribbean, Colombia	Duarte *et al*., 1999
Both sexes a = 0.025 b = 2.805 Adj. r^2 = 0.9912	Both sexes 6.8 – 106.2 cm TL (5.8 – 86 cm FL)	Both: 312	Trinidad	This study

1.8.4 Total catch

1.8.4.1 Objective

The objective was to estimate total catch of *Caranx hippos* taken from the portion of the stock taken off Trinidad and for the Western Central Atlantic Region in general to ascertain the main exploiters of the resource and as input to a biomass dynamic model.

1.8.4.2 Data used

Estimated landings by gear for 1963, 1975 and 1995 to 2006 for the fishery operating off Trinidad and data in the FAO FishStat Database (Annual landings data for 1950 to 2006 from Caribbean countries fishing in the Western Central Atlantic region) were examined. Caribbean countries comprised Antigua and Barbuda; Bahamas; Barbados; Bermuda; British Virgin Islands; Cuba; Dominican Republic; Grenada; Mexico; Puerto Rico; Saint Kitts and Nevis; Trinidad and Tobago; US Virgin Islands and Venezuela.

1.8.4.3 Method/Models/Data

Catches of *Caranx hippos* in Trinidad were estimated from a landings sampling programme for the artisanal multi-gear fleet as well as the artisanal, semi-industrial and industrial trawl fleets. The discarded by-catch of the trawl fleets is not captured in the statistics. The sampling programme records catches from fishing vessels landing at nine zones around the coastline of Trinidad. All fishing vessels of similar characteristics within a specific zone are assumed to operate similarly i.e. utilize the same gear and fishing areas, as well as operate during the same times of the year. This assumption is based on a 1991 intensive analysis of fishing activity around Trinidad and Tobago (McClure, 1991). Within each zone data are collected from at least one landing site, over 20 randomly selected days per month. Overall, data are collected from between 18 and 21 landing sites across all zones. Data are checked and validated prior to computerization in an Oracle-based system specially designed for the management of fisheries information (Fisheries Management Information System, FISMIS).

The recorded data are adjusted to represent total landings using two raising factors. The first raising factor (the ratio of number of enumerated days and number of fishing days) is used to estimate the total monthly landing at the enumerated site. The second raising factor (the ratio of the total number of boats and number of enumerated boats within each zone) is applied to the total monthly landing at the enumerated site, to estimate total monthly landing for the zone. The number of boats were derived from vessel census conducted in 1980 (Fisheries Division, unpublished data), 1991 (Fisheries Division, unpublished data), 1998 (Chan A Shing, 1999) and 2003 (Fisheries Division, unpublished data). The number of boats in 1963 was derived from interpolation between estimates available for 1959 (Kenny, 1960) and 1968 (Vidaeus, 1970) and similarly, the number of boats in 1975 was derived from interpolation between estimates available for 1968 and 1980 (Fisheries Division, unpublished data). Total landings for 1995 were estimated using census data for 1991, total landings for 1996 to 2000 were estimated using census data for 1998 and total landings for 2001 to 2006 were estimated using census data for 2003. The raised data are further adjusted to better represent landings of the respective trawl fleets as well as overall zone landings when the quality of data from a designated representative beach is uncertain.

Regional catch data were extracted from the FAO FISHSTAT Database (Capture production) for Caribbean countries fishing in the Western Central Atlantic Region.

1.8.4.4 Results and Discussion

Between 1995 and 2006, the average annual landing of Crevalle Jack in Trinidad was 245 tonnes from the artisanal multi-gear and trawl fleets. Annual landings varied between 153 and 400 tonnes (Figure 2). Point estimates of landings for 1963 and 1975 were 135 and 189 tonnes respectively. Over the long-term (1963 to 2006) average annual landings have increased.

The species is caught by 20 different gear types. Catches from gillnets (fillet and monofilament), beach seines, a-la-vive, trolling and banking and switchering accounted for 43%, 22%, 11%, 9%, 8% and 2% overall landings respectively, between 1995 and 2006. Beach seines, monofilament gillnets, fillet (multifilament gillnets) and a-la-vive are the main gears, the combined catches of which accounted for 76% of the annual catch between 1995 and 2006 (Figure 3). The seasonality of gear deployment is inferred from landings data. Monofilament gillnets are used mainly during the second half of the year, while fillet (multi-filament gillnets) are used year- round (but less so from November to February), troll lines are used from March to August, a-la-vive are used mid-year and bank lines are used year-round (Figure 4). There appears no clear seasonality of the species, as landings (combined over all gears) have varied in magnitude from month to month each year across (Figure 5). However, the occurrence of periodic high landings in July observed in 1999 and 2002 (Figure 6) suggests that either biological or environmental factors influence the abundance of the species.

Landings of *Caranx hippos* by Caribbean countries in the Western Central Atlantic region are aggregated with other jacks in the FAO FISHTAT database. As a result it is difficult to assess trends in landings of *C. hippos* specifically. Generally landings of jacks (carangids) in the region have increased from 7,000 tonnes in 1950 to 19,029 tonnes in 2003, reflecting either the growing commercial importance of the group or improved data collection systems (Figure 7). If data from Mexico are excluded (Figure 8), catches of 'Jacks, crevalles nei' appear to have been declining since the early 1990s. Venezuela's average percent contribution to annual total landings was 98% in the 1950s, but this has since decreased to about 42% between 2000 and 2006, due mainly to increased landings by Mexico (Figure 9). Mexico's average percent contribution to annual total landings between 2000 and 2006 was 48%. Trinidad and Tobago's contribution to overall landings of jacks in the Western Central Atlantic region is negligible (Figure 9).

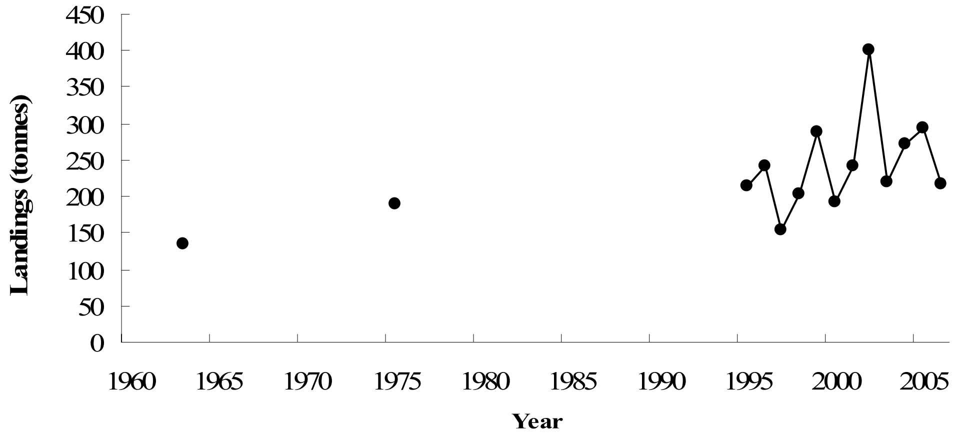


Figure 2. Landings of *Caranx hippos* in Trinidad.

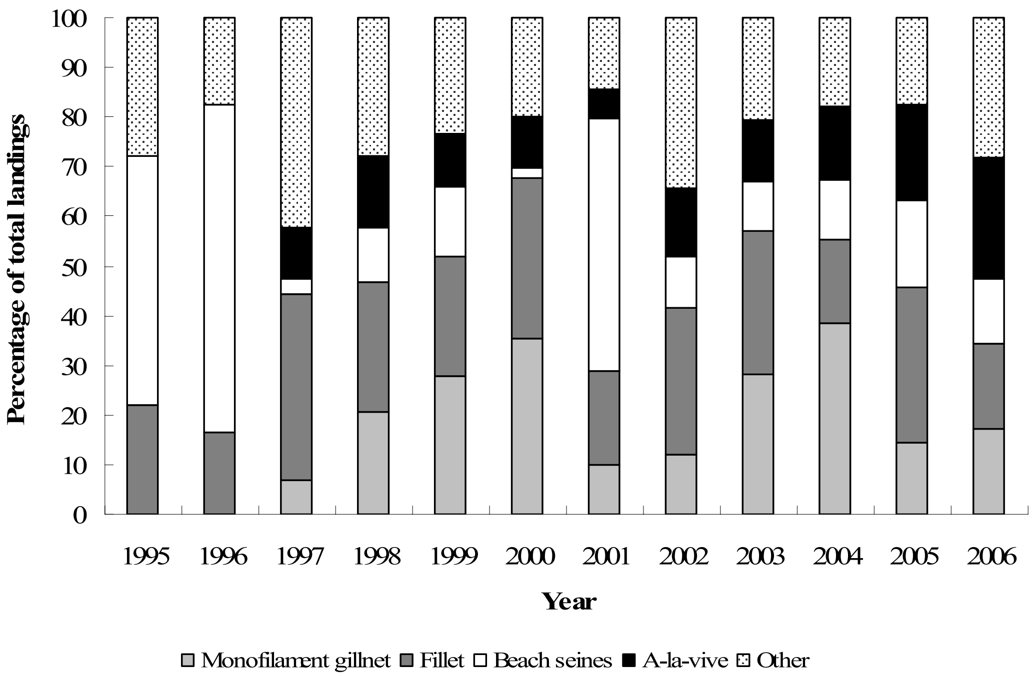


Figure 3. Landings of *Caranx hippos* in Trinidad by main gears.

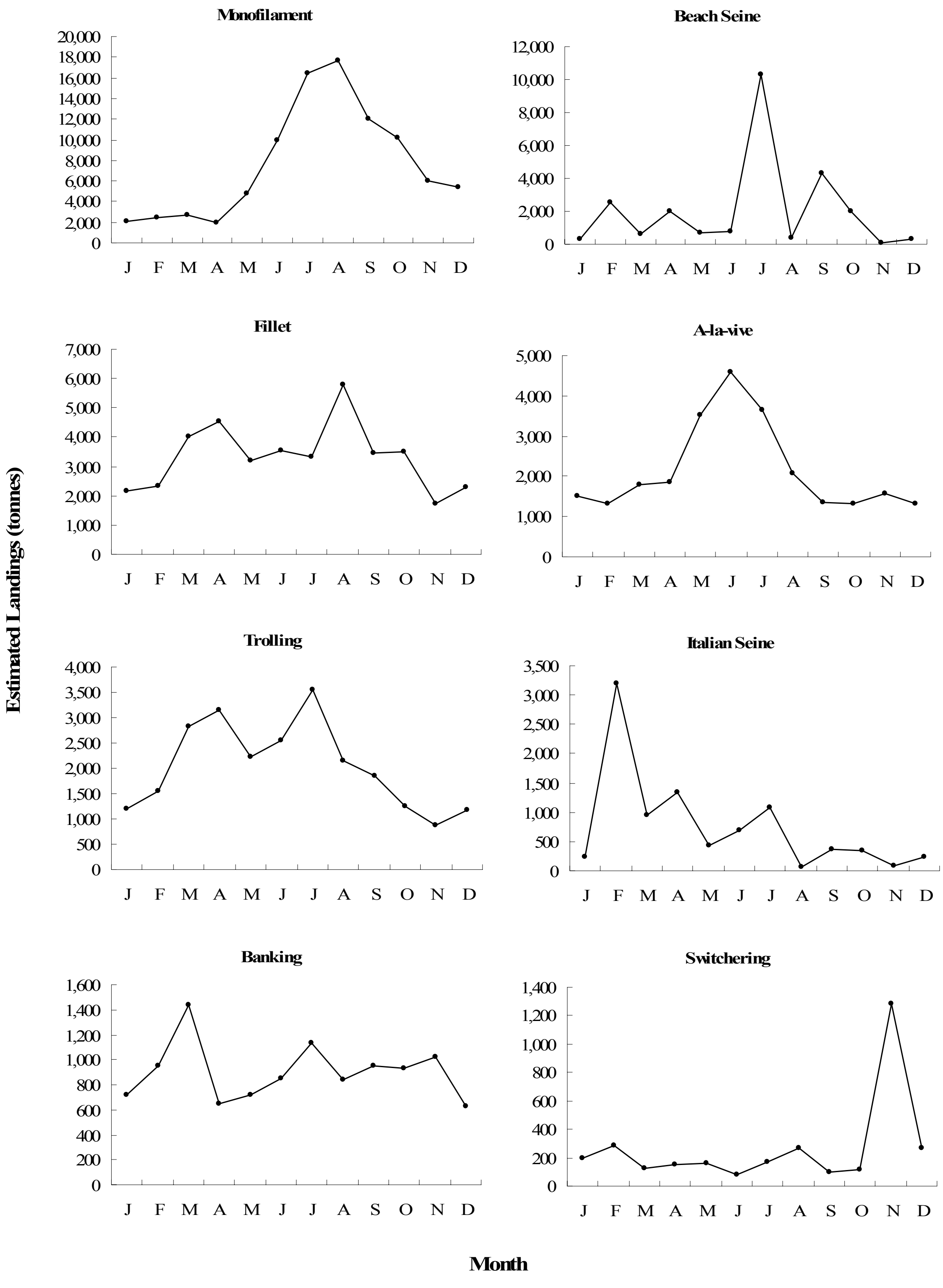


Figure 4. Seasonality of *Caranx hippos* landings from various gears in Trinidad.

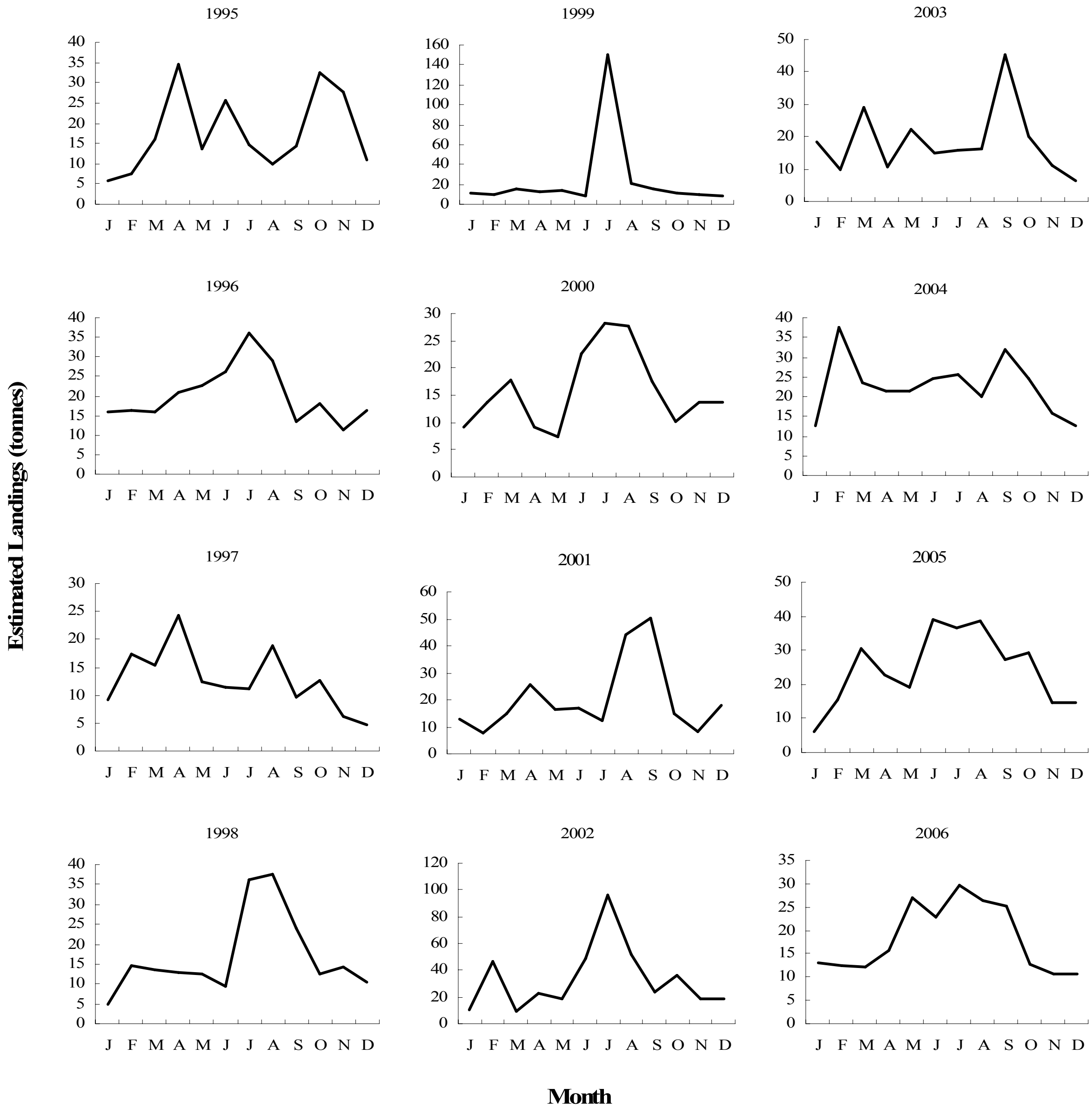


Figure 5. Estimated monthly landings of *Caranx hippos* combined for all gear types used in Trinidad (1995 to 2006).

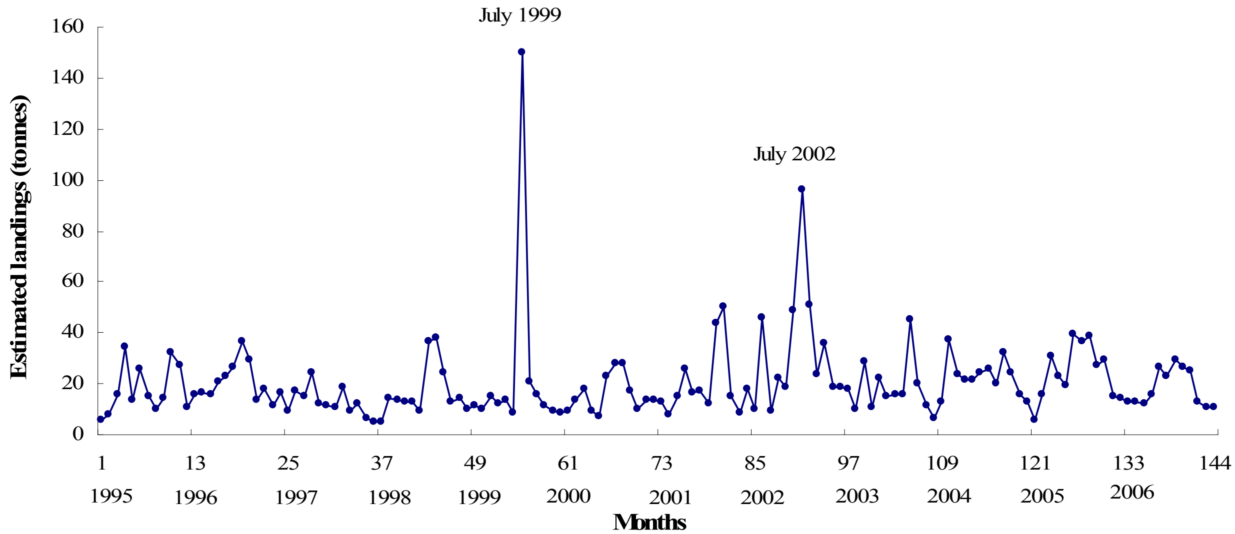


Figure 6. Estimated monthly landings of *Caranx hippos* in Trinidad from January 1995(Month 1) to December 2006 (Month 144).

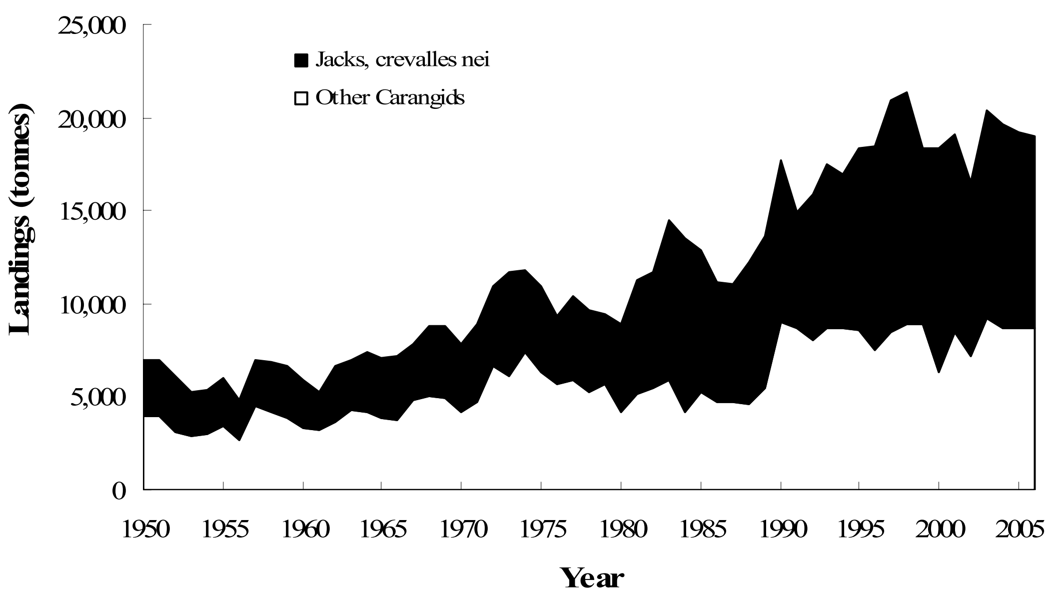


Figure 7. Landings of Crevalle Jacks and other Carangids by Caribbean countries in the Western Central Atlantic Area (data from Mexico included).

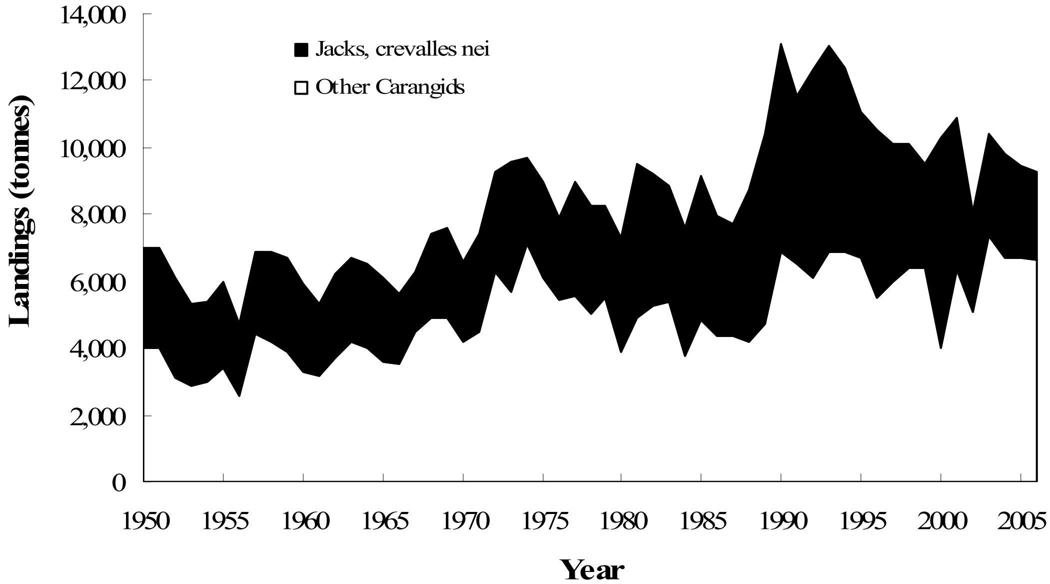
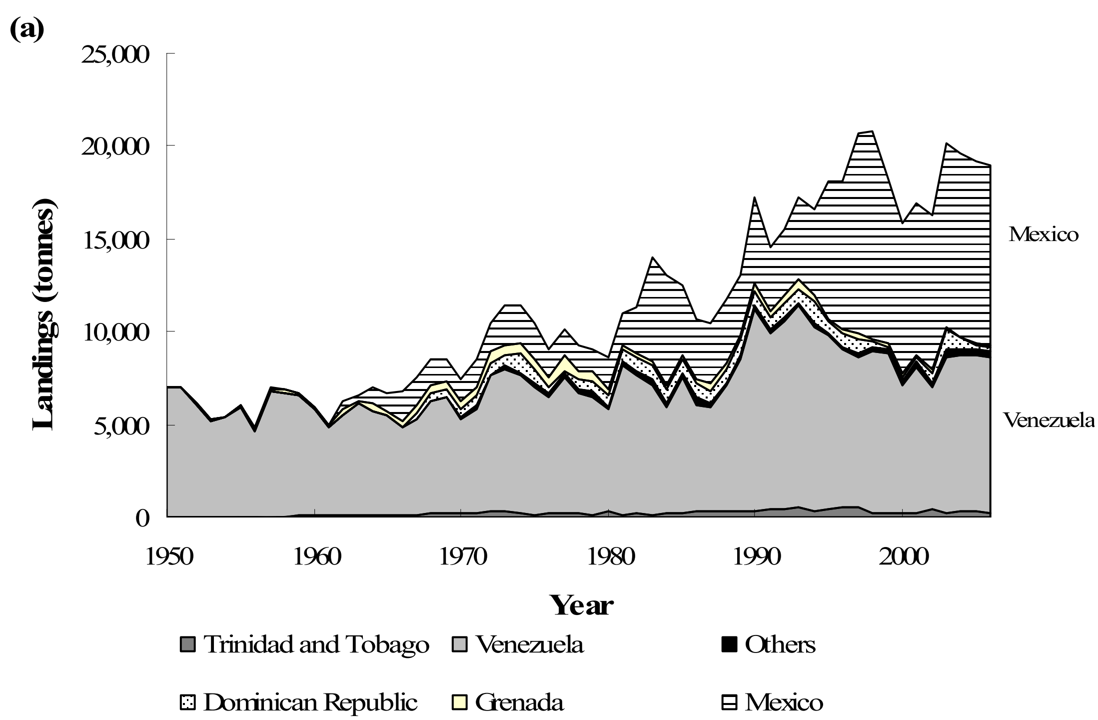


Figure 8. Landings of Crevalle Jacks and other Carangids by Caribbean countries in the Western Central Atlantic Area (data from Mexico excluded).



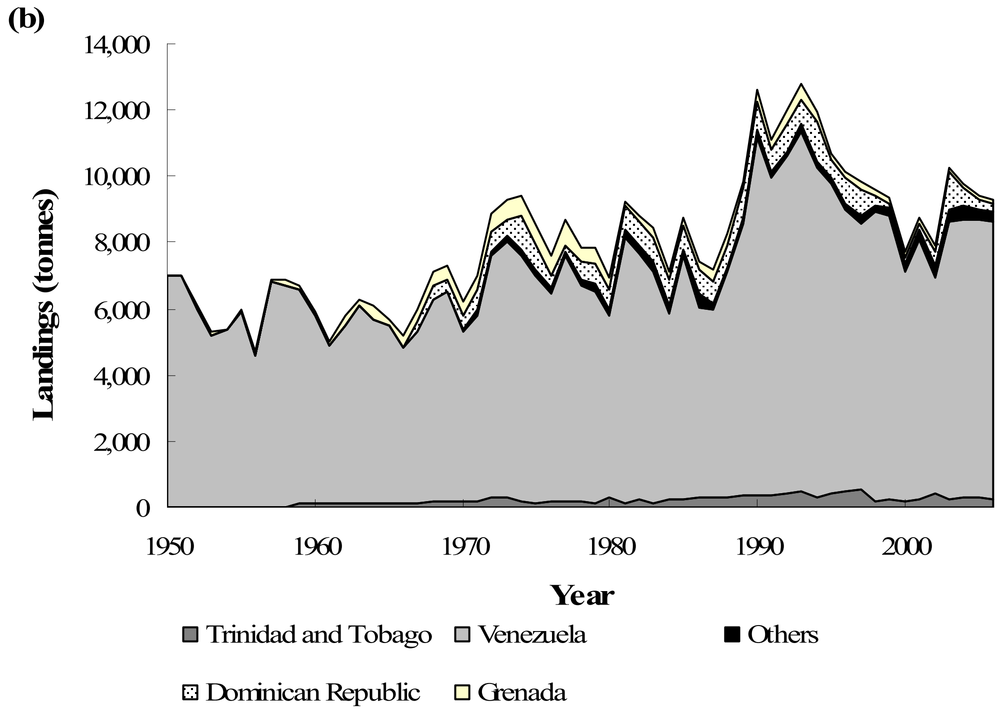


Figure 9. Landings of Crevalle Jacks and other Carangids by Caribbean countries in the Western Central Atlantic Area (a) data for Mexico included; (b) data for Mexico excluded.

1.8.4.5 Recommendations

Catch and effort data collection in Trinidad and Tobago should be expanded to include the semi-industrial multi-gear fleet, trawl fleets (by-catch) and recreational fleets, as well as artisanal fleets in Tobago. This expansion would facilitate calculation of better estimates of catches for the species. In addition, catch and effort data from other countries in the Eastern Caribbean should be obtained. Currently catches of *Caranx hippos* are either grouped with other Carangids or not reported. Data in the FAO FishStat database for the Western Central Atlantic Region should also be disaggregated to the species level to facilitate better estimation of total removals of *Caranx hippos* due to fishing.

Delineation of the *Caranx hippos* stock(s) and improved reporting by species would facilitate more accurate interpretation of the landings data i.e. uncertainties arising from whether or not data from Mexico should be included in the analyses (as these two scenarios show entirely different trends) and whether or not landings data for the United States, Japan, Korea and Colombia in the WECAFC area should be included in the analyses, would be reduced.

1.8.5 Total Mortality

1.8.5.1 Objective

The objective was to estimate total mortality of *Caranx hippos* from examination of length frequency data.

1.8.5.2 Data used

A total of 2,294 length measurements collected each month from July 1995 to July 1998 and from March to December 2004 were examined. Samples were taken from 293 boat trips which utilized a variety of gears: A-la-vive, banking, beach seine, fishpot, gillnet, switchering and trolling.

1.8.5.3 Method/Models/Data

Trends in length frequency data for each gear type were explored using simple bar graphs created in Excel and changes in mean length of all fish as well as fish caught in gillnets only were examined.

Total mortality (Z) was estimated for two periods, 1995 to 1998 and 2004, using Beverton and Holt (1956, 1957) mean length mortality estimator and length-converted catch curve analyses. Length-at-full vulnerability (L_c = 33 cm) was estimated from a cumulative length frequency plot of all individuals captured. Alternative L_c estimates of 25 and 30 cm were also used for sensitivity. Estimates of Linf, K and t0 were taken from a modified version of Kishore and Solomon (2004), for observed length-at-age on sectioned sagittae. Since length frequency data were not disaggregated by sexes the estimates of Linf, K and t0 considered most appropriate for the species in Trinidad were 1237.5 mm, 0.082 year^{-1} and -1.799 respectively, for 179 fish examined. These estimates were used as the maximum in sensitivity analyses. The growth parameter estimates, derived for males (Linf = 1018.5 mm; K = 0.104 year-1; t0 = -1.691), from a sample size of 81 fish was used as the minimum estimate in the total mortality sensitivity analyses. Due to limited sample size an analysis was also conducted using all samples across all gears that had been measured during the study. The trade-off in this decision was between increasing sample size and the uncertainty that arises from the different selectivity patterns of the different gears.

Total mortality using the Beverton-Holt estimator

The derivation of the Beverton-Holt estimator begins with the assumption that growth is asymptotic as described by the von Bertalanffy equation

$$L_t = L_\infty(1 - \exp(-K(t - t_o))) \qquad (1)$$

where L_t is the length at age t, and L_∞, K and t_o are the parameters. Also assume that the instantaneous total mortality rate is constant over time and over age for all ages $t > t_c$, where t_c is the age at which animals are fully vulnerable to the fishery and to the sampling gear. Denote this mortality rate by Z yr^{-1}. Further, assume that recruitment is continuous over time at constant rate R. The mean length of those animals above the length L_c corresponding to the age t_c is

$$\bar{L} = \frac{\int_{t_c}^{\infty} N_t L_t dt}{\int_{t_c}^{\infty} N_t dt} \qquad (2)$$

where L_t is given by (1) and $N_t = R\exp(-Z(t-t_c))$. Performing the integrations in (2) and simplifying yields

$$\bar{L} = L_\infty(1 - \frac{Z}{Z+K}\exp(-K(t_c - t_o))) \quad . \qquad (3)$$

Equation (3) is easily solved for the mortality rate and the parameter t_o can be eliminated through algebraic manipulation using equation (1):

$$Z = \frac{K(L_\infty - \bar{L})}{\bar{L} - L_c} \qquad . \qquad (4)$$

There are six assumptions behind this method.

1) Asymptotic growth with known parameters K and L_∞ which are constant over time.
2) No individual variability in growth.
3) Constant and continuous recruitment over time.
4) Mortality rate is constant with age for all ages $t > t_c$.
5) Mortality rate is constant over time.
6) Population is in equilibrium (i.e., enough time has passed following any change in mortality that mean length now reflects the new mortality level).

Total mortality using the length-converted catch curve

The length-converted linearized catch curve model, based on a graph of the logarithm of numbers caught against relative age, was used (described in Sparre and Venema 1992, pg 126). The approach assumes a "constant parameter system", i.e. recruitment, fishing and natural mortality are constant each year and as a result the population of a single cohort over its entire lifespan is no different from the population of all the different cohorts of the entire stock in a particular year.

Length data were converted to relative age (t) using a modification of the von Bertalanffy equation at (1) with growth parameters from Kishore and Solomon (2004): t = -(ln (1-Lt/Linf)). Two points were selected on the graph of ln catch (numbers) versus relative age, one representing one of the three estimates of Lc and the other a maximum length at which fish were thought to be fully vulnerable. Total mortality (Z) was estimated from the slope of the line joining the two selected points, from the equation: Z = K (1 – slope); where K is one of the von Bertalanffy growth parameters.

1.8.5.3 Results and Discussion

Length frequency

There was an uneven distribution of sampling effort across gears, years and months (Tables 3 and 4). Of the 2294 fish measured 1287 were from gillnet catches, 475 from banking, 242 from a-la-vive, 186 from switchering, 74 from trolling , 21 from beach seines and 9 from other gears. Annually, sample sizes ranged between 93 (1995) and 863 (1997) fish. Except for fish measured from gillnets, sample sizes from other gears were too small for examining the modal progression of individual year classes (Figure 10). Although mean length of fish caught in gillnets varied from month to month, there appeared no clear change between mean length in the early (1995 to 1998) and late (2004) periods (Figure 11). The length at full vulnerability was estimated at 33 cm FL from a cumulative length frequency plot (Figure 12).

Table 3. Summary of length frequency sampling coverage (number of fish measured) in Trinidad by gear and year.

Year	Gillnet	Banking	A-la-vive	Switchering	Trolling	Beach Seine	Other	Total
1995	40	48		1		4		93
1996	422	58	10	69	17		1	577
1997	301	286	205	21	26	17	7	863
1998	76	82	3	8	2		1	172
2004	448	1	24	87	29			589
Total	1287	475	242	186	74	21	9	2294

Table 4. Summary of length frequency sampling coverage (number of fish measured) in Trinidad by month and year.

Month	1995	1996	1997	1998	2004	Total
1			3	45		48
2		3	252	4		259
3		41	130	4	37	212
4		78		46	22	146
5		34	19	15	139	207
6		14	101	33	256	404
7	4	34	66	25	39	168
8	3		2		62	67
9	50	180	94		2	326
10		124	171		31	326
11	35		13			48
12	1	69	12		1	83
Total	93	577	863	172	589	2294

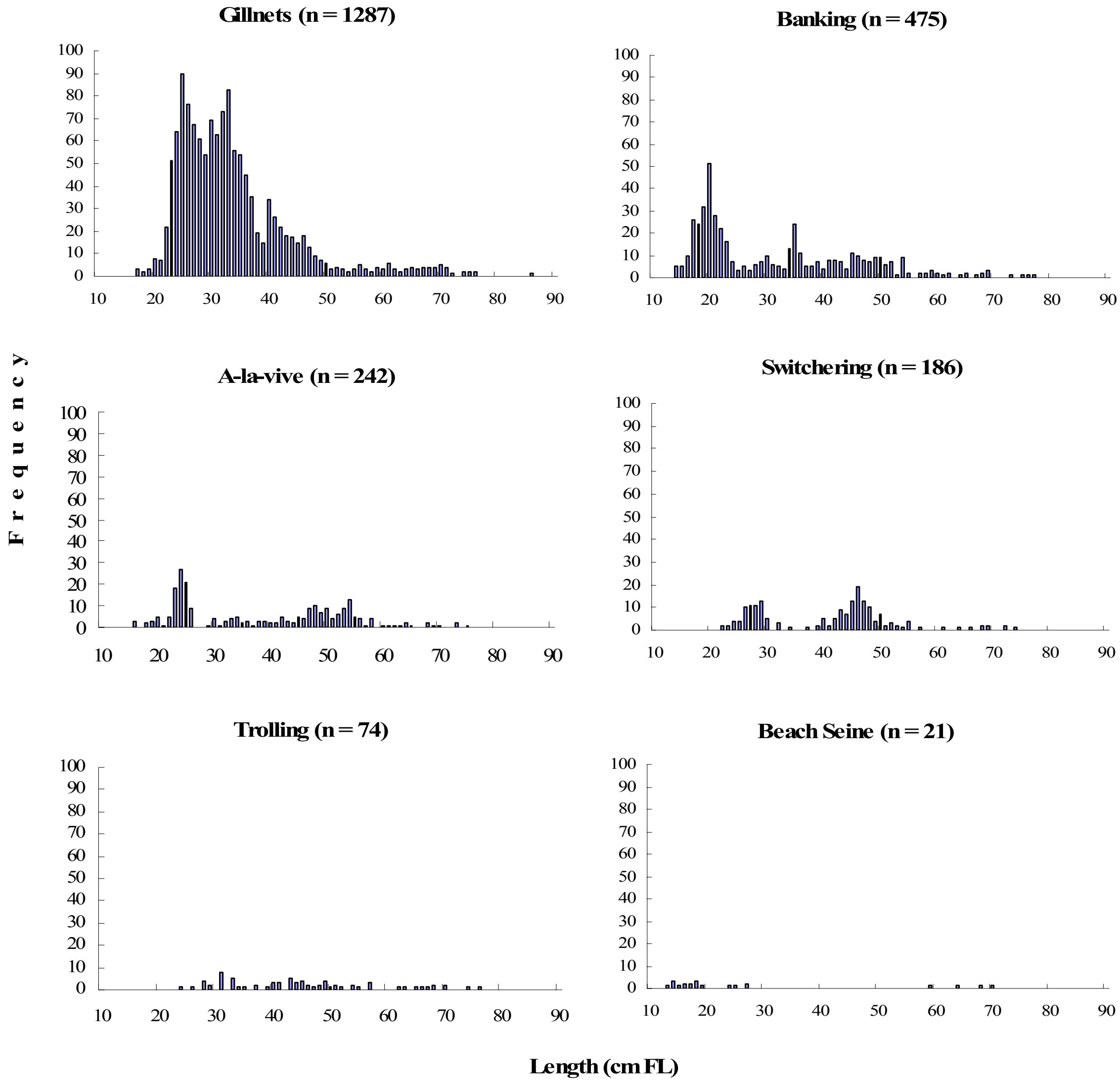


Figure 10. Length frequency distribution of *Caranx hippos* for a variety of gears.

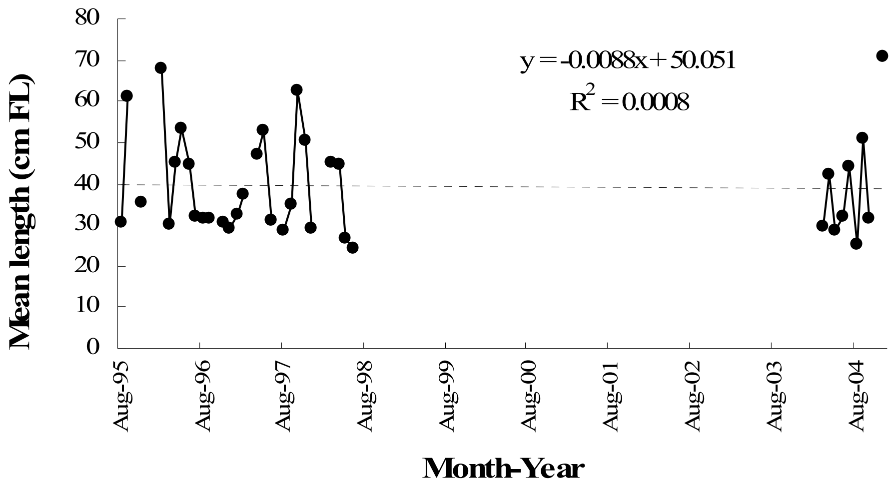


Figure 11. Monthly mean length of *Caranx hippos* caught in gillnets.

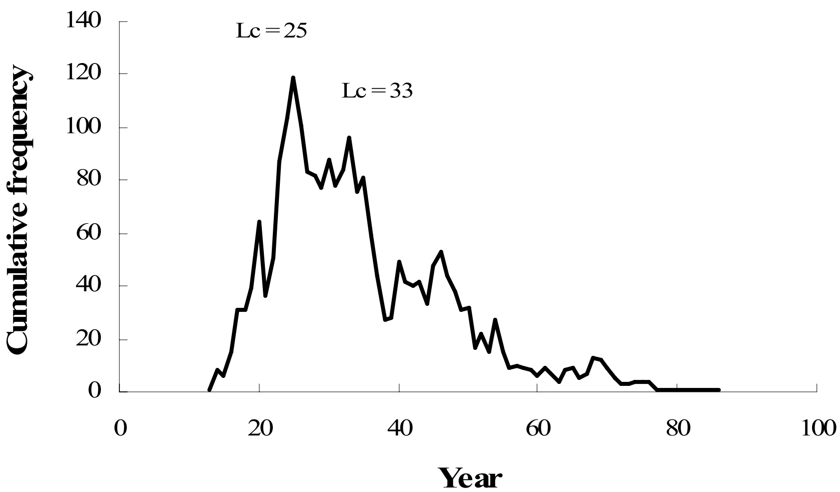


Figure 12. Cumulative length frequency of *Caranx hippos* caught by a variety of gears. (Length at full vulnerability = 33 cm FL)

Total mortality using the Beverton-Holt estimator

Due to the varying selectivity of different gears utilized in the fishery and observation of corresponding length frequencies, it was felt that the length frequency data from gillnet samples most appropriately depicted total mortality for the species. Based on the higher estimate of Lc and best estimate of growth parameters for *C. hippos* in Trinidad, the best estimates of total mortality were 0.673 $year^{-1}$ and 0.88 $year^{-1}$ for the 1995 to 1998 and 2004 periods respectively (Table 5). The corresponding range in total mortality was 0.441 to 0.673 $year^{-1}$ in the 1995 to 1998 period and 0.589 to 0.95 $year^{-1}$ in 2004. It is noted that gillnets are possibly selective for larger sizes and therefore total mortality may be overestimated, thus explaining the associated higher estimates in Table 5.

Table 5. Total mortality estimates using the Beverton and Holt (1956) equation. Maximum: Linf = 123.75 cm; k = 0.082 year^{-1}; Linf = 101.85 cm; k = 0.104 year^{-1}.

Lc (cm LF)	**All fish**			**Fish caught with gillnets**		
	Lmean (cm FL)	Maximum	Minimum	Lmean (cm FL)	Maximum	Minimum
1995 - 1998						
25	39.674	0.470	0.441	36.781	0.605	0.574
30	43.542	0.486	0.448	40.365	0.660	0.617
33	45.775	0.501	0.457	42.861	**0.673**	0.622
2004						
25	36.504	0.622	0.591	33.651	0.854	0.820
30	40.292	0.665	0.622	37.447	0.950	0.899
33	43.335	0.638	0.589	40.739	**0.880**	0.821

Total mortality using the length-converted catch curve

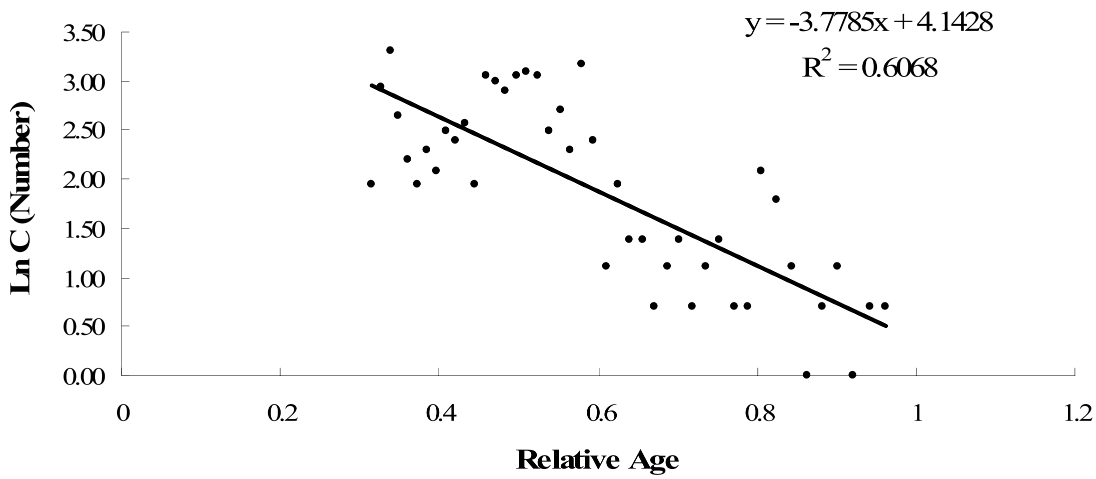
Estimates of Z, derived using data for fish caught in gillnets only, were consistently higher than those estimated when data from catches of all gears were combined (Table 6). This is due to the elimination of larger fish in the catch curve analysis after inspecting the residuals of the catch curve relationship (Ln (number of fish)*relative age), Figure 13). The observation of large fish may be due to the selectivity pattern of the gear. The elimination of these fish in the analysis results in estimates of Z that are likely biased high (i.e. and upper bound).

Based on the higher estimate of Lc and best estimate of growth parameters for *C. hippos* in Trinidad, the best estimates of total mortality were 0.938 year^{-1} and 0.88 year^{-1} for the 1995 to 1998 and 2004 periods respectively (Table 6). The corresponding range in total mortality was 0.409 to 0.938 year^{-1} in the 1995 to 1998 period and 0.578 to 0.959 year^{-1} in 2004.

Table 6. Total mortality estimated from a linearized length-converted catch curve. Maximum: Linf = 123.75 cm; k = 0.082 year^{-1};Minimum: Linf = 101.85 cm; k = 0.104 year^{-1}.

Lc (cm LF)	**All fish**		**Fish caught with gillnets**	
	Maximum	Minimum	Maximum	Minimum
1995 to 1998				
25	0.446	0.415	0.767	0.734
30	0.448	0.412	0.830	0.784
33	0.447	0.409	**0.938**	0.786
2004				
25	0.616	0.604	0.891	0.868
30	0.578	0.622	0.959	0.924
33	0.583	0.570	**0.880**	0.848

(a)



(b)

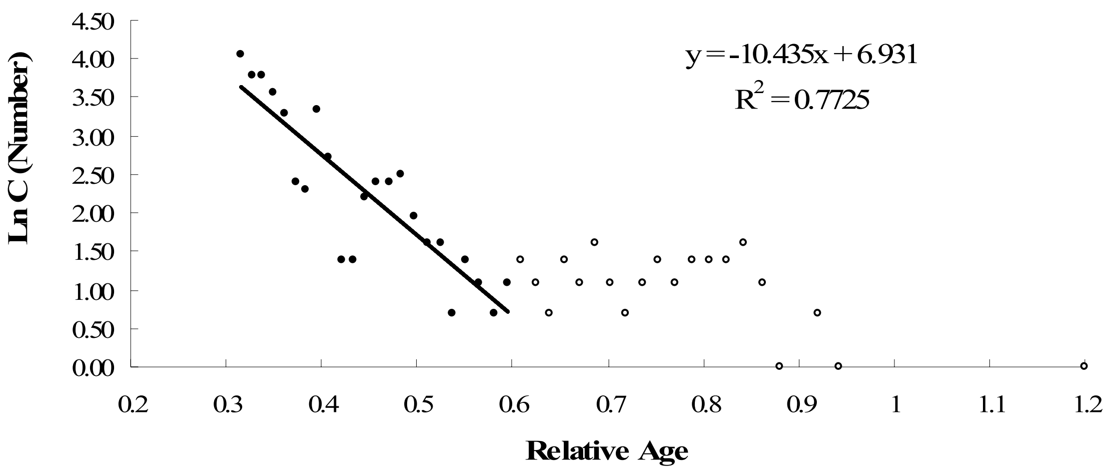


Figure 13. Linearized length converted catch curve analysis using data from 1995 to 1998 with maximum growth parameters and Lc = 33 cm for (a) all fish and (b) fish caught with gillnets.

1.8.5.4 Recommendations

The sampling strategy for collection of length frequency data should be evaluated to maximize the benefit of data collected given the limited resources. The goal of the sampling strategy should be to investigate selectivity of the gears and provide a reliable estimate for the mean length of the population. Sub-sampling strategies which account for temporal and spatial distribution of effort within the different fisheries will increase the likelihood of successful sampling trips and therefore minimize the work necessary to provide reliable results. An alternative approach may be to generate estimates of mean length from a single, consistent, annual sampling event (e.g. large number of samples taken from the same locations and gears at the same time of year). Collection of length frequency data should commence in 2009.

1.8.6. Natural and Fishing Mortality

1.8.6.1 Objective

The objective was to estimate natural mortality and fishing mortality of *Caranx hippos*.

1.8.6.2 Method/Models/Data

Natural mortality was estimated using empirical formulae after Peterson and Wroblewski (1984), Hoenig (1983), Pauly (1986), Chen and Watanabe (1989), Jensen (1996) and estimates of parameters in the length-weight relationship derived above, growth parameters from Kishore and Solomon (2004), age-at-maturity from the Florida Fish and Wildlife Conservation Committee (2005) and an assumed temperature of 27 ºC. Fishing mortality was estimated as the difference between total and natural mortality.

1.8.6.3 Results and Discussion

Natural mortality estimates ranged between 0.123 and 0.33 $year^{-1}$ (Table). Since estimates of age-at-maturity were not specific to the species in Trinidad and Tobago greater confidence was placed in the estimate of 0.23 $year^{-1}$ derived from Pauly (1986) using locally derived growth parameters (Kishore and Solomon, 2004).

Fishing mortality was estimated at between 0.443 and 0.708 $year^{-1}$ in the earlier period (1995 to 1998) and 0.65 year-1 in the later period (2004). Fishing mortality ranged between 0.211 $year^{-1}$ and 0.708 $year^{-1}$ for the lower and upper bound estimates of total mortality respectively.

Table 7. Natural mortality of *Caranx hippos* in Trinidad.

Method	Inputs	M ($year^{-1}$)
Peterson and Wroblewski (1984)	Length-weight parameters: a = 0.025; b = 2.805 (this study)	0.211
Hoenig (1983)	Max. Age = 13 years (Kishore and Solomon, 2004)	0.323
Pauly (1986)	Linf = 123.75 K = 0.082 (Kishore and Solomon, 2004) Temperature (T) = 27 ºC	0.230
Chen and Watanabe (1989)	K = 0.082 t0 = -1.799 (Kishore and Solomon, 2004)	0.151
Jensen (1996)	Age-at-maturity = 5 years (Florida Fish and Wildlife Conservation Committee, 2005)	0.330
Jensen (1996)	K = 0.082 (Kishore and Solomon, 2004)	0.123

1.8.7. Catch per Unit Effort

1.8.7.1 Objective

The objective was to examine trends in abundance of *Caranx hippos* from 1995 to 2007, using the catch per trip as an index of abundance.

1.8.7.2 Method/Models/Data

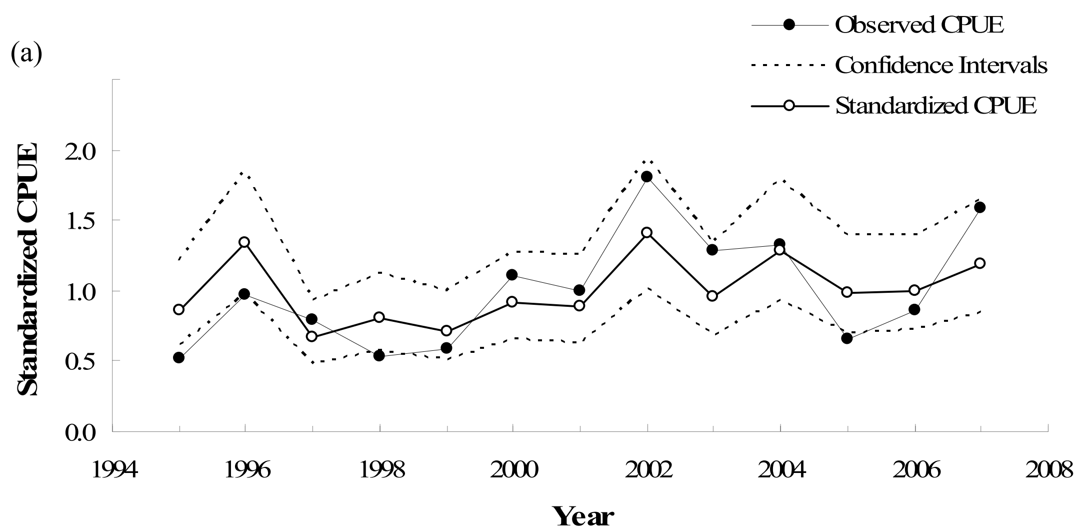
A preliminary assessment of stock status was carried out using catch per trip (CPUE) data collected from the artisanal multi-gear fleet. The observed CPUE were used to develop a standardized index for evaluating changes in stock abundance. General linear modeling regression methods were used to obtain yearly estimates of CPUE. The analyses were carried out using all of the fishery CPUE observations from 1995 through 2007 from the primary gears accounting for the majority of the landings (beach/land seine (43%), monofilament and multifilament gillnets (22%), a-la-vive + trolling + switchering (22%), banking (8%)) and the minor gears were included for completeness (Fishpots , trawling ~ 2%). Observations from fisheries with similar operating characteristics were combined into a single fishery (gear) for the model (e.g., monofilament + multifilament gillnets; a la vive + trolling + switchering). Values of standardized CPUE were obtained using a general linear model (GLM) which accounted for the variation in CPUE across time (year, month), fishery (gear), and area (fishing landing area), Table 8. During development of the master data set used in the CPUE analyses a number of data coding inconsistencies was revealed, in particular relating to calculation of hours fished using date of departure and date of return as well as time of departure and time of return. It was necessary to exclude those observations which could not be reconciled.

Table 8. Class level information for general linear modeling method to estimate a standardized catch per trip.

Class	Levels	Values
Year	13	1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Month	12	1 2 3 4 5 6 7 8 9 10 11 12
Area	10	Guyana, East Coast, Northeast, North Coast, Northwest, South Coast, Southeast, Southwest, Venezuela, West Coast
Gear	6	Gillnets, A-la-vive + Trolling + Switchering, Banking, Beach Seine, Fishpots, Trawling

<u>1.8.7.3 Results and Discussion</u>

The standardized CPUE index did not indicate large changes over the time series, 1995-2007 (Figure). In general the CPUE predicted by the model followed the CPUE pattern of the observed data, unadjusted for variation in time (month), fishery (gear) or space (area). There was some tendency for the model to overestimate the observed yearly abundance trend. Although there appears small increases in CPUE in recent years, results are inconclusive due to the wide confidence intervals assigned to the standardized index. Since *Caranx hippos* stock is a shared resource the CPUE index developed may be representative of local, rather than regional, abundance. Based on the results, there is no strong evidence to suggest that the population size has changed. However, without contrast in the data, it is also difficult to fully assess the stock status. Although Kishore and Solomon (2004) reported that the preference for smaller fish by consumers is reflected in the catch, suggesting that growth overfishing may be occurring, this inference was not supported by CPUE analyses, simply because the overall catch per trip has not changed considerably.



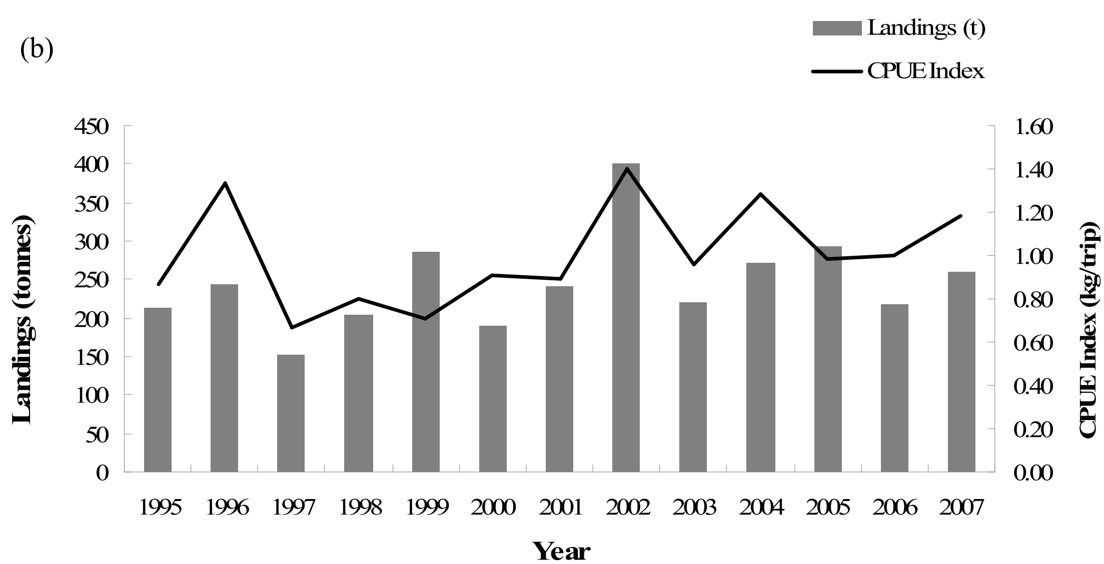


Figure 14. Annual trends in (a) standardized CPUE (kg per trip) and (b) standardized CPUE superimposed on estimated landings of *Caranx hippos*.

1.8.7.4 Recommendations

It is recommended that the time series of CPUE data be extended backwards prior to 1995 (at least ten years back or corresponding to about one life span) as this information could be useful in explaining trends in local abundance of the stock. This activity should commence within the next three months. Continued analyses of the CPUE data should be conducted in the intercessional period to investigate possible causes for the overestimation of CPUE by the model. Additional effort should focus on identifying fishing trips that provide a representative sample of the catch and effort for evaluating the local abundance of the stock.

Physical and ecological indices related to productivity and mortality should be compiled to investigate whether fluctuations in local abundance can be explained. Since indices are already available this activity can provide an inexpensive and potentially useful alternative to prediction of future catches and more specific management advice.

1.8.8 Yield per Recruit

1.8.8.1 Objective

The objective was to determine the current stock status and to examine changes in yield per recruit with various length-at-first capture and fishing mortality to identify management options to maximize yield per recruit.

1.8.8.2 Method/Models/Data

The method after Beverton and Holt (1956, 1957) was used. The inputs were the growth parameters considered most appropriate from Kishore and Solomon (2004), (Linf = 1237.5 mm; k = 0.082 $year^{-1}$ and t0 = -1.799); natural mortality derived using the method after Pauly (1980), (0.23 $year^{-1}$); parameters of the length-weight relationship (a = 0.025; b = 2.805); length at recruitment (L_r) and length at full selection or capture (L_c) both assumed = 300 mm initially; Winf estimated as $a*Linf^b$; age at recruitment (T_r) and age at full selection (T_c) estimated from

$(–\ln (1-L_r/Linf)/K)+ t0$ and$(–\ln (1-L_c/Linf)/K) + t0$ in the following equation for fishing mortality ranging between 0 and 1.1 $year^{-1}$:

$$Y/R = F * \exp[-M * (Tc – Tr)] * Winf *[1/Z – 3S/(Z + K) + 3S^2/(Z + 2K) – S^3/(Z + 3K)]$$

Where:

S = exp (-K * Tc – t0); K = von Bertalanffy growth parameter; t0 = von Bertalanffy growth parameter; Tc = age at first capture; Tr = age at recruitment; winf = asymptotic body weight; F = fishing mortality; M = Natural Mortality; Z = total mortality (F+M).

The assumptions of the Beverton and Holt Yield per Recruit model (Sparre and Venema, 1998) are as follows:

1. Recruitment is constant, yet not specified;
2. All fish of a cohort are hatches;
3. Recruitment and selection are knife-edge;
4. The fishing and natural mortalities are constant once fish enter the exploited phase;
5. There is a complete mixing within the stock and
6. The length-weight relationship has an exponent (b) of 3.

1.8.8.3 Results and discussion

Due to the limitations in length frequency data, described previously, and the resulting wide range in the estimated total mortality (Z), and as a consequence fishing mortality (F), the results of the analyses were inconclusive (Figures 15). At the estimate of F corresponding to the lower bound of Z (0.2 $year^{-1}$), the fishery was either at or close to achieving maximum yield per recruit (MY/R), while at the estimate of F corresponding to the upper bound of Z (0.7 $year^{-1}$) the fishery was either close to MY/R or considerably lower, depending on the length at first capture. The yield per recruit is extremely sensitive to the estimate of natural mortality and varies considerably over the range of F values corresponding to the lower and upper bound of Z, particularly at low M (Figure 16). Improved estimates of total mortality are required to more reliably assess the stock status.

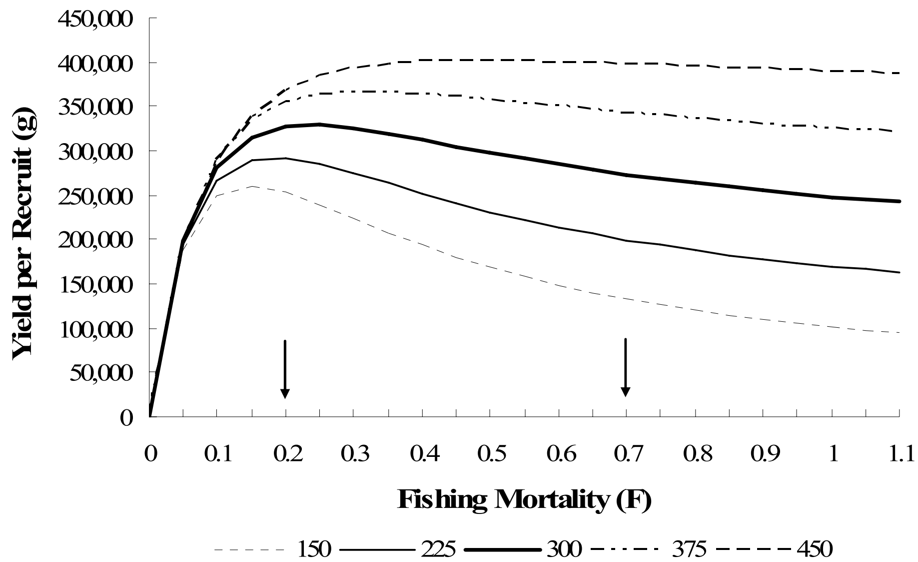


Figure 15. Yield per recruit (g) of Caranx hippos at varying lengths (mm) at first capture. Fishing mortality corresponding to lower and upper bound total mortality estimates indicated by arrows.

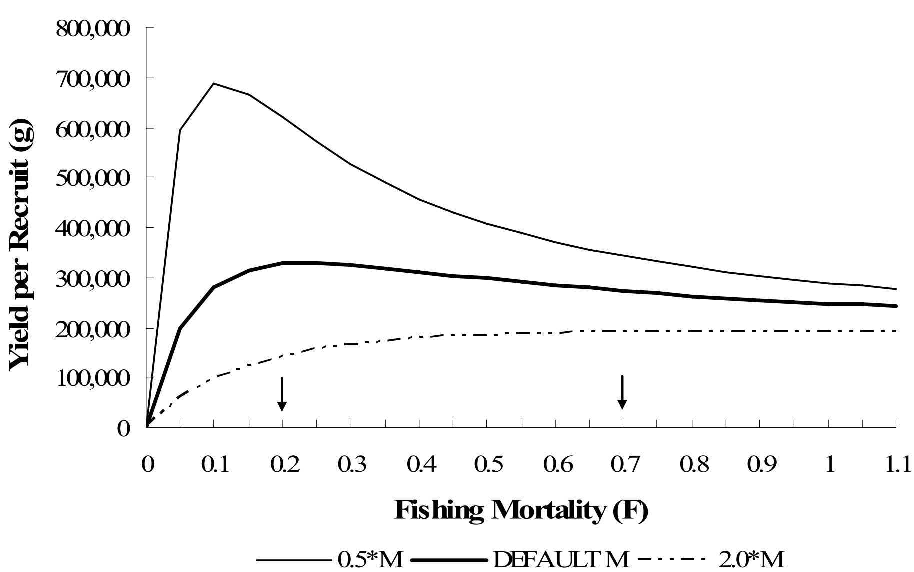


Figure 16. Sensitivity of Yield per Recruit (g) to natural mortality (M) at the default length at first capture (300 mm). Fishing mortality corresponding to lower and upper bound total mortality estimates indicated by arrows.

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REPORT OF THE CONCH AND LOBSTER RESOURCE WORKING GROUP/REEF AND SLOPEFISH RESOURCE WORKING GROUP

Chairman: Lester Gittens (CLWG)
Chairperson: Kathy Lockhart (RSWG)
Rapporteurs: Ramon Cacarmo (Belize), Kishmo Clarke (St. Kitts and Nevis), Lester Gittens (The Bahamas), John Jeffers (Montserrat), Kathy Lockhart (Turks and Caicos Islands), Anginette Murray (Jamaica), Sophia Punnett (St. Vincent and the Grenadines), Sarita Williams-Peter (St. Lucia),
Other group members: June Masters (CRFM Secretariat), Paul Medley, PhD (Consultant)

A. OVERVIEW

It was deemed necessary for the CLWG and RSWG to combine efforts during the current workshop, and hence a joint report was produced. Analyses completed at the current meeting included a preliminary stock assessment (production model) for the Caribbean spiny lobster fishery of Jamaica, development of preliminary carapace length to tail length conversion equations for Caribbean spiny lobster for Jamaica, an updated stock assessment (production model) for the queen conch fishery of St. Lucia, refinement and exploration of catch per unit effort data for the Caribbean spiny lobster fishery of The Bahamas, estimation of fishing mortality trends using a length-converted-catch-curve method for the Caribbean spiny lobster fishery of The Bahamas, the development of proposed minimum size limits for grouper and snapper for the Turks and Caicos Islands as well as quantification of their impacts on fishermen based on fishing gear utilized. St. Vincent and the Grenadines fortified plans for a visual survey for Caribbean spiny lobster and queen conch fishing grounds whereas Montserrat and St. Kitts made plans for data collection. In the case of Belize, a cohort analysis for the Caribbean spiny lobster fishery was completed before the current meeting and presented to the CLWG.

The analyses completed largely fulfill and exceed the proposed analyses promulgated for the Conch and Lobster Resource Working Group for the Fourth Scientific Meeting. The only exception was the refinement of the lobster Total Allowable Catch (TAC) for the Turks and Caicos Islands. This refinement was conducted inter-sessionally.

Recommendations made by the CLWG and RSWG include:-

1. Long-term consideration should be given to making the annual scientific meetings less demanding. Possible avenues for addressing this include the shortening of the plenary session by one day and limiting the scope of the Meeting.
2. Assistance in obtaining funding for small scale research and data collection for individual countries is needed. Recognizing that countries are ultimately responsible for the resources allocated towards managing their fisheries, there is still the occasional necessity of obtaining funding from external sources. Possible avenues of assistance include training in the writing of funding requests and drafting of such requests by the CRFM.
3. There needs to be greater emphasis placed on transfer of knowledge between country representatives and their compatriots in order to facilitate the continued and efficient work of the working groups when there are changes in country representatives from meeting to meeting. This includes where persons leave their department altogether and where circumstances dictate that a different person attend the meeting from year to year.

4. A long-term goal is to maximize the amount of analysis done between meetings and to utilize the meeting for fine tuning, review and planning. This depends heavily on the time that can be spent on such activities between meetings and the abilities of the individuals involved.
5. Greater attention needs to be placed on the inter-sessional work of the working group in order for countries to gain maximum benefit from the meeting.
6. Further training on basic analytic and data handling skills is needed, for example use of pivot tables. The suggested timing of this training in basic skills is during the first day of the meeting so that there is a greater chance that the skills learnt will be retained as they will be used immediately. In addition, the person receiving the training would be the one attending the meeting.
7. Efforts to obtain all data useful in fisheries analysis should resume. This includes sources outside of the agencies that the various representatives work such as visiting researchers, weather departments and universities.
8. The work of organizations that provide eco-labels, such as the Marine Stewardship Council, should be considered by the working groups as there is a possibility that such labels will be needed for continued access to particular markets. Adherence to MSC standards also promotes improved stock assessments and management. The course of action for incorporating such organizations should first be addressed by the Caribbean Fisheries Forum.
9. A consultant, familiar with incorporating socio-economic data into resource assessments, should be invited to the next meeting to provide technical support during the work sessions.

Based on the data that are expected to be available and subject to the approval of the Caribbean Fisheries Forum, the proposed resource assessments for the Fifth CRFM Scientific Meeting are noted below.

Table 1: Proposed Species to be assessed at the Fifth Scientific Workshop

Country	**Species**	
	CLWG	**RSWG**
Belize	lobster, conch	mutton snapper
Jamaica	conch, lobster	
Montserrat		red hind, queen triggerfish
St. Lucia	*conch	multiple species
St. Kitts and Nevis		parrotfish
St. Vincent and the Grenadines	lobster	
The Bahamas	lobster, conch	
Turks and Caicos Islands	lobster, conch	

* dependent on presence of consultant to link socioeconomic analysis to status of the resource

B. FISHERY REPORTS

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

Rapporteur: Lester Gittens
Consultant: Paul Medley

1.1 Management Objectives

Officially endorsed management objectives specific to the spiny lobster fishery are under development. However, the Department of Marine Resources has based management actions on the understanding that export earnings and employment are to be maximized within the limits necessary for sustainable harvests.

1.2 Status of the Stock

The status of the stock is unknown. While length-converted-catch-curve (LCCC) analysis indicates little change in total instantaneous mortality and fishing mortality over the last 9 seasons, the status of the fishery is classified as unknown due to a large degree of uncertainty in the LCCC estimates as well as estimates based on the available catch per unit effort data.

1.3 Management Advice

Efforts to improve assessments of the fishery need to continue as a priority. Aspects of this should include improvements to data collected, research and continued utilization of expert assistance provided through avenues such as the CRFM, the FAO, suitably qualified consultants, research organizations and highly trained staff members.

1.4. Statistics and Research Recommendations

1.4.1 Data Quality

The data utilized for the LCCC analysis was of good quality. However, detailed information on gear selectivity is needed to further advance length-based stock assessments. This is further addressed in Section 1.4.2.

The catch per unit effort (CPUE) data utilized was of limited use for the stock assessment attempted. It remains to be seen whether it accurately functions as an index of abundance. Further refinement of the CPUE is likely to lead to bias. Other avenues of improvement need to be explored such as expansion of landing sites sampled, refinements to data collection methodology for landing sites already sampled and the introduction of log sheets for long fishing trips.

1.4.2 Research

More information on selectivity of fishing gear is needed in relation to the LCCC method. In particular the gear selectivity of traps needs to be compared to the lobster hook-casita combination. This information may serve to explain the excessively high mortality estimates obtained using the LCCC method and improve the reliability of results obtained from this method.

The time delay between catches and exports needs to be quantified and elucidated in order to improve stock assessment options. This includes the delay between catching and selling to processing plants and the delay between purchase by processing plants and exports. This information is needed because there is currently great difficulty in assigning landings to the date that the lobsters were actually caught and landed when monthly export records are utilized.

1.5 Stock Assessment Summary

1.5.1 Length-converted-catch-curve-analysis

A length-converted-catch curve analysis was updated and yielded an estimate of total instantaneous mortality and fishing mortality for the 2007-2008 season based on size-frequency data obtained from processing plants. These mortality estimates do not show a major trend since 1999-2000 thus indicating a degree of stability in the fishery (Figure 1). However, the mortality estimates are unrealistically high and contain enough uncertainty that they do not allow for the status of the fishery to be accurately determined. Evidence of the unrealistic nature of the estimates is seen when one applies the total mortality estimates to a hypothetical fishery. After 5 years the hypothetical fishery would collapse. However, the true fishery continues to exist after the nine seasons depicted.

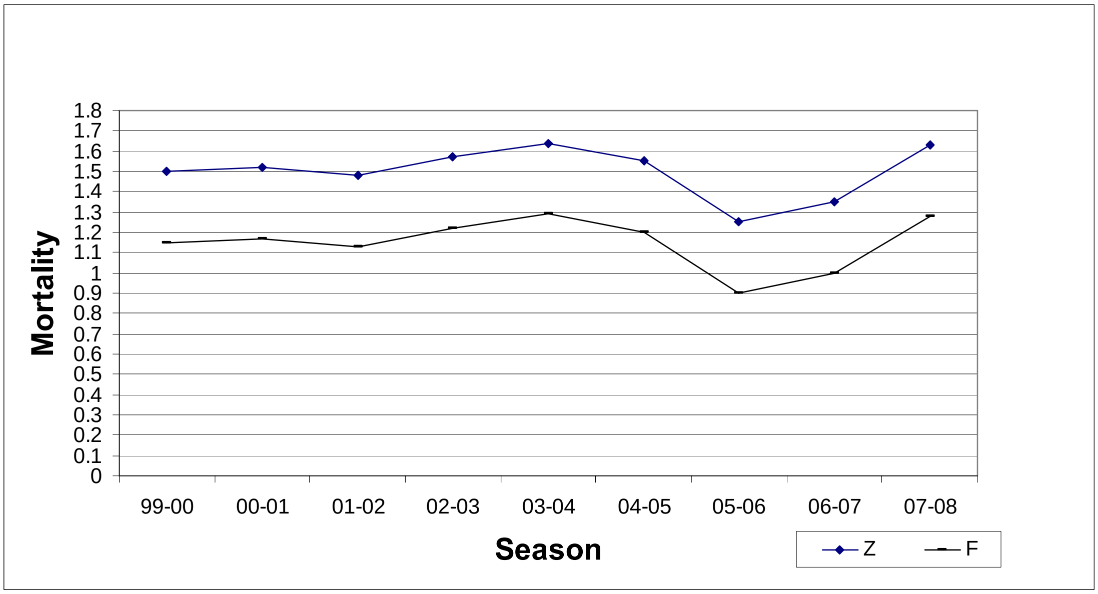

Figure 1: Mortality Estimates Based on Length-Converted-Catch-Curve Analysis

1.5.2 Catch per Unit Effort (CPUE) Analysis

Analysis of CPUE data that were collected between 1988 and 2007 indicated that there was a strong relationship between catch and effort and thus the likelihood that models involving CPUE would be appropriate (Figure 2). However, an attempt to apply an in-season depletion model to the data showed that the CPUE data did not serve as a good index of abundance for the fishery.

Further refinement of the CPUE data is likely to introduce bias; however this should still be explored given the absence of any other index of abundance for this fishery and the unknown status of the fishery.

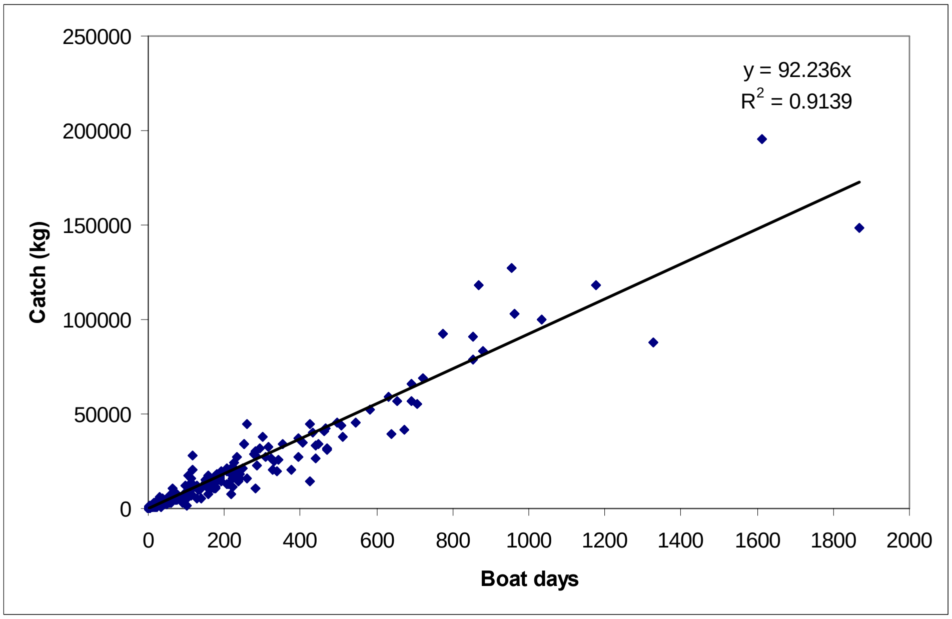

Figure 2: In Season Catch vs. Effort for the Spiny Lobster Fishery

1.5.3 Monthly Export Records Analysis

The time it takes between catching and purchasing of lobsters by processing plants, as well as the time it takes between purchasing of lobsters by processing plants and actual exportation currently confounds allocating the amounts of lobsters exported to actual catch dates. Analysis of monthly export records is potentially useful in stock assessments if a method can be developed to allocate exports to catch dates.

1.6 Special Comments

During the Second CRFM Scientific Meeting (two years ago), The Bahamas was able to convert commercial export data obtained from processing plants into length-frequency data for one season. Since then, progress has been made in converting data from the 1999-2000 season through the 2007-2008 season to length-frequency data for use in length based assessments such as length-converted-catch-curve-analysis. This yielded total instantaneous mortality and fishing mortality estimates for the period specified. Current efforts are now focused on improving the estimates obtained from the LCCC method and exploring methods that utilize an index of abundance.

1.7 Policy Summary

Much work remains to be done to determine whether spiny lobster harvests are at all sustainable. From that point onward, determinations can be made on whether maximum export earnings and employment are being accomplished within the limits of sustainable harvests.

1.8 Detailed Scientific Report

1.8.1 Description of the Fishery

The commercial fishing industry of The Bahamas is based primarily on the Little Bahama Bank and the Great Bahama Bank.

A fisheries census conducted in 1995 showed that there were approximately 9,300 fulltime fishers and over 4,000 small boats and vessels. 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. Some vessels stay at sea up to five weeks. Some mother ships have a freezer capacity of 40,000 lbs; however, around 20,000 pounds is the typical maximum landed by a large mothership at one time. Many of the smaller vessels and persons who fish only at the beginning of the lobster season make only 1-day trips. Virtually all landings from the fishery are lobster tails.

Fishing gear utilized includes spears, the lobster hook, compressors, lobster traps and casitas. Of these, a license is required for compressors and for lobster traps. The number of casitas is unknown. However, it is known that there is widespread use. Records show that approximately 60,000 traps are in use.

Most lobsters are caught with the aid of casitas (locally known as condominiums). Casitas have increased in popularity since the late 1980s and usually consist of a sheet of zinc placed on concrete blocks or wood. It is estimated that during 1995-1997 the proportion of lobsters caught using casitas vs. other fishing gear peaked and has remained unchanged. A casita is not usually removed from the sea except to be relocated although relocation is not very common. A typical casita lasts about five years. Large scale replacement occurs following hurricanes.

When lobsters aggregate under a casita, a fisher simply lifts the sheet of zinc, uses one end of a lobster hook to catch a lobster and the other end to pierce the exoskeleton on the ventral surface of the thorax. This immobilizes the lobster. The majority of lobsters under the casita are caught before they find refuge elsewhere and either released or retained depending on the size.

There has been a general increase in annual landings from the lobster fishery since the 1980s with an eventual peak in 2003 (Figure 3). Since 2003, there has been an overall decline in landings.

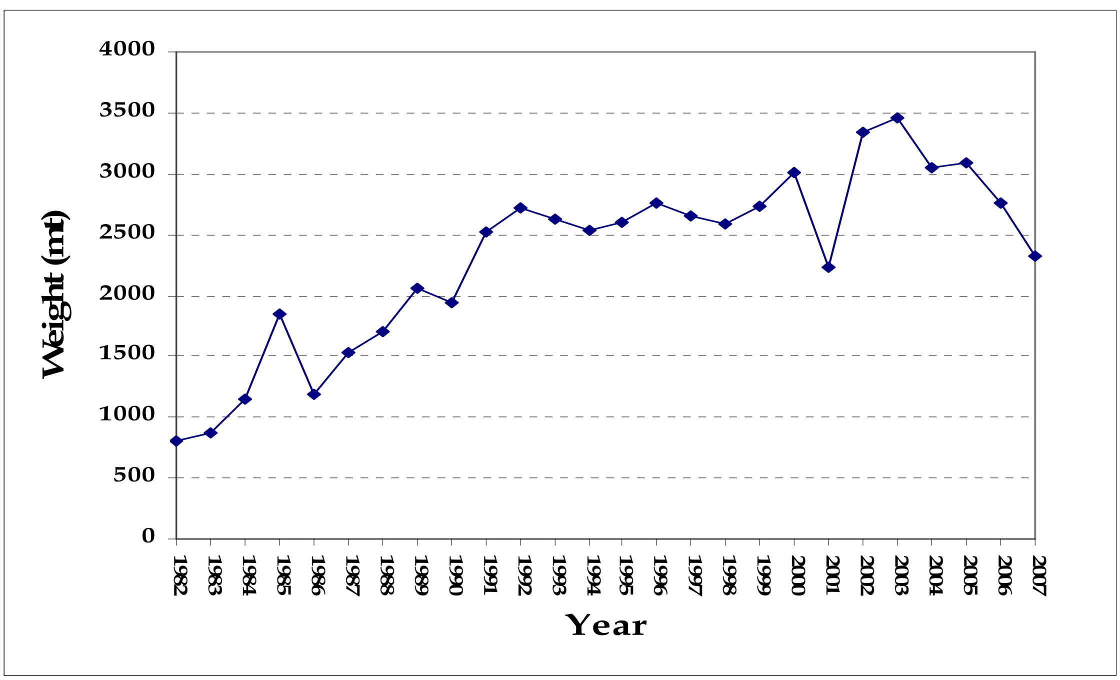

Figure 3: Spiny Lobster Annual Landings in The Bahamas (Tail Weight)

1.8.2 Assessment Objective

The objective of the assessments was to determine the status of the stock in relation to current fishing mortality using generic based reference points.

1.8.3 Data Utilized

Data utilized for the LCCC analysis included processing plant export records that give details on the total weight of each commercial export grade exported for the season, for example, the total weight of 5oz and 6oz tails exported. Other data utilized for the LCCC included tail-length frequency samples from each of the commercial weight categories.

For the CPUE exploration, daily CPUE records from 1988-2007 and total annual landings were utilized.

Total monthly export records were also analyzed.

1.8.4 Assessment 1- Length-Converted Catch Curve (LCCC)

<u>1.8.4.1a Objective</u>

The objective of the LCCC analysis was to estimate total mortality and fishing mortality for the 2007-2008 season and to determine whether over-fishing had occurred during the last nine seasons.

<u>1.8.4.2a Methodology/Models/Data</u>

The majority of the LCCC analysis was conducted during the inter-sessional period after the 2nd CRFM Scientific Meeting. The Bahamas was not a participant at the 3rd CRFM Scientific Meeting. During the current meeting, the LCCC analysis for the 2007-2008 season was conducted and the mortality estimates obtained were compared with those for previous seasons. In addition, we determined ways to improve the LCCC analysis.

The LCCC analysis involved converting commercial export records mentioned in 1.8.3 to numbers per commercial category. The length-frequency data also mentioned in 1.8.3 were then utilized to convert the numbers per weight category to a length-frequency distribution (Figure 4). A spreadsheet based LCCC analysis written by Ehrhardt and Legault (1996) was then utilized to estimate total instantaneous mortality (Z). Population parameters that were utilized in the calculation also included a growth rate estimate of K = 0.24 (Waugh, 1980; FAO, 2001a) and the asymptotic tail length L_∞. L_∞ was calculated utilizing the Taylor (1958) method (L_∞ = max. length observed\0.95). Fishing mortality was calculated based on a natural mortality estimate of M = 0.35 (Arce, A.M. and de León, M. E., 2001) that is believed to be representative of most lobster fisheries and utilizing the formula F = Z-M.

<u>1.8.4.3a Results</u>

The length-frequency distribution (Figure 4) can be considered representative of the lobsters landed in the fishery. Cohorts also appear to be present and the distribution thus appears to be appropriate for length-based stock assessments based on visual inspection of the histogram.

The LCCC analysis yielded a catch curve that allowed the length at first capture to be estimated at Lc = 15cm and the total instantaneous mortality to be estimated at Z = 1.6. Fishing mortality was calculated to be F = 1.3 based on a natural mortality estimate of M = 0.35, L_∞ = 30.5 and K = 0.24.

The 2007-2008 Z and F estimates were higher than the estimates from the previous season; however, there was no overall trend when the last 9 seasons were considered as a whole (Figure 5).

The mortality estimates utilizing the LCCC were considered unrealistically high.

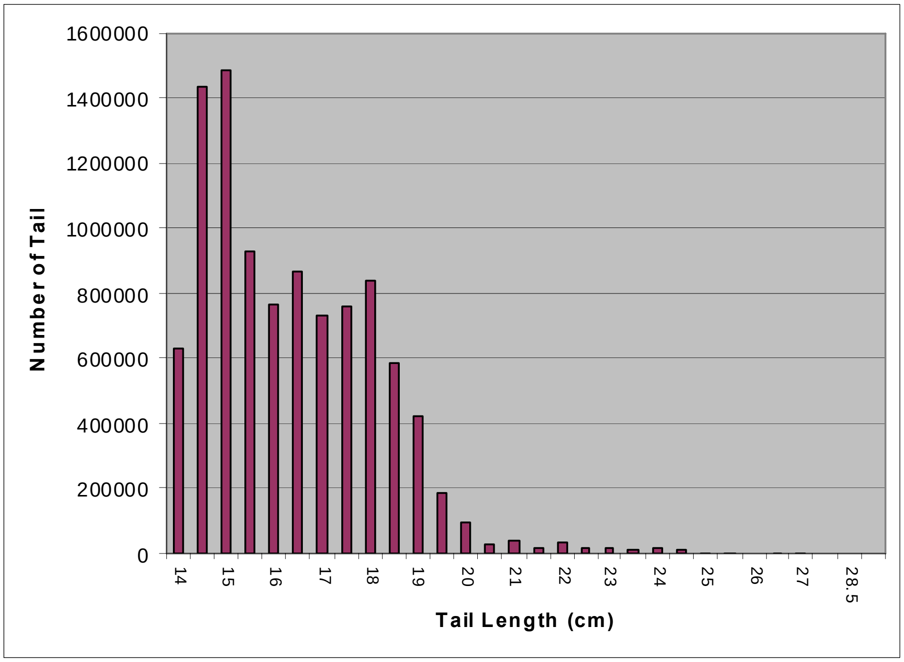

Figure 4: Length Frequency of Spiny Lobsters Exported from The Bahamas in 2007-2008

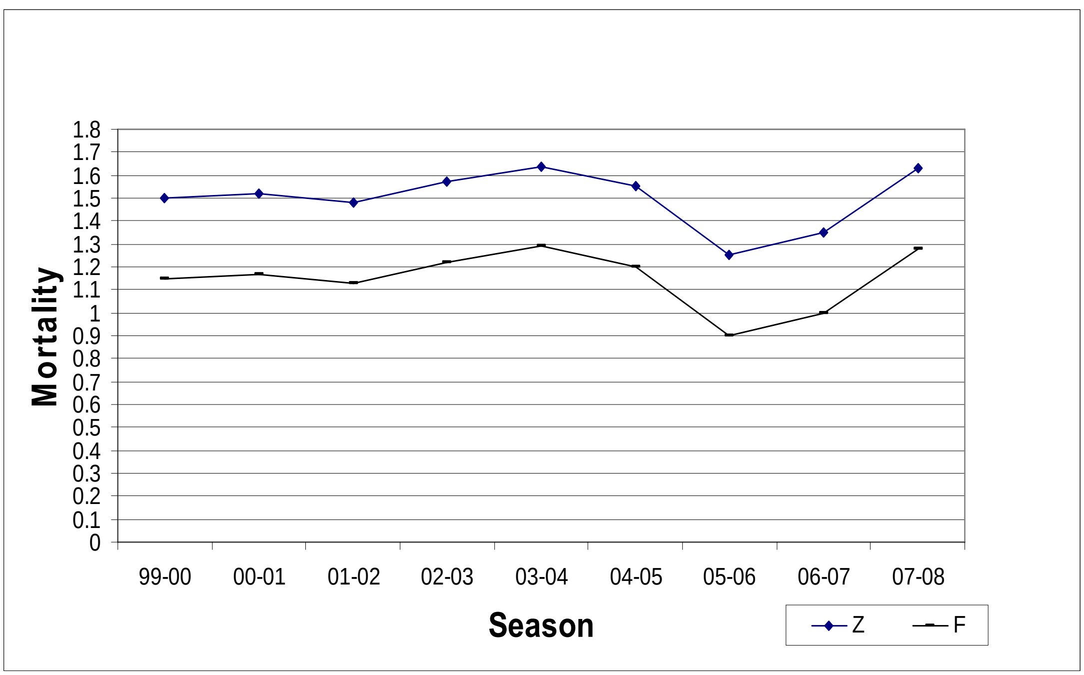

Figure 5: Mortality Estimates for the Spiny Lobster fishery for the 99-00 through 07-08 Seasons

Mean tail length of exported tails was also updated and showed an increase since the previous season. The estimates for the last two seasons reverse a declining trend that existed since the 99-00 season (Figure 6).

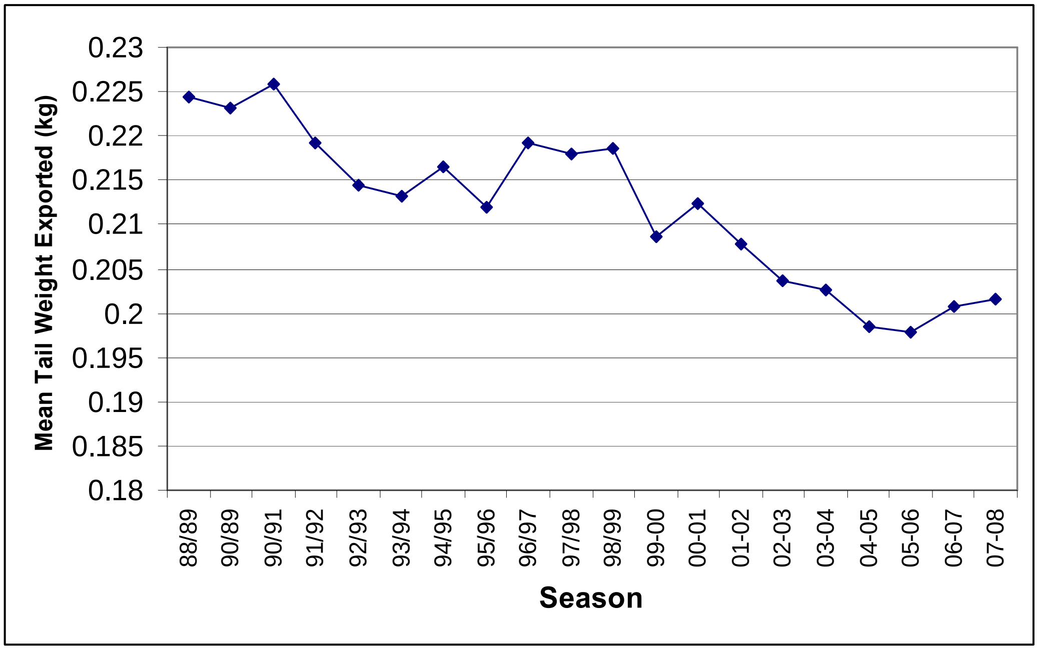

Figure 6: Mean Tail Length of Lobsters Exported from the Bahamas per Season

1.8.4 Assessment 2- Catch per unit Effort (CPUE) exploration

1.8.4.1b Objective

The objective of the CPUE exploration was to review CPUE data and consider standardization to improve CPUE as an index of abundance.

Much of the data cleaning was carried out during the inter-sessional period before the 2008 scientific meeting. The objective at the 2008 Meeting was to finalize this work and reach a conclusion on whether and how these data should be used. This inter-sessional work was funded by CRFM.

1.8.4.2b Methodology/Models/Data

Although The Bahamas has catch and effort data, these data have proved difficult to use in the past due to the problems with the way effort were recorded, errors in the data and problems with interpretation. All data were re-evaluated based on a new cleaned data set.

The data were reviewed and three options for a CPUE index were identified: days fishing, man-days fishing (crew*days fishing) and boat days (boats*days fishing).

The main standardization would be based on gear types: hook and spear. These gears would need to be separated. Unfortunately, when there was a change from spear to hook, the change was not recorded and therefore it may be necessary to break the time series, estimating different catchabilities for spear over time. This could be done within the stock assessment if necessary.

A number of tasks were completed in on-going cleaning and improving the data and are described below:-

- Only the diving catch and effort data were retained; catch and effort based on traps were removed. The lack of trap soak time data and non-linear relationship between soak time and abundance would make any index based on these data unreliable. This was a significant change from the inter-sessional activity, which was trying to deal with all records.

- Dealing with only lobster allowed faster progress, but does not deal with problems in the underlying database.

- Catch and effort data for 1988-2004 and 2005-2007 have different formats. The data were converted from the 2005-2007 format to the 1988-2004 format to combine the data into a single data table.

- All records were removed where the landings were less than 50% lobster. This ensured that the effort was predominantly targeting lobster. In these cases, noting that a diving gear was being used, it was argued that some bycatch would indicate difficulty finding lobster so a lower CPUE would be appropriate.

- Excessively long days fishing (>30 days) were removed as either there was an error in data entry or the trip length would make the trip interview less reliable. Even where such trip lengths are correct, without logbooks, it is not likely that effort can be recorded accurately. Only 5 records were removed.

- Catch-effort records were removed where CPUE was too high to be realistic, indicating a recording error or that important data were missing:
    - Where the CPUE > 1000 lbs per man per day,
    - Where CPUE < 10 lbs per man per day and days at sea > 1.

- In all cases the catch and effort data were corrected where possible. Reviewing the data however suggested that many CPUE data remain which are unrealistically high although possible. Dealing with these may require a "robust" likelihood which is not strongly influenced by outliers.

- Where the number of dinghies exceeded the number of crew on board or the crew was recorded as zero, the records were removed (when these were removed boats required 2 crew per vessel). In some cases the number of boats was given as zero. In these cases, based on the crew size, the number of boats could be safely assumed to be 1 (i.e. a single vessel).

- Where appropriate, catches were converted from lobster landed whole to lobster tails, which make up the majority of the landings. The date mid way between the date the vessel left on the trip and the report date is used to allocate the CPUE among months. Otherwise the record was checked for consistency with respect to days-at-sea >= days-fishing and that trip start date and report date were consistent. Records which were inconsistent were deleted.

1.8.4.3b Results

The catch and effort exhibited high correlation, suggesting that there are no gross errors of catch relative to effort. The degree to which the fishing effort is correlated with the trip landings within the time and gear implies that the measure of effort is a reasonable measure of the work done and therefore a better measure of effort suitable for an abundance index (such as area searched). If this relationship is linear, a constant catchability with increasing catch and effort may be assumed (the slope of the regression line).

Boat days seemed, unsurprisingly, the best effort measure. Boat days showed the highest correlation with catch, and a linear relationship (Figure 7). Using man days implied everyone aboard the vessel fishes, which is probably untrue. With, on average, 2 crew per boat, most of the variation in man days is captured in boat days.

The CPUE also shows a within-season decline (Figure 8), which is a common pattern for spiny lobster fisheries which target new recruits at the beginning of the season (Medley and Ninnes, 1997; FAO 2001b, FAO 2003). The average decline translates to a fishing mortality of approximately 0.23 $year^{-1}$ assuming a natural mortality of 0.36 $year^{-1}$ (Arce and de Leon, 2001). The decline only estimates a small proportion of the variance, and there are several outliers evident which are strongly influenced by single data records. Data are also missing, particularly from recent years, making it unreliable for estimating recent mortality.

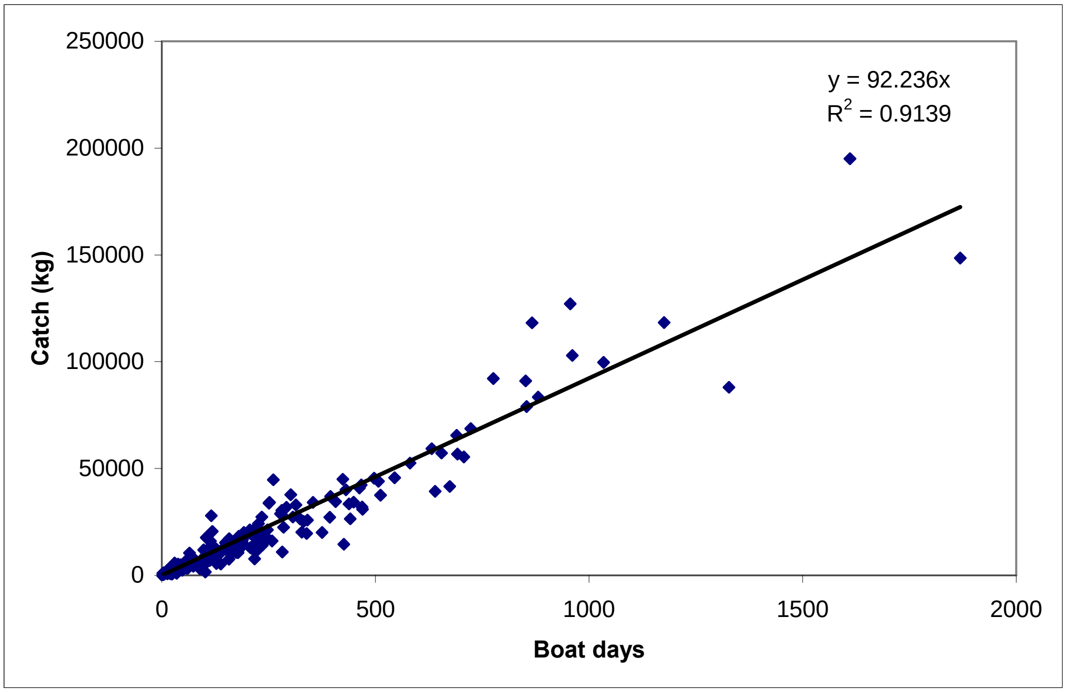

Figure 7 Catch plotted against the proposed effort measure, boat days. The relationship looks to be approximately linear, although there is some indication of an increase in variance of the catch with effort.

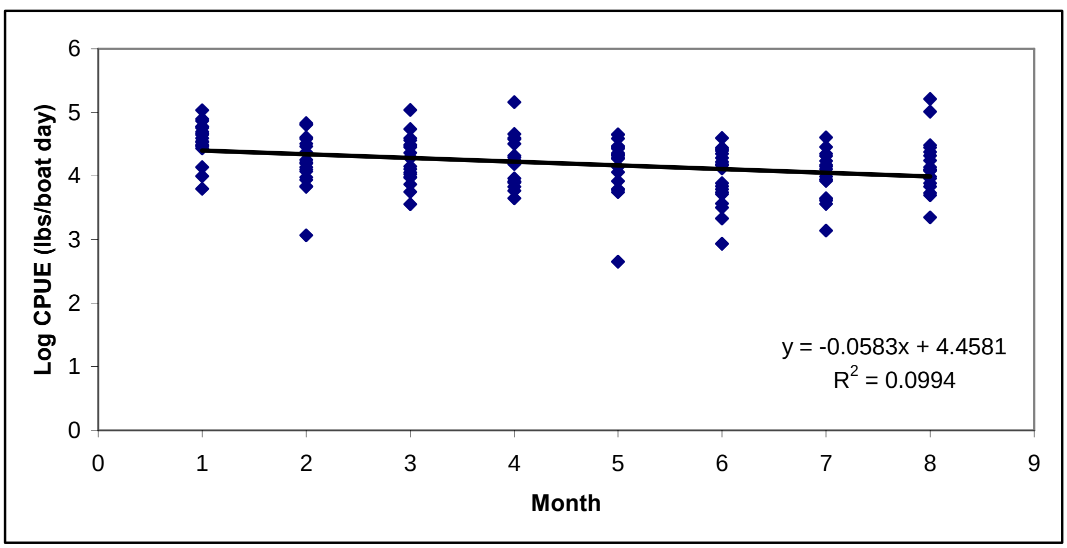

Figure 8 Logarithm of the observed average monthly CPUE plotted against the month of the year from the opening of the season in August (1) to closure in March (8). The CPUE show an average 5.8% decline within the season suggesting a 0.466 total mortality over 8 months. This would translate to an overall average fishing mortality of 0.2264 $year^{-1}$.

1.8.4 Assessment 3- Monthly export Records Analysis

<u>1.8.4.1c Objective</u>

Using the export data, develop a method to estimate or allocate exports to catches.

<u>1.8.4.2b Methodology/Models/Data</u>

Exports are delayed after the catch is taken as they are stored on the vessel in multiday trips and then processed over a period. It will be necessary to take account of this delay when using the within season dynamics to assess the stock. The days at sea are reported from the trip interviews, which give some indication on how long it is between capture and landing.

There are no data for estimating a processing delay. Most lobsters are landed as tails, and processing consists of treatment with preservative and repackaging the tails for exports. The processing itself is unlikely to take long, but processors will need to consolidate landings to produce a single export amount requested by the importer, which may take some time. It is expected that the delay between landing and export may be 1-3 weeks, and could vary during the season depending on the rate of landing.

<u>1.8.4.2c Results</u>

No information was available on the processing delay, but the trip length indicated delays between capture and landing may be considerable. 55% of landings resulted from trips of 15 days or more, which suggests on this alone there will be considerably reallocation from the month of export to previous month. This would help explain the high exports in September, much of which is likely to come from the August harvest.

A critical assumption for the interpretation of these data is that the available trip interviews are representative of the frequency of trip length. Average trip length for 2005-7 has changed. There has been no change in the way the fishery is being conducted, suggesting that this assumption is false at least for this period (Table 1). This may require excluding 2005-7 from the analyses of these data for the purpose of estimating delays.

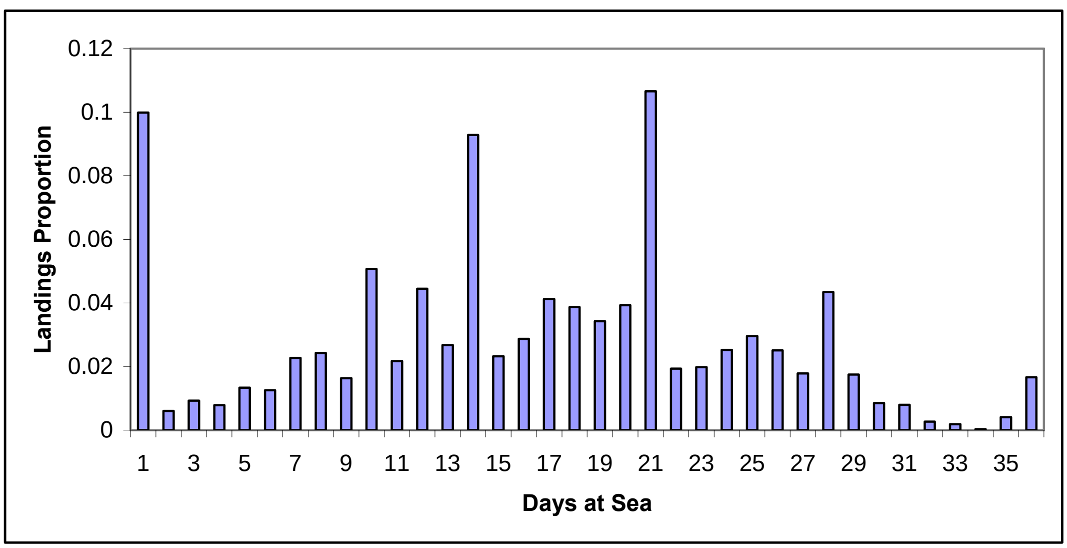

Figure 9 Sum of trip landings as a proportion of total landings for the different trip lengths (days at sea). This can be used with other information to redistribute exports to past dates estimating when they would be caught. The peaks at 2 and 3 week intervals are thought to be real rather than an artefact of the interview, although this should be checked. It is likely that trips are timed with whole weeks in mind.

Table 1 Average days at sea weighted by landings and for months and years. Note that the August trip length appears longer than other months. Although trip lengths by year vary, it is not clear that this represents anything more than natural and sampling error. The very low trip length 2005-7 could be an artefact of sampling. The database was changed in 2005 and trip records have also become much sparser, with a higher proportion of one day trips.

Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Average
18.611	14.045	16.436	15.352	14.373	13.953	10.688	15.708	16.240

1988	1989	1990	1991	1992	1993	1994	1995	1996
16.149	14.505	18.714	17.457	15.930	19.510	20.774	14.197	13.648

1997	1998	1999	2000	2001	2002	2003	2004	2005
14.674	20.363	17.775	17.002	15.943	16.380	17.602	18.318	7.040

2006	2007
6.135	6.399

1.8.4.4 Discussion

The mortality estimates obtained from the LCCC analysis show very little change between 1999-00 and 2007-08. While this may indicate that a collapse of the fishery is not imminent, it does not allow one to ascertain whether the fishery is in an over-fished state. The mortality estimates are unrealistic and at best allow relative seasonal changes to be detected.

Two possible major sources of error include migration and gear selectivity or a combination of both. Spiny lobsters are known to migrate to deeper waters periodically. This migration can occur to depths to which casitas (the predominant fishing gear) are not usually utilized. The combination of migration and gear selectivity can result in elevated mortality estimates when length based estimates are used and especially when the larger lobsters tend to migrate to deeper waters more than smaller lobsters.

Research on gear selectivity and migration of lobsters in the Bahamas is needed to improve estimates obtained using the LCCC method.

With regard to the catch per unit effort data, with extensive cleaning, the CPUE does show the expected patterns suggesting it contains information on stock size and might be pursued for estimating fishing mortality. However, there are clearly still a considerable number of errors in the index. This will introduce significant uncertainty into any assessment.

The CPUE index is really a biomass index. The estimate of fishing mortality (0.23 yr^{-1}) implicitly assumes all lobsters are the same size. It is thought that fishing focuses on smaller lobsters, so when converting to numbers, it is probable that the fishing mortality will increase. There is also no allowance for growth within the season. Again, allowing for growth will lead to higher estimate of fishing mortality. Therefore the estimate given here is probably lower than the true value.

While the catch and effort data should be kept under review to remove erroneous records, the cleaned data set represents the best that might be done without introducing bias by removing records which do not fit a fisheries model rather than solely on their own merits.

It would therefore be worth completing the procedures and conducting an assessment, bearing in mind the uncertainties. The following still needs to be done:

- The CPUE is a biomass index. The model will need to provide the fishing mortality for the numbers, so mean weight is required for each month to convert from weight to numbers. These are available from the export records.

- The delay associated with processing needs to be estimated to allocate exports as near as possible to the date they were caught. An equal distribution over a three week period might be assumed if no further information is obtained. However, it should be possible to get some indication for likely delays, and identify the key causes of delay between landing and export.

Exports need to be converted to numbers by size and redistributed back to the estimated time of capture. Where the export date is recorded, the estimated date of capture can be obtained and the catches accumulated within the appropriate month. Where there is no export date a proportion reallocation will be required, that is the proportion recorded as exported in any given month to be reallocated to that month and each of the possible months before that. These proportions can be estimated from those years where the export dates are available.

Once these tasks are completed, a simple population model can be fitted to the available data, consisting of one or two age groups: a single population or new recruits and a plus group, modeled on a month time step. Trying to model more cohorts would probably lead to lower accuracy due to the problems with the data.

This assessment, albeit uncertain, is likely to give the best available fishing mortality estimates so far for this stock.

1.8.5 Management

Based on the magnitude of landings and the extensiveness of fishing grounds, The Bahamas spiny lobster fishery is one of the most valuable and important amongst the different species of spiny lobster fisheries in the world and the most important amongst Caribbean spiny lobster (*Panulirus argus*) fisheries. Given this importance and the very real possibilities for international sanction, the uncertainty of the stock status of the fishery needs to be urgently addressed.

Multiple avenues for conducting a stock assessment in the near future needs to continue in some instances or initiated in some instances. These include taking advantage of expertise made available through avenues such as the CRFM and FAO, securing long-term highly trained expertise on staff (up to the PhD level), developing more than one stock assessment method in case one method eventually proves fruitless and conducting the needed research.

Meanwhile, management of the fishery based on the precautionary principle must continue with strict adherence to management measures in particular minimum size regulations and the closed season.

1.9 References

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2. The Spiny Lobster (*Panulirus argus*) fisheries of Jamaica

Rapporteur: Anginette Murray

2.1 Management Objectives

The management objective for the spiny lobster fishery of Jamaica is "Biological sustainable use of the fishery resources in order to ensure present and future economic earnings from the fishery" (CFRAMP 2000).

To achieve this, current management measures include a closed season for the months of April to June for all lobster fishers. Enforcement includes end-of-season declarations of lobster by the processors and inspections of fish processing plants, hotels, beaches, and restaurants. Also, the industrial fishery operates under a limited access system that controls the numbers of industrial vessels.

2.2 Status of Stock

An assessment was carried out on the industrial lobster fishery of the Pedro bank. The results, due to limitations of the available data, were not conclusive, but provide some indications of the status of the fishery.

There is no evidence that the stock is currently overfished. However, the assessment indicates that recent catches might be unsustainable, and total catch of spiny lobster from the Pedro Bank should be limited to around 200 t. The catch in 2004 was 450t, and catches of this level are very likely to be unsustainable for this stock.

2.3 Management Advice

Jamaica should consider implementing a total allowable catch of around 200 t for this fishery, enforced through an export quota. The maximum sustainable yield is likely to be in the range of 78 – 1098 t, with 200 t being the median. The last available information suggests that the most recent catch (450 t) is likely to have exceeded the maximum sustainable catch from this stock. If this level of catch should continue, the stock is likely to become overfished.

The Government should also consider establishing minimum tail weight and length regulations, so that these size regulations can still be enforced after processing. A minimum tail size, consistent with the minimum legal carapace length, could not be determined at this meeting, as the data presented did not cover some of the required length frequencies. More observations of the carapace and tail lengths, along with tail weight, should be acquired before detailed recommendations can be made.

2.4 Statistics and Research Recommendations

2.4.1 Data Quality

The annual total catches that were used in the assessment included data from the industrial fishery from Pedro Bank. Total catches of lobsters from the industrial fleet were estimated to be equal to total exports. Export data were available from 1979 – 2004 with three years missing (1982, 1983, 1990). CPUE was obtained for lobster pot fishing operations on Pedro Bank for 10 years (CARIFIS database). The major challenges posed by the data were the gaps in the data series, and uncertainty in the CPUE index as a good index of abundance.

The following activities will need to be undertaken to improve the assessment:

- Obtain missing catch and CPUE data for the periods 1982-3, 1990 and 2005-7, completing the time series used in the most recent assessment and check the CPUE data for errors.
- Obtain exports by size category from the processors for as long a time series as possible. Historical data will be important in assessing the stock.

- Obtain size compositions from tail measurements within the size categories. This can only be done for current and future landings.
- Consider ways to improve the catch and effort data. These data still present a problem with missing data and suspected significant errors in recording and collection.

2.4.2 Research

During the 1980s about 60 percent of total lobster landings came from the Pedro Bank but that declined to 20 percent in 1996-1997. The contribution of lobsters landed in Jamaica that come from the island shelf and the banks have not been recently quantified (Kelly, 2002).

According to Munro (1983), the lobster populations in Jamaica have changed considerably since 1983. Kelly (2002) noted that fishing effort had increased significantly in the preceding recent years and that the level of fishing mortality at that time appeared to be greater than the optimum recommended for the fishery in 2002. FAO (1993) declared that from a biological perspective, fishing mortality should be reduced to minimize the risk of over-exploitation.

More intense specific monitoring should be carried out on a single lobster fishery to determine the detail necessary for a full assessment, as well as the seasonal patterns in landings, estimates of current fishing mortality etc. The work could be conducted as a single one or two year project, although it would need to be conducted as a continuous activity during this period by dedicated staff to avoid any breaks in the time series.

Another aim of such monitoring would be to establish a conversion factor from carapace length to tail length, so that a minimum tail length could be established which is consistent with the minimum carapace length.

2.5 Stock Assessment Summary

The most important new data to be used in the assessment of the Pedro Bank spiny lobster fishery were the total exports since 1979 (Fig. 1). These have increased since 1979 when the stock was likely to have been only lightly fished.

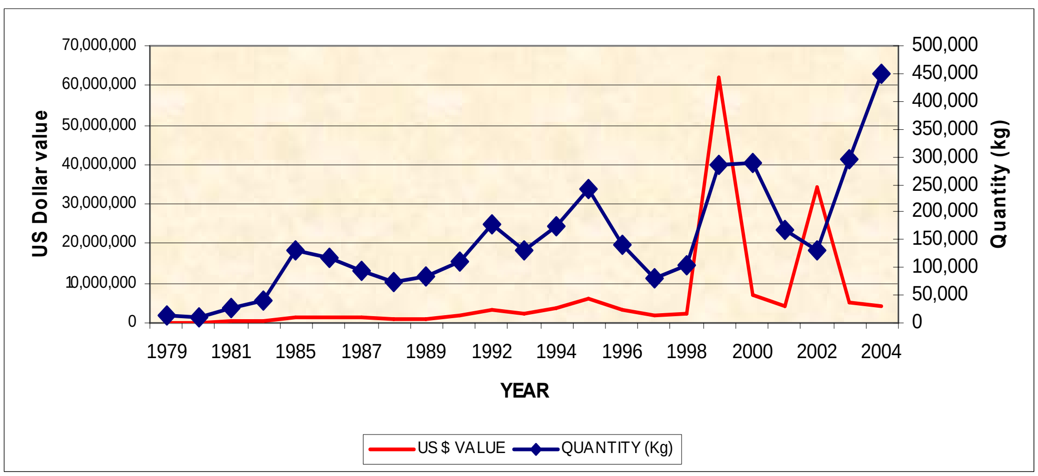


Figure 1. Export quantities and US$ value of the spiny lobster for Jamaica period 1979 – 2004 (Data Source: Statistical Institute of Jamaica)

Attempts were made to assess the status of the lobster stock using a surplus production model fitted using maximum likelihood (ASPIC software), which was unsuccessful. ASPIC requires index of abundance series (such as CPUE) and total yield (catch) data. ASPIC was run, fitting a logistic model conditioned on catch. ASPIC software was unable to interpret the data due to a lack of contrast in the CPUE series.

The same surplus production model was then fitted in a Bayesian framework. The Bayesian statistical analysis offers a method in which uncertainty can be explicitly incorporated in inference, and decision making, and external information can be used formally to improve the fit through providing priors. Priors were derived from previous Turks and Caicos Islands and The Bahamas assessments.

However, results from this assessment were highly uncertain (Table 1), with confidence intervals being wide for the indicators and reference points of interest. The general indications were that the stock was not likely to be overfished, but the most recent catches were too high to be sustainable.

Table 1. Parameter estimates and reference point estimates from the Jamaica assessment. The confidence bounds are generally wide illustrating the uncertainty in the assessment. The main information contribution for the assessment was the priors (based on information from the Bahamas and Turks and Caicos Islands) and the total catches. The CPUE index was relatively uninformative.

90% Confidence Intervals (percentiles)	5%	Median (50%)	95%
r	0.06	0.21	0.71
B_∞ (t)	2280	4415	10734
$B_{current}$ / B_∞	0.34	0.66	0.92
MSY (t)	78	207	1098
Observed Yield in 2004 (kg)		450807	
Replacement Yield (t)	73	187	352
B/BMSY	0.69	1.31	1.84
F/FMSY	0.25	1.63	6.64

Though the results were not conclusive, preliminary indications are that catches could have already exceeded MSY and be unsustainable.

<u>Minimum tail length</u>

Figures 2 a, and b illustrate the relationship that tail lengths have with carapace length in male and female lobsters respectively. The minimum tail length that a male lobster should have that corresponds to the minimum legal size carapace length (CL) of 76.2 mm is 140 mm, while for female lobsters, it is 146 mm. These values were calculated from the linear equations generated from the data provided.

In both instances the correlation coefficient indicates that the relationship between the carapace and tail length are reliable. However due to the data supplied being biased towards lobsters over the minimum legal CL it is strongly advised that more data be collected to include the size category down to 60 mm CL for both male and females, prior to consideration of this in management decisions.

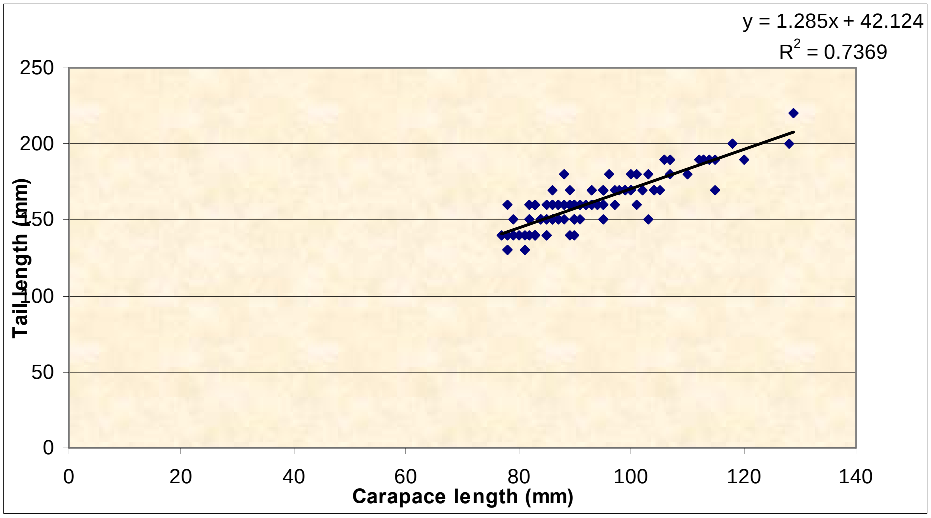


Figure 2a Linear regression analysis of male spiny lobster

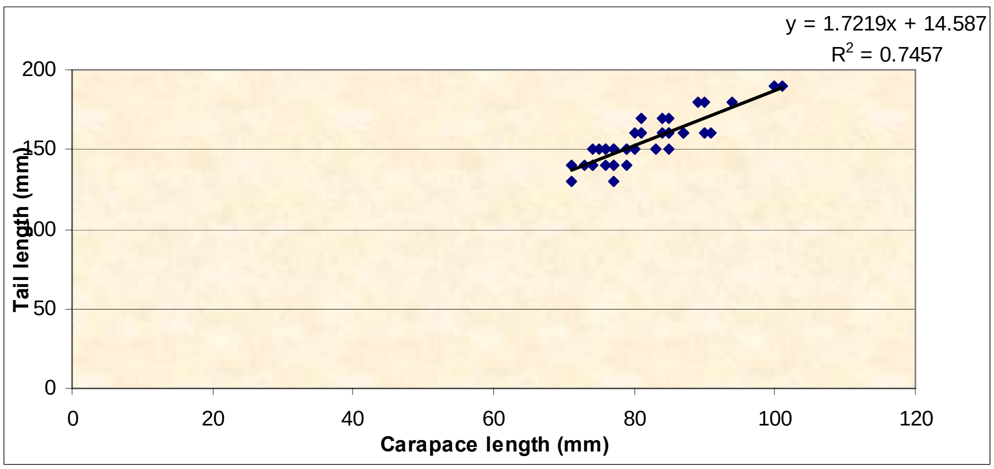


Figure 2b Linear regression analysis of female spiny lobster

2.6 Special Comments

A significant problem with surplus production models in assessing spiny lobster is it is assumed that the population is self-recruiting, whereas it is generally thought that lobster recruitment is spread widely across islands. This will add considerably to the uncertainty of this assessment. With better data, alternative approaches to assessment would need to be considered.

2.7 Policy Summary

The goal to be achieved for management of the marine fisheries of Jamaica is the sustainable use of fisheries resources for the maximum benefit of the people of Jamaica. In the draft management plan for the lobster fishery, the stated management objective is to restore/rehabilitate the fishery through protection of lobsters, and protection and enhancement of their habitat.

The management tools of gear restrictions, effort reduction, and enforced closed season and co-management arrangements, should be examined for use in this fishery. There is already legislation in place to prevent the taking of berried lobster, and to prohibit the landing of lobsters during the closed season. However, monitoring data suggest that these regulations are not being strictly respected.

2.8 Scientific Assessments

2.8.1 Background or Description of Fishery

Introduction

The spiny lobster, *Panulirus argus*, is widely distributed in the coastal waters and on the offshore banks around Jamaica. This resource represents an important component of the total landings of the Jamaican commercial fishery. There are six types of lobsters that are found in Jamaican waters viz., *Panulirus argus, Panulirus guttatus, Justitia longimanus, Palinurellus gundlachi, Scyllarides aequinoctialis and Parribacus antarcticus*. *Panulirus guttatus and Panulirus argus* are the only two species that are commercially valuable (Aiken, 1984). A large concentration of lobsters is found on Pedro Bank, (Figure 3) which accounts for about 60 percent of the total landings in the industrial fishery. During the 1980s, about 60 percent of total lobster landings came from the Pedro Bank but declined to 20 percent in 1996-1997. The contributions of lobsters landed in Jamaica that come from the island shelf and the banks have not been recently quantified. Figure 4 reflects the total production for a nine year period, based on the available export data.

Figure 3. Jamaica's Fishing Grounds (Offshore and Inshore Banks)

According to Munro (1983), the lobster populations in Jamaica have changed considerably since 1983. Kelly (2002) noted that fishing effort had increased significantly in the preceding recent years and that the level of fishing mortality at that time appeared to be greater than the optimum recommended for the fishery in 2002. According to FAO (1993), from a biological perspective, fishing mortality should be reduced to minimize the risk of over-exploitation.

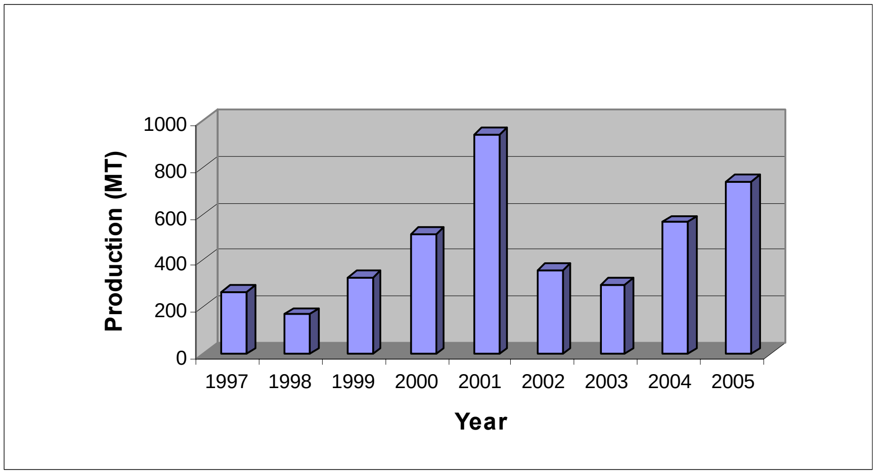


Figure 4. Export of spiny lobster for the period 1997 – 2005.

Fishing for lobster is done mainly on the island shelf and the banks (Pedro Bank, Morant Bank and Formigas Bank). The fishery has two components: artisanal and industrial.

<u>The artisanal fishery</u>
This fishery has two categories of fishers:

a) Mainland artisanal fishers using Antillean Z-traps, diving (free lung, SCUBA and Hookah) and gill nets. The lobster is sold to the catering and tourist industry, and households as well as some also go to the processing plants.
b) Offshore artisanal fishers, based mainly on Pedro and Morant Banks. Fishers in this category are mainly divers. The lobster is marketed to 'packer boats' who subsequently distribute to the same markets as the mainland artisanal fishers.

The crew size for the artisanal fishery is mainly three. The fish pot or trap is considered to be the primary gear; however, lobsters are usually by-catch in the trap fishery. Divers on the mainland target lobsters. A maximum of ten divers may travel in one vessel to respective fishing grounds, and the captain keeps watch while the divers harvest lobsters. Trammel nets are also commonly used. Lobster is sold locally to the public either at the boat side or via vendors. Vendors then distribute the lobster to the catering industry. Sometimes the catch is sold to respective fish processors. Figure 5 shows the weight of spiny lobsters caught by artisanal fishers using various gear types for 2005.

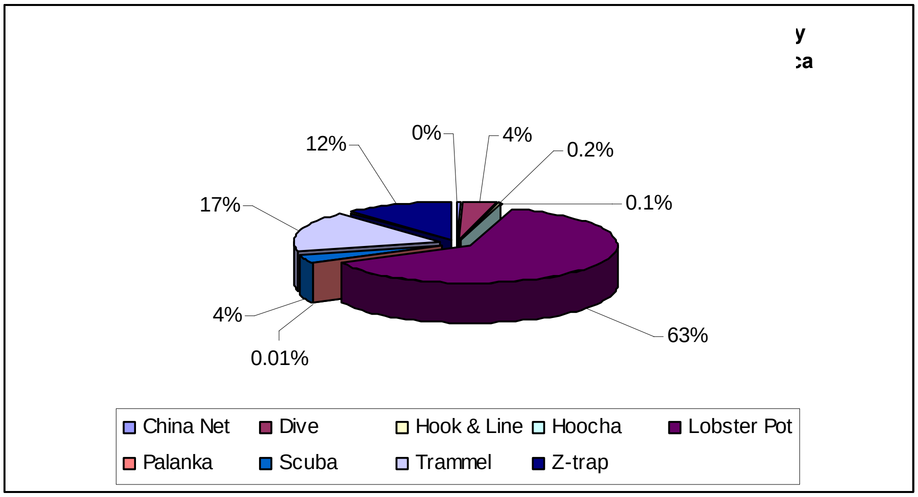


Figure 5. Percent Distribution of weight of spiny lobster landed by artisanal fishers using various gears on the South Shelf of Jamaica in 2005.

<u>The industrial fishery</u>
Fishers within this fishery are based on the mainland but operate mainly on the Pedro and Morant Banks from 20-35 m length vessels. These fishers are licensed to use Florida traps only. Most times, they are contracted by the processors to whom they solely sell their catch. Fish processors cater primarily for the export market.

About ten industrial licences were issued to fish lobsters on the Pedro Bank using Florida traps in 2006. These vessels are operated from 4 companies. These vessels are steel hulled, 20 m x 5.7 m x 3 m and have an inboard engine up to 500 hp. Crew size on these vessels ranges from 8 – 12. Vessels transport about 1000 traps and about 500 traps are deployed in the water at any one time. The average immersion time is about three days. Fishers spend up to three months at sea before returning to the mainland. Smaller quantities of lobsters may be transported back to the mainland by other vessels en route to the mainland. Lobsters are exported mainly to the United States, Canada, Panama, Netherlands Antilles, Cayman Islands and Martinique. The spiny lobster fishery is the second most lucrative export fishery. In 2004, the total production of lobster was estimated to be 450.8 t, valued at US $4,368,229.00. Landings for lobsters usually peak in March and late September.

<u>Biology/Research</u>
Several studies on lobsters have been conducted over the years a few of which are mentioned here. Studies conducted by Aiken (1977, 1983), Munro (1983) and Haughton (1988) confirmed a significant reduction in the mean and modal size of the lobster population in Jamaica. Haughton and King (1990) reported that the fishing effort had increased significantly and the level of fishing mortality at that time appeared to be greater than the optimum required for the fishery. In 1991, a tagging study was conducted by department staff, but recovery was too small for any significant quantitative analysis. Young (1992) did a study on puerulus settlement rates on the south coast of Jamaica and found that settlement was continuous throughout the year.

In 1975, the Fisheries Division reported that 76 percent of the commercial lobster consisted of immature females (by comparison, Florida showed 17-21 percent immature females harvested), suggesting that there was an urgent need for strict management and protection. For 2005, 30 percent of the total lobster sampled was under the minimum size as noted in The Fishing Industry Act of 1975.

The Fisheries Division has embarked on a new project called The Lobster Casita Project which is investigating a more efficient and sustainable system for the lobster fisheries. This is being achieved through:

- Investigating the use of casitas in major fishery areas.
- Establishing juvenile enhancement systems
- Establishing pueruli (lobster larvae) monitoring programmes, which is useful for forecasting lobster catches.

The pilot project is being conducted in Bowden Bay, St. Thomas.

Management Regulations

The Fishing Industry Act of 1975 recommended a minimum size for spiny lobsters (*Panulirus argus*) of 7.62 cm (3 ins). Aiken (1977) recommended a gradual increase to 85 mm CL and Haughton *et al*., (1989) also called for an increase in the minimum size limit to 89 mm CL as they found that about 55 percent of the females were mature at this length. It is illegal to land lobsters below this minimum size or offer such lobsters for sale. Female lobsters with eggs are also protected by the Act. Both provisions carry a maximum penalty of J$500 or six months in jail. This penalty is inadequate and certainly does not serve as a deterrent to offenders. The Act is being revised to implement fines of greater magnitude.

In order to combat the decline of lobsters, further management measures were implemented such as a closed season which runs from April 1 to June 30 annually. Further restrictions were placed on the industrial vessels: limited entry and gear restriction (Florida traps only).

Licences for the industrial lobster fishery are granted with the following conditions:

a) All licensed lobster fishing vessels shall fish only in the areas specified by the licence
b) No fishing shall take place on the island shelf of Jamaica or on any proximal bank
c) All licensed lobster motor fishing vessels shall only fish, catch or land spiny lobster and no other species.
d) All lobsters caught, except undersized and/or berried which should be returned to the sea, shall be landed on mainland Jamaica no later than eight weeks after the commencement of each fishing trip.

Lack of adequate resources continue to incapacitate the effective enforcement of management regulations.

Monitoring, Control and Surveillance

The lobster closed season runs from April 1 to June 30, annually. Joint patrols are done by police, game wardens and fishery inspectors, at sea, food establishments and fishing beaches. Persons who intend to store lobsters during this period are asked to voluntarily declare the amounts to the Director of Fisheries prior to the commencement of the closed season. Inspection teams then verify these amounts at these locations and issue a declaration certificate and inspection receipt.

The remaining three quarters are used to undertake enforcement through the deployment of teams from the various supporting entities along with the Fisheries Division.

Available data

a) Fishery-dependent

The Data Collection Programme of the Fisheries Division was initiated in September 1996 with assistance from the CARICOM Fisheries Resource Management Programme (CFRAMP). Catch and effort data are collected by gear from artisanal fishers through random stratified sampling. Data from the industrial fishers are collected by census. Biological data are collected where possible, usually on three gear types (SCUBA, free lung and gill net) and at two major landing sites – Hellshire and Bull Bay.

At the processing plants, lobsters are landed tailed. The data collectors, therefore, measure tail length which then needs to be converted to whole weight and carapace length. Morphometric measurements (carapace length, tail length, weight, telson length and carapace depth) were collected on catches taken at the Pedro Bank in an effort to calculate a country specific conversion factor for tail length to carapace length.

b) Socio-economic

Since 1962, the exports of lobsters have increased significantly, from 0.68 percent in 1962 to 69 percent in 1995. Presently lobster is exported as frozen, live, fresh, dried salted or in brine. Trends in lobster exports during 1979 to 2004 were explained earlier and illustrated in Figure 1.

Lobster is an important and sought after delicacy in the Jamaican tourist industry, luring visitors to savour the mouth-watering taste. A major portion of the lobsters landed in western Jamaica goes to the tourist industry. This portion has not yet been quantified. The peak demand for lobsters within the export and tourist industries is just before the start of the three-month closed season. This demand coincides with increased fishing effort as consumers try to stock up on lobster. This clearly has management implications, and in the new Fisheries Act, recommendations will be made to implement a total ban on the possession of lobsters during the closed season. Table 2 shows a comparison of landings of lobster and other species groups in for period 1996 to 2005.

Table 2. Quantity (kg) of fish type landed (2003) and the value (US $'000) (Average US$ value per Kg: Finfish $3.31, Conch $6.50, Lobster $8 and shrimp $7)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Finfish	41,267	18,450	13,761	20,782	15,165	14,382	23,150	15,196	29,140	23,543
Conch	9,308	11,838	11,050	8,879	-	6,149	6,149	3,278	3,575	4,160
Lobster	6,400	2,157	1,357	2,639	4,138	7,547	2,869	2,400	1,076	2,400
Shrimp	1,267	469	102	31	257	270	263	259	280	280
Total Value	58,242	32,914	26,270	32,331	19,560	28,347	32,432	21,133	34,071	30,383

2.8.2 Overall Assessment Objectives

The overall objectives were to establish a minimum tail length (conversion factor) from carapace length and to assess the status of the stock through examination of existing export and catch per unit of effort data to derive a MSY based reference point for the Pedro Bank lobster stock.

2.8.3 Data Used

Name	Description
Catch and effort data	The catch and effort system notes catch by gear types, since catch rate differs by gear type. Lobster is caught using many different gear types: Antillean Z-traps, SCUBA, free dive, hookah and nets. The catch landed by each boat is recorded on a standard form and is submitted to the Data Unit.
Biological data	Samples were taken from landed catches, and data on sex, maturity stage, carapace and tail length was recorded for each sample. The total weight of the catch, as well as the sampled weight, was also

	noted. All biological data are linked to the boat from which the sample was taken.
CPUE Index	From trip interviews (TIP) 1995-97, 2000-02, and 2004-06, catch per trap hour was available.
Total lobster exports	Annual exports were obtained from the 1979-2004 reports retained at the government statistics office (Statistical Institute of Jamaica, STATIN).

2.8.4 Assessment 1: Conversion factor

2.8.4.1 Objective

The objective was to identify and to establish a conversion factor based on the relationship between tail length (conversion factor) from carapace length.

2.8.4.2 Method/Models/Data

During the Third CRFM Scientific Meeting it was noted that in order to provide advice to management on a conversion factor the data available were inadequate. Consequently, during the inter-sessional period both the carapace and tail length for specimens were measured. A total of 160 specimens were examined. The data were divided according to sex. In order to establish the relationship between the carapace and tail length of a given sex, a best-fit straight line was plotted. The correlation R (which gives a measure of the reliability of the linear relationship) was also determined. Based on the relationship generated ($y = mx + b$) for each sex, the legal minimum carapace length was used to determine the minimum tail length. A generalized linear model was fitted in Genstat, linking tail and carapace length by sex:

Tail length = a + b * carapace + c * sex

2.8.4.3 Results/Discussion

From the fit, it was shown that sex parameters were significantly different where $P<0.001$. Consequently two models – male and female – were considered when establishing the minimum tail length. Figure 6a and b illustrates the relationship between tail length and carapace length for male and female lobsters respectively. The minimum tail length for a male lobster, corresponding to the minimum legal size carapace length is 140 mm, while for a female lobster, it is 146 mm. These values were calculated from the linear equations generated. In both instances the correlation coefficient (R) indicated that the relationships between the carapace and tail length were reliable.

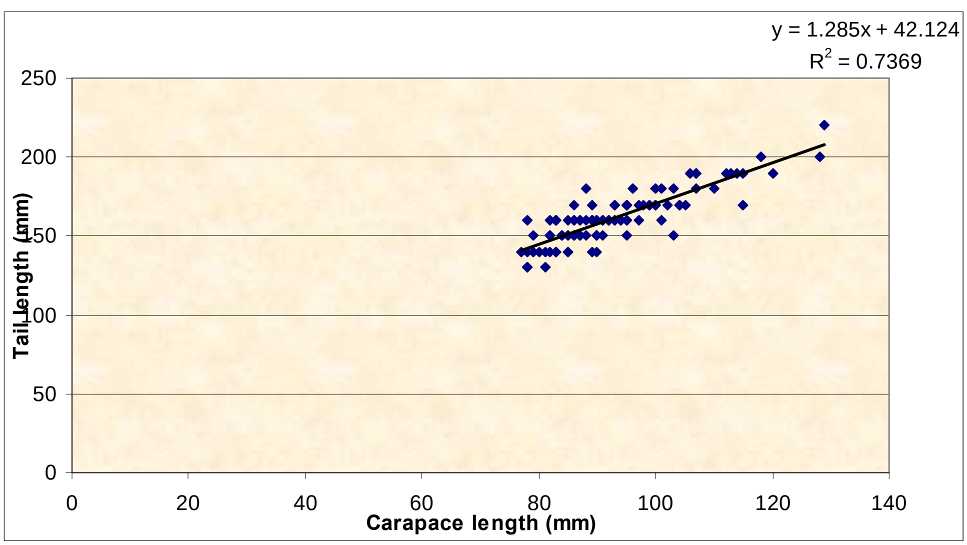


Figure 6a. Linear regression analysis of male spiny lobster

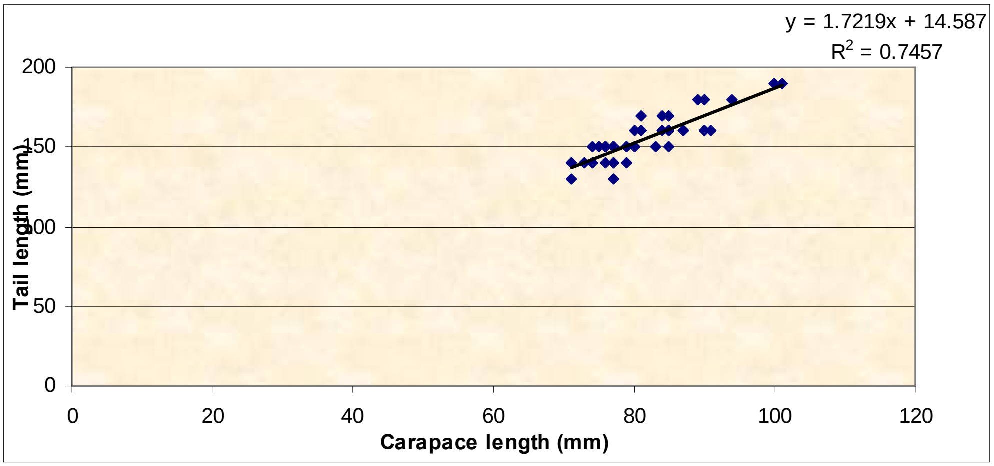


Figure 6b Linear regression analysis of female spiny lobster

It is strongly recommended that more observations of the carapace and tail lengths, along with tail weights, should be acquired and examined, prior to inclusion of this information in any detailed recommendations.

2.8.5 Assessment 2: Stock Assessment

2.8.5.1 Objective

The initial aim was to attempt Bayesian assessment using the available CPUE, exports (used as total catch) and priors derived from assessments elsewhere.

21.8.5.2a Method/Models/Data

Catch and effort data and total catches for spiny lobster from the Pedro Bank were available. Surplus production models are perhaps the best way to handle this type of data. The data were entered into ASPIC. However ASPIC was unable to interpret the data. ASPIC requires a series of catch data and indices of stock biomass. The CPUE index and the total export (landings from the industrial fishery) were entered into the software and ASPIC was run fitting a logistic model conditioned on catch. The run using the available CPUE and effort data failed due to an uninformative CPUE series. The CPUE indices showed no contrast.

2.8.5.2b Method/Models/Data

Overview

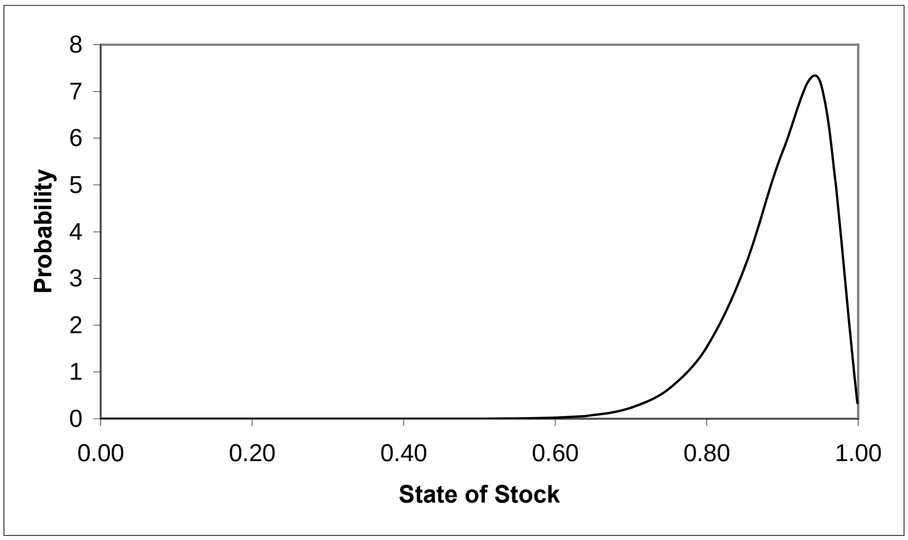
The method applied is the same as that applied in the 2008 assessment of St. Lucia's conch fishery. The detailed fitting methodology is not reproduced here. This document focuses on specific aspects required for this lobster assessment.

This is a preliminary assessment for Pedro Bank spiny lobster. The model is not necessarily appropriate for this species. Recruitment for this stock is likely to be shared (Arce and de Leon, 2001). If the stock size is dependent to a large extent on recruits, this will be exhibited in greater uncertainty in stock size.

There are four parameters requiring priors. The catchability parameter (q) is assumed uniform on a log scale (i.e. uninformative prior). More importantly, the population model requires an initial stock state (B_0), rate of increase (r), and unexploited biomass (B_∞), which have informative priors developed from data elsewhere. The proposed priors are based on a preliminary method, as no standard method exists.

The method is important as it affects the final outcome. A standard approach, ensuring results are precautionary would be valuable in using this method.

The initial state of the stock at the start of the catch time series is stock specific and so information from other assessments cannot be used. The longer the catch time series, the less important this parameter is. In this case, the exports are thought to cover most catches to the beginning of the fishery, so the initial stock state will be close to 1.0. The proposed initial stock state prior (Figure 7) was subjective and while it allows for some level of depletion, the prior indicates that we expect the initial stock size to be close to the unexploited in 1979.



A. Figure 7 The beta distribution for the prior of the initial stock state (α=18, β=2, μ=0.9). The initial state probability was subjective, but based on the assumption that the stock was likely to be close to unexploited in 1979, so that almost all the probability mass was between 0.7 and 1.0.

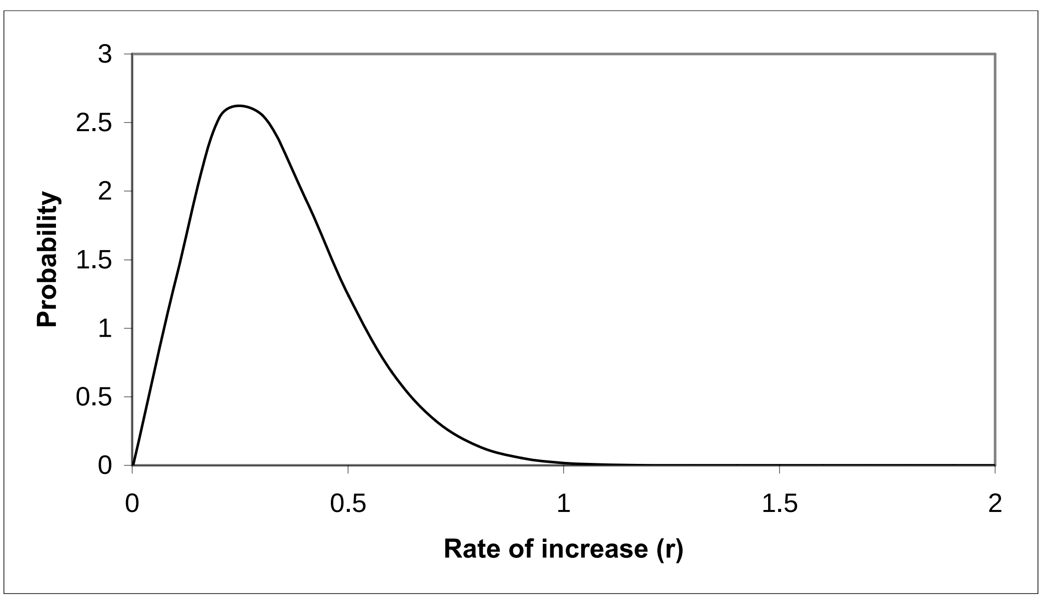
The rate of increase will be an attribute of the species and affected by the local productivity. A prior based on the species is the most appropriate. As data become more available, this should be updated by local productivity information. The only estimates for rate of increase were for a Turks and Caicos Islands 2003 assessment (Clerveaux *et al.* 2003), based on a fit to catch and effort data. The fit to these data were not particularly good due to variations in recruitment, but followed the available trends fairly well.

A beta distribution was used to model the uncertainty around this parameter (Figure 8). Parameters were chosen for this distribution such that the probability mass was below 1.0, with a mean around the Turks and Caicos Islands estimate. Given that the location and therefore productivity may change, this is good practice, but there is no standard approach.

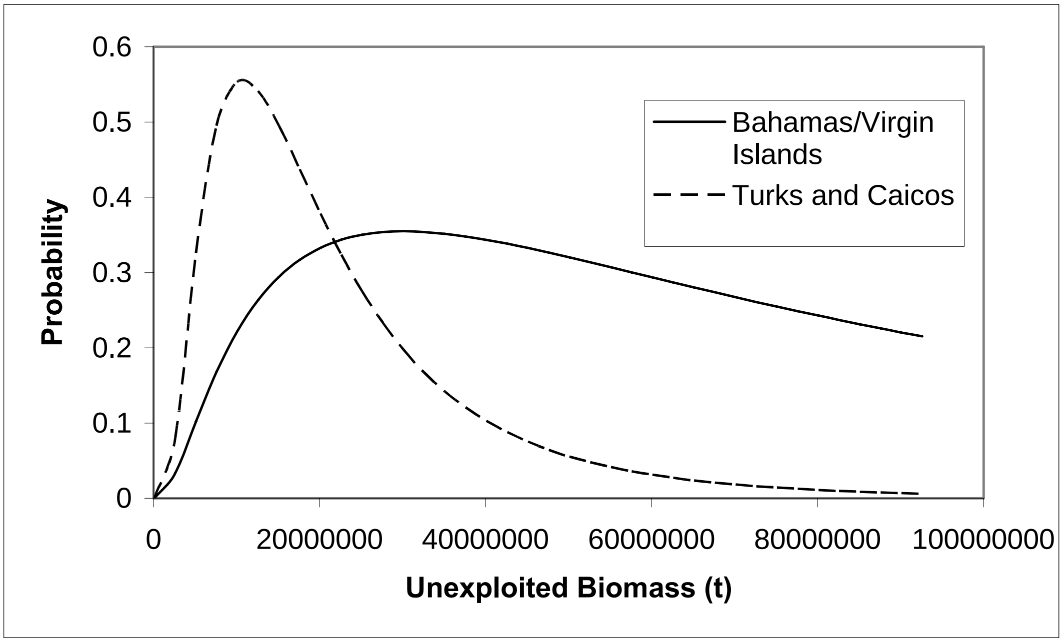
The unexploited abundance prior (Figure 9) was based on a log-normal with hyper-parameters estimated from reported abundance and unexploited biomass for the Bahamas, Virgin Islands and Turks and Caicos Islands (Table 3). While the various estimates for tons per hectare covered the likely range, the total habitat area for Jamaica was unknown. An estimate based on the shelf area to the 200m contour was used, but was probably too high. A more consistent approach might be to use the fished area, which could be estimated for Jamaica over the next year.

Table 3. Values of abundance were based on reported lobster densities from estimates found in the literature for the unexploited resources. The average weight per lobster was estimated from a yield-per-recruit model. The numbers of lobsters per unit area were estimated from surveys or from estimates of the unexploited biomass from the Turks and Caicos Islands (dived by the Caicos Bank area of 65000 ha.) The tons per hectare were raised for Pedro Bank by multiplying by the presumed habitat area (37000 ha – 201000 ha). In all cases ranges in biomass were preserved and used to define the 90% confidence interval for a log-normal, which was converted to a mean (μ) and coefficient of variation (σ) for a log-normal. Two log-normals were developed from the different sources and used. They are automatically combined as part of the numerical integration method.

Source	Basis	μ (Log Mean Abundance)	σ (CV)
Waugh (unpubl.)	Survey ranges of density reported for The Bahamas and Virgin Islands	17.22	1.12
Lockhart and Medley (2007) Arce and de Leon (2001)	Mean recruitment from 2007 stock assessment. Negative exponential population model simulation based on life history parameters to get biomass when F=0	16.19	0.72



B. **Figure 8. Beta distribution for the rate of increase (*r*) prior based on the 2003 Turks and Caicos Islands assessment (α=3, β=14.91, μ=0.168; x values are multiplied by 2.0 to get the *r* parameter) and preserving 98% of the probability mass for r values between 0 and 1.0. The value is limited to exist only between 0 and 2, outside this range the model becoming unstable and biologically unrealistic.**



C. Figure 9. Log-normal probability density for the unexploited stock size. The prior was designed so that 90% of the probability mass was between the minimum and maximum values derived from the Turks and Caicos Islands and Jamaica assessments scaled for the range of Pedro Bank habitat areas (37000-201000 ha).

Likelihood
The likelihood for the observations was the normal (Gaussian) probability density function fitting between the observed and expected CPUE index. The expected CPUE index is calculated as the catchability parameter multiplied by the biomass abundance. The variance (σ) parameter was not fitted using Bayesian methods, but fixed at an estimated value. The parameter was estimated from the squared residuals between the observations and a smoothed CPUE series (moving average).

The catches also were not fitted, although they could have been if the sampling error was to be included. This source of error was small, and least squares fitting suggested allowing for this sampling error would make little difference to the assessment.

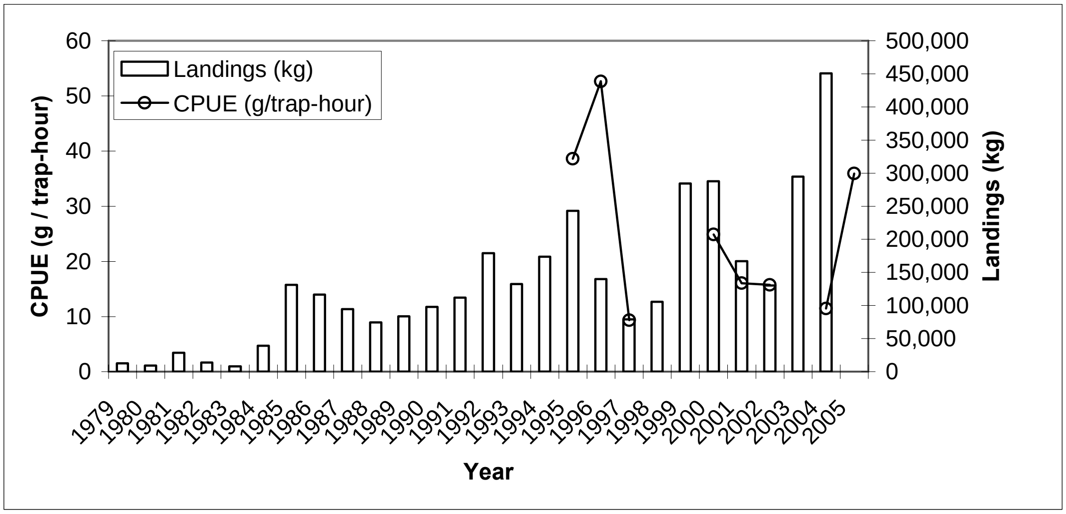
Fitting Method
The fitting method is described in the 2008 St. Lucia conch assessment report (current CLWG report).

2.8.5.3 Results
The fitting method worked well, and the model was able to apply the rejection sampling method. The results are therefore a reliable representation of the posterior, but all uncertainties with respect to model and data still apply.

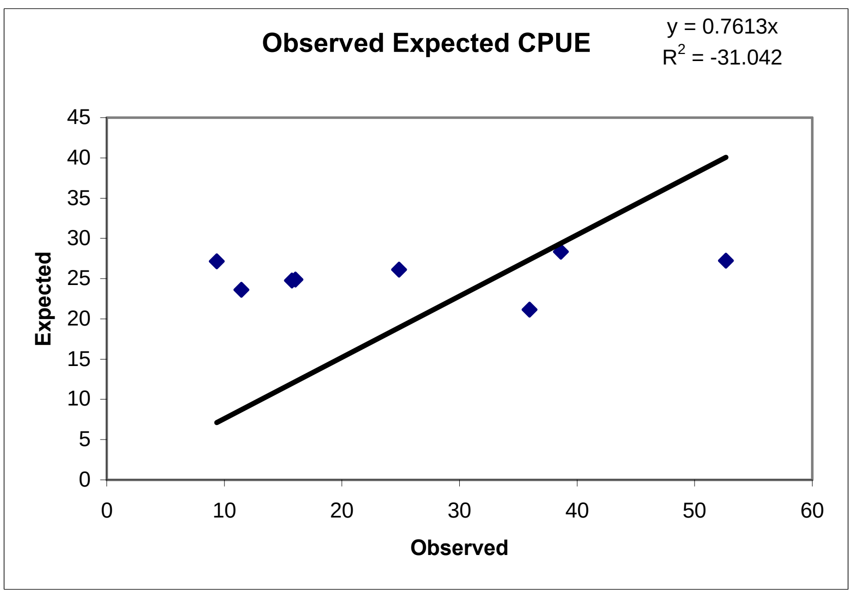
The CPUE indices show no trend and were uninformative on abundance change. That is, the catchability parameter (q) scaled the expected CPUE from the model to run through the mean of the observed CPUE points, but there was no trend in the points to use to estimate changes in abundance (Figures 10 and 11).

The marginal probabilities of various performance indicators were obtained from the posterior. These are true probabilities and can be interpreted as such. The main performance indicators were biomass relative to biomass at MSY, current fishing mortality relative to fishing mortality at MSY, the replacement yield, and the maximum sustainable yield.

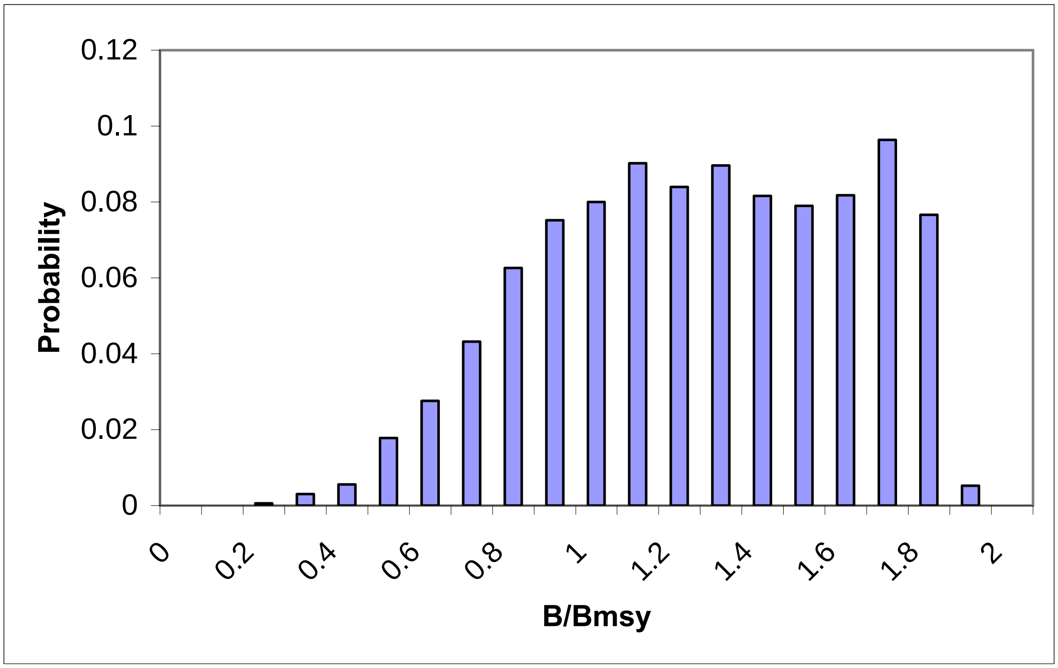
These results suggest that it is likely that the stock is not overfished (Figure 12), but that overfishing occurred in 2004 (Figures 13 and 14). The MSY suggests the fishery will be small (Figure 15), but that catches could be allowed to increase once the stock has recovered.



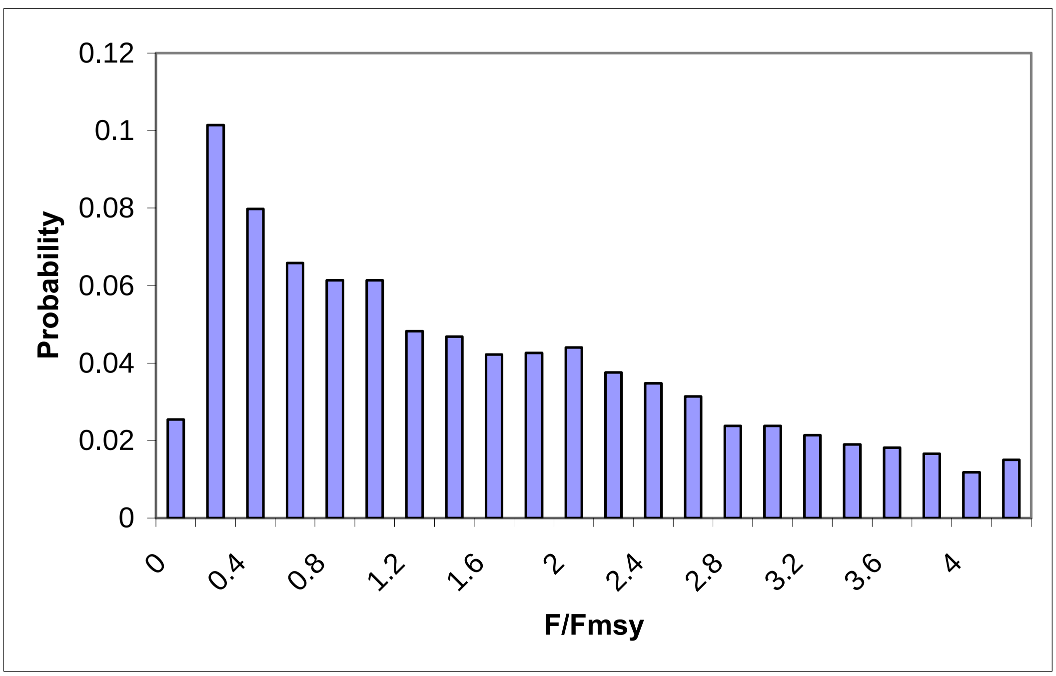
D. **Figure 10. Exports and CPUE data for the Pedro Bank spiny lobster fishery. Artisanal catches are not covered, but thought to be an insignificant proportion of the catch.**



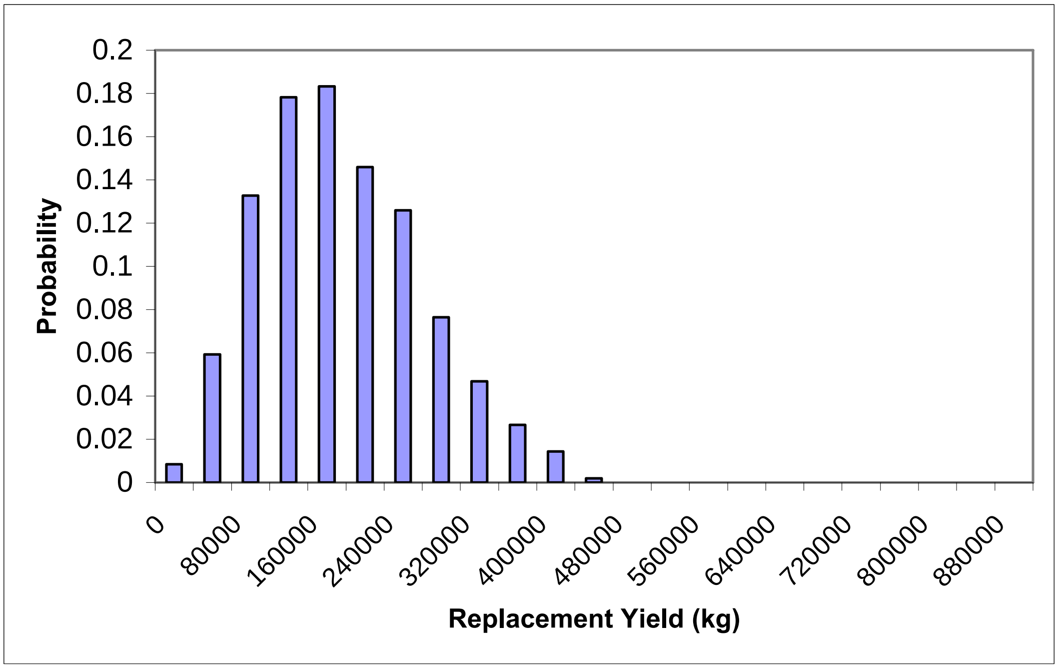
E. **Figure 11. Observed and expected CPUE from the fitted model. There is no trend in the observed CPUE, and the CPUE are not informative on the abundance for this model.**



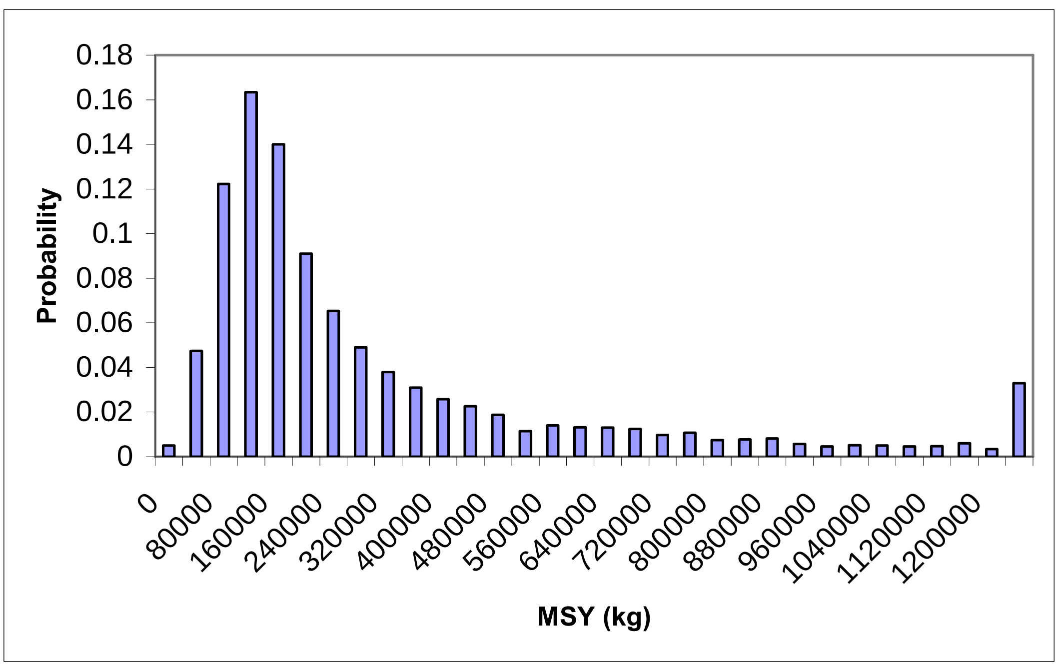
F. **Figure 12. Stock status (Biomass / Biomass at MSY) as a probability function based on the prior information on likely stock size and productivity, and the available catch-effort data. The results indicate that it is likely that the current biomass is above the MSY reference point ($B/B_{MSY} > 1$).**



G. **Figure 13. Overfishing status (fishing mortality / fishing mortality at MSY) as a probability function based on the prior information and the available catch-effort data. The results indicate that overfishing ($F/F_{MSY} > 1$) based on a 2004 exports of 450t, is likely. However, there is a very high level of uncertainty exhibited by the long tail of the density. Based on the available information high levels of overfishing are possible.**



H. Figure 14. The replacement yield as a probability function based on the prior information on likely stock size and productivity. The replacement yield is the current production from the stock, so that exceeding this yield will result in the stock biomass falling. The results indicate that the 2007 catch (450t) is likely to be above the replacement yield so that the stock should decrease.



I. Figure 15. The estimated maximum sustainable yield suggests that yields above median 200t are unlikely to be sustainable, and catches in general should be kept below this level. Lower catches would be more precautionary, and catches below 100t per year are unlikely to cause overfishing.

2.8.5.4 Discussion

The results indicate that the stock size is likely to decrease if 2004 catch levels are continued into the future (Figure 14). Given that the biomass is likely to be above the MSY point (Figure 12), this is probably not critical. The more important statistic is the MSY itself (Figure 15), which is poorly estimated. The long term yield from this stock is estimated to be around 200 t.

The method does not really account for uncertainties associated with model assumptions. Lobster is to a large extent driven by recruitment as exhibited by the fluctuating catches (Figure 10). This not only undermines the validity of this approach, but may make the assessment of the long term yield less useful for management. Limiting catches to 200 t in any given year may prevent taking advantage of good recruitment years, which would be unacceptable. Improving the catch and effort data should result in advice based on effort control, which may be much more useful for management.

The key assumptions of the stock assessment and source of uncertainty not represented in the probability density functions are:

1. The CPUE index is proportional to abundance.
2. The biomass dynamics model is appropriate for describing the dynamics of the species.
3. Total catches are well estimated.
4. The information included in the priors is valid.

The MSY based reference points are assumed to be an appropriate target reference point defining the lower bound before additional management action is taken. This is an interpretation of the stated policy.

2.8.5.5 Research Recommendations

Improved priors need to be developed to represent likely values for the productivity which could be used in these sorts of models. The results depend upon the prior information introduced. There is no generally acceptable way to design informative priors. An array of alternatives were used here, but were not definitive. Other methods, such as polling experts or using models of the life history and the ecology of the species, would require inter-sessional work to obtain the data and conduct the analysis.

Additional information for use as priors should be sought. This would include but not be limited to:

- Additional density observations and estimates around the region, including Cuba, Mexico and Florida.
- Leslie matrix Monte Carlo simulation model to estimate population doubling time and therefore a likely probability density for the intrinsic rate of increase.

Priority should be given to assembling raw catch and effort trip records (date, catch, days or hours fishing, traps pulled, soak time per trap) for as long a time series as possible. This could lead to better advice for management focusing on controlling the number of traps rather than an export quota.

2.8.6 Management

The available data for the fishery has improved though there are still gaps which need to be addressed urgently. The present management strategies will have to be improved and periodically assessed to evaluate their efficacy in curbing decline of the lobster stocks. The Fisheries Division must also attract the attention it needs from the government and must be institutionally strengthened to efficiently execute its mandate.

Jamaica must address at least some of its national fisheries issues in order to play a more effective role in the overall regional management of lobsters. Other recommendations for increased management of the fishery could include:

- Ensure that current closed season is enforced as there is evidence of continuous landings
- Conduct data collection training exercises with data collectors
- Collect one year of concentrated data (catch and effort and biological) from at least two main landing sites, ensuring that there are no gaps even during the closed season. This implies that fishery-independent data needs to be collected.
- Establish no take zones to protect recruited stock
- Increase the minimum carapace length with increased enforcement
- Reduce fishing effort (limit entry) and begin to change the open access regime
- Increase coverage in collecting biological, catch and effort and socio-economic data from fish processing plants
- Collaborate with research institutions such as the University of the West Indies (UWI) to assist in data collection and analysis.
- Continue ongoing public education to sensitize fishers, other stakeholders and the general public on spiny lobster management.
- Encourage co-management approaches in regulatory efforts
- Increase sampling on Pedro Bank from quarterly to monthly; otherwise ensure that sampling is carried out in the same month each year.

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3. Queen Conch Fishery in Saint Lucia

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Consultant: Paul Medley

3.1 Management Objectives

The management objectives for the conch fishery in Saint Lucia (Department of Fisheries, 2006) are to:

- Rebuild queen conch stocks, particularly in the near shore;
- Ensure sustainable use of the queen conch resource.

3.2 Status of the Stock

The abundance of the stock continues to decline. The 2007 landings were beyond the thirty-five (35) tonnes recommended by the Third Annual CRFM Scientific Meeting; hence, the stock is likely to be over fished. The status of the stock appears to have worsened compared to the assessment conducted in 2006.

3.3 Management Advice

In order to ensure the sustainability of the queen conch fishery and to rebuild the density of the stock over time, the following are recommended:

1. Fully enforce existing regulations, which make it illegal to harvest immature conch and which allow for a closed season by:
   - Developing and implementing a National Plan of Action for IUU[1] Fishing.
   - Improving on monitoring, control and surveillance capabilities of the enforcement agencies (Department of Fisheries, Saint Lucia Royal Police Force, Coast guard etc.)

2. Establish and enforce the total allowable catch (harvest quota), which, initially, should not be beyond 30 tonnes per year. The reduction of the catch should speed recovery and reduce the risk of further over fishing.

3. Limit entry into the fishery to traditional fishers, in order to control the fishing effort.

3.4 Statistics and Research Recommendations

3.4.1 Data Quality

- The catch and effort data appear generally very reliable.

- The data were not sufficient to conduct the assessment alone; therefore, in addition to catch and effort data from Saint Lucia, information from Jamaica and the Turks and Caicos was used to estimate key values used in the assessment for Saint Lucia.

- There is a need for the collection of additional data on the density and habitat of conch in Saint Lucia to improve estimates of stock status.

- The socioeconomic importance of the conch fishery needs to be assessed because it is likely to influence the implementation of the harvest quota, the entry limit into the fishery and a closed season.

3.4.2 Research

[1] IUU - illegal, unreported and unregulated fishing

- As suggested by the Third Annual CRFM Scientific Meeting, the inclusion of the following data may improve the reliability of the assessment:
  - Catch and effort
  - Abundance /Density survey
  - Habitat mapping (both fished and non fished areas)

- At present, with funding from the European Union Special Framework of Assistance (2003) a conch assessment project is being conducted to gather data on the density of conch in fished areas and the socioeconomic importance of the conch fishery in Saint Lucia.

- The collection of catch and effort data on the conch fishery should be continued to include depth estimates.

- In the medium term, the conch habitats in Saint Lucia should be mapped.

- In the long term, it is recommended that data on the density of conch in Saint Lucia be conducted regularly as to estimate better the existing biomass and the rate of increase of the conch stock in Saint Lucia.

- With the current location of the conch stock in Saint Lucia, it would be difficult to conduct density surveys and habitat mapping in areas which are not currently fished because the depth becomes a limiting factor.

3.5 Stock Assessment Summary

- The assessment of the conch stock in Saint Lucia was updated using the Schaefer surplus-yield model to include catch and effort data collected in 2007.

- Catch per unit effort (CPUE)[2] was used as an index of stock abundance. We attempted to use *crew hours at sea* as a measure of effort to calculate the CPUE index. However, an assessment of the linearity of the relationship revealed that it was, in fact, not appropriate. The measure of effort used was *number of used tanks*.

- The CPUE index appears to be declining each year (Figure 1). The CPUE for 2007 was estimated at 11.13: this is an indication that for every one unit of effort (SCUBA tank) the fishers are catching approximately 11 pounds (5 kg) of conch.

- Bayesian Statistics and the Monte Carlo (rejection algorithm) methods were used to estimate Maximum Sustainable Yield (MSY)[3], replacement yield[4], current biomass relative to biomass at MSY, and current fishing mortality relative to fishing mortality at MSY.

- The results indicate that the current biomass of the stock is below the biomass of the stock at MSY (Figure 2) and the current catch of 41.1 tons is likely to result in over fishing.

[2] **CPUE** is the quantity of fish caught (in number or in weight) with one standard unit of fishing effort.
[3] **Maximum Sustainable Yield** or **MSY** is, theoretically, the largest yield/catch that can be taken from a species' stock over an indefinite period. Any yield greater than MSY is thought to be unsustainable.
[4] **Replacement Yield** is the largest yield/catch than can be taken from a species stock when the current biomass is below the biomass at MSY.

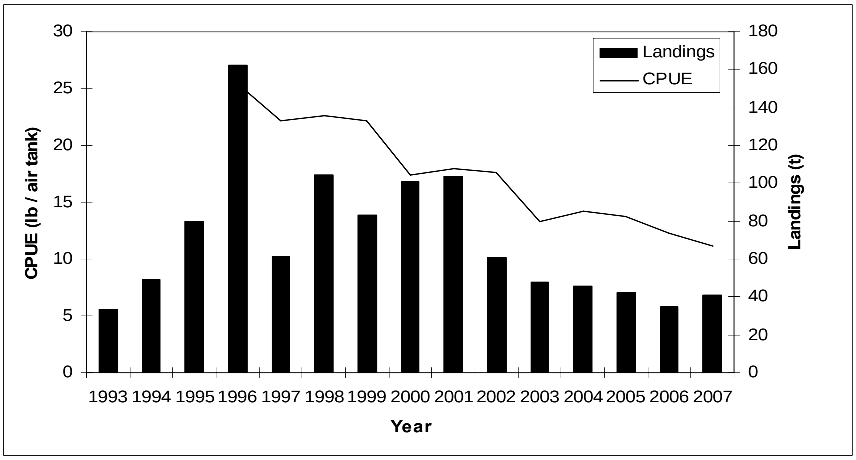


Figure 1. The CPUE abundance index shows a continuous decline since 1996, suggesting that the stock abundance has declined over this period. The catch time series 1993-2001 has some uncertainty as to the recorded data (see Section 1.4.1).

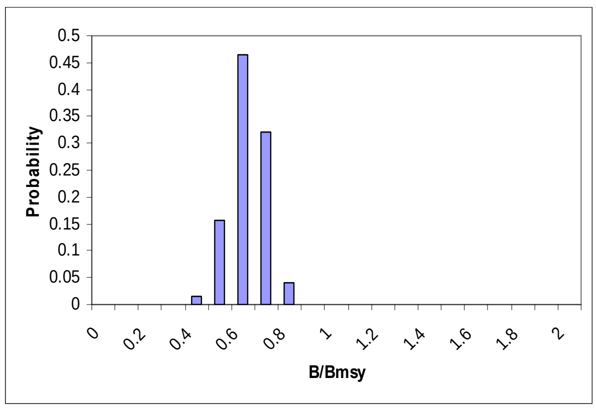


Figure 2 There is a high probability that the current biomass of the stock is below the MSY target of 1 (B/B_{MSY} < 1).

3.6 Special Comments

- The Bayesian priors[5] may be estimated to be too high because values used in their calculation are believed to be higher than what really exist. That is, there is concern that comparing bank areas without taking account of the local habitat leads to greater uncertainty in the assessment.
- Improved prior information, based on actual conch habitat areas in St. Lucia, compared with use of data from TCI and Jamaica, is expected to increase the accuracy of the assessment.

- There is a need for management to apply measures such that the CPUE for this fishery increases. This, as a by-product, would also lead to better parameter estimates.

3.7 Policy Summary

[5] A prior is a probability distribution for a variable with an uncertain quantity. The value assigned is based on probability.

The policy of the Government of Saint Lucia is the commitment to the conservation and sustainable use of its fisheries resources for the long-term benefit of the people of Saint Lucia (Department of Fisheries, 2006).

The overall goals for fisheries management are:

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

- Preserve rare and fragile ecosystems, as well as habitats and other ecologically sensitive areas, especially coral reef ecosystems, estuaries, mangroves, seagrass beds, and other spawning and nursery areas.

- Protect and restore endangered marine and freshwater species.

- Prevent the use of destructive fishing gear and methods.

- Take into account traditional knowledge and interests of local communities, small-scale artisanal fisheries and indigenous people in development and management.

- Develop and increase the potential of living marine resources to meet human nutritional needs, as well as social, cultural, economic and development goals in a manner which would ensure sustainable use of the resources.

- Ensure effective monitoring and enforcement with respect to fishing and other aquatic resource uses.

- Promote relevant scientific research with respect to fisheries resources.

- Ensure that the fishing industry is integrated into the policy and decision-making process concerning fisheries and coastal zone management.

- Promote a collaborative approach to freshwater and marine management.

- Co-operate with other nations in the management of shared and highly migratory fish stocks.

3.8 Scientific Assessments

3.8.1 Description of the Queen Conch Fishery in Saint Lucia

The Queen conch, *Strombus gigas* (Linaeus, 1758) is one of the single species nearshore fisheries of Saint Lucia. At present, near shore stocks have been over exploited, and most fishers harvest at deeper depths with 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 (Nichols & Jennings-Clark, 1994).

Information obtained from a recent survey of vessels targeting conch resources (Walker, unpubl.) 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. At this point the northern population is thought to be more heavily exploited than the southern population.

Conch is exploited commercially all year by over 40 fishers in depths ranging from 11 m to 43 m. Fishers operate mainly out of fibreglass pirogues ranging in length from 7.02 – 8.45 m, powered by outboard engines of 115 – 250 hp. Walker (unpubl.) reported that whilst conch is targeted commercially by some fishers throughout the year, other fishers focus their efforts on this resource during the low period for "offshore" pelagic species, which lasts an average of five months.

Fishers of this resource can be divided into part-time and full-time. Full-time fishers conduct an average of four dive trips each week alternating harvesting and rest days, whilst part-time fishers operate twice each week (Walker, unpubl.). It is common for two divers to enter the water per trip. Walker (unpubl.) reported that the majority of divers conduct more than three dives per trip and an average of 300 conchs are landed per trip. The quantity of conch landed is dependent on the number of divers and the number of dives conducted during the trip. Subsistence exploitation in shallower areas occurs but the extent is unknown.

In 2000, the Department of Fisheries, in response to the increased accidents/injury resulting from unsafe diving practices during harvesting of conch, administered a questionnaire to collect information for implementation of a training programme in safe harvesting practices. Information gathered has been used in the preparation and delivery of training. Through this training workshop, several traditional divers have been certified in SCUBA diving; however, some use unsafe SCUBA gear.

Due to the nature of the fishery, the marketing system and an informal policy of the Department of Fisheries, the majority of 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. Currently, the major market for conch meat is the local market, which serves both the tourism sector and nationals. Over the past three years, there has been a growing demand for conch meat as a result of activities such as seafood festivals, which developed in several communities to stimulate economic development in these communities. To date, these festivals take place weekly in four major communities namely, Gros Islet, Dennery, Anse la Raye and Vieux Fort.

3.8.2 Overall Assessment Objectives

The main objective of this assessment was to update the status of the stock from 2007 and to derive a MSY based reference point for the stock.

3.8.3 Data Used

Name	**Description**
Catch and effort data	Observed lobster landings using trip interviews during 1996-2007
Total conch landings	Annual landings from 1993-2007 raised from the trip interview data.

3.8.4a Assessment 1

<u>3.8.4.1 Objective</u>

The initial aim was to attempt a new assessment using an alternative measure of effort (man hours) to that used in the previous assessment (number of air tanks) to see whether this would improve the assessment.

3.8.4.2 Method/Models/Data

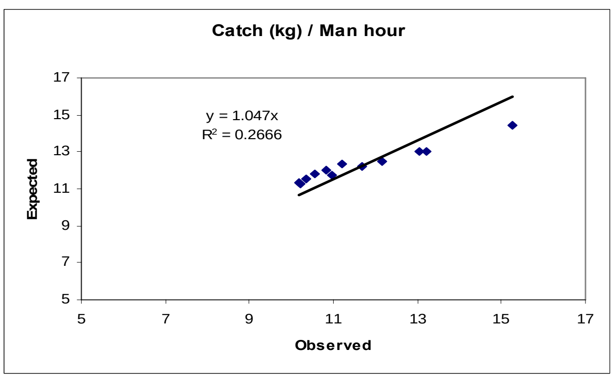
Concern had been previously expressed that air tanks may not provide a good representation of fishing effort because, on occasion, the number of tanks recorded may not actually be the number of tanks used and the number of tanks used will vary with depth. However, if the proportion of tanks used on a trip and the average depth does not change over time, tanks may provide a good effort index.

The best alternative to tanks is 'man hours' (crew*hours) at sea, which showed the highest correlation with the trip landings (Table 1). The 'man hours' effort measure was rejected in the original assessment because the relationship between landings and effort appeared non-linear despite the higher correlation. The 'man hours' measure may not be suitable because not all time at sea is spent fishing. However, as long as the proportion of time at sea spent fishing remains constant, 'man hours' should remain a good index.

There were no options for standardization of the CPUE. Vessels do not vary much in size, and only the target species, conch, is caught on a trip. Vessels operate over one day, leaving in the morning and returning later that same day.

Table 1. Correlation coefficients between the trip landings and possible effort measures. On the basis of correlation, the hours at sea or crew*hours measure appears to more correlated to trip landings compared to the number of tanks.

Number of Tanks	Hours at Sea	Crew * Hours	Crew * Hours * Tanks
0.487	0.548	0.552	0.611



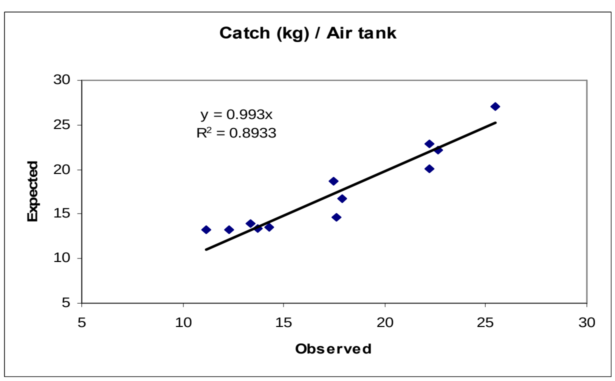


Figure 3. Observed and expected CPUE derived from the fitted model for the two CPUE indices. The fit of the model to the CPUE based on effort measured as 'number of air tanks' is better than the effort measure of 'man hours'. The R^2 indicates a better fit and the residuals show no pattern compared to using 'man hours'.

3.8.4.3 Results and Discussion

The stock assessment carried out in 2007 was repeated in 2008 using both 'number of air tanks' and 'man hours' in calculating the observed CPUE (Figure 3).

3.8.4b Assessment 2

Objective

Using the CPUE index based on 'number of air tanks', update the full stock assessment from 2007, implementing where possible the recommendations made in the previous year's assessment. The primary objective was to update the 2007 assessment.

In 2007, it was recommended that the next assessment should include:

- *Corrected, recalculated catches, with the estimated error, for the annual catches and the time series extended back as far back as possible.* The catches with their current corrections were checked and considered adequate. No further data were recovered.

- *Various sensitivity analyses including alternate CPUE indices, notably 'hours at sea' which may be a better effort measure, and alternative forms of the biomass dynamics models.* 'Crew hours at sea' was tried as the measure of effort and found to provide a worse fit to the population model. Alternative forms of the model were not tried. As there continues to be little contrast in the data it is unlikely that the assessment will be able to discriminate between the different models.

- *The assessment can be used to estimate recovery times, test whether changes in CPUE will be detectable and indicate when recovery might be determined.* This task was not undertaken at this session. If management controls are provided, this may be conducted at the next session.

3.8.4.2 Method

Overview

The method applied is the same as that applied in 2007 (Hubert-Medar and Medley, 2007). For completeness the methodology is reproduced here with appropriate improvement and annotation.

The available data suggest a biomass dynamics model is a suitable assessment method for these data. The Schaefer model is suitable for independent fishery populations. The short pelagic larval stage (2-3 weeks) makes it likely that, in many cases, conch forms independent populations which are predominantly self-recruiting. Hence, the Schaefer model is widely and successfully used for conch fisheries such as the Turks and Caicos Islands and Jamaica in setting TAC and was used in 2007 for Saint Lucia to provide management advice. The model appears to have the ability to describe changes in CPUE, and in the case of the Turks and Caicos Islands, estimates a biomass close to the abundance survey. Therefore, without evidence to the contrary in a particular case, the logistic (Schaefer) model is appropriate.

The priors for the four model parameters remain the same as those used in 2007. The population model requires an initial stock state (B_0), rate of increase (r) and an unexploited biomass (B_∞). These parameters each require information to improve the estimation. The proposed priors are based on a preliminary method, as no standard method exists. The method is important as it affects the final outcome. A standard approach ensuring results are precautionary would be valuable in using this method. The catchability parameter (q) prior is assumed uniform (uninformative) on a log scale.

The initial state of the stock at the start of the catch time series is stock specific and so information from other assessments cannot be used. The longer the catch time series, the less important this parameter is. The proposed initial stock state prior (Figure 4) was subjective and based on general observations in previous reports that exploitation had increased in recent times with markets opening up in neighbouring islands. Therefore, the stock was assumed unexploited in 1993, but otherwise the state of the stock at this time was uncertain.

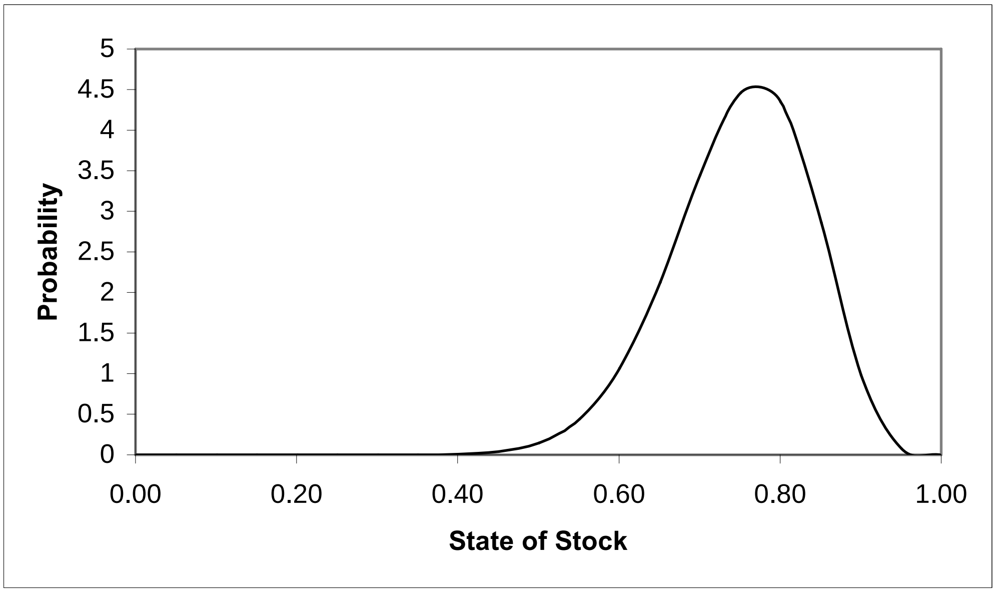


Figure 4 The beta distribution for the prior of the initial stock state (α=18, β=6, μ=0.75). The initial state probability was subjective, but based on the assumption that the stock was very unlikely over-exploited (below MSY) in 1993, but some exploitation was occurring, so that almost all the probability mass was between 0.5 and 1.0. The fishery expanded when markets opened up in neighbouring islands. This was assumed to be occurring 1993-1996 in the time series, but should be verified.

The rate of increase (r) will be an attribute of the species and affected by the local productivity. A prior based on the species is the most appropriate. As data become more available, this should be updated by local productivity information. The only estimates for rate of increase were for the Turks and Caicos 2003 assessment. A beta distribution was fitted to the bootstrap estimates for the *r* parameter (Figure 5), and adjusted to increase the uncertainty (the β parameter was rounded down from 12.4 to 10, flattening the beta function). Increasing the uncertainty in the prior makes the prior less informative and lowers its influence of the results. Given that the location and therefore productivity may change, this is good practice, but there is no standard approach.

The unexploited abundance prior (Figure 6) was based on a log-normal with hyper-parameters estimated from reported abundance and unexploited biomass for the Pedro and Caicos banks (Table 2). While the various estimates for tons per hectare covered the likely range, the total habitat area for Saint Lucia was unknown. An estimate based on the shelf area to the 200m contour was used, but was probably too high. A more consistent approach might be to use the fished area, which could be estimated for Saint Lucia over the next year.

Table 2 Values obtained for Pedro and Caicos Banks used to estimate the range for the Saint Lucia prior for the unexploited biomass (B_{∞}).

Source	Basis	Area (ha)	Biomass	t / ha	Saint Lucia (t)
Pedro Bank	Current survey biomass	571700	14556	0.0255	1177

2002 abundance survey	estimate				
Pedro Bank MSY	Confidence interval from reported MSY confidence interval, assuming *r*=0.5		10400 14400	0.0182 0.0252	841 1165
Turks and Caicos Islands	Estimated B_∞	650000	8636	0.0133	614

The tons per hectare were raised for Saint Lucia by multiplying by the presumed habitat area (45500 ha 85% of the shelf area to 200m depth contour). The highest and lowest biomass estimates were used to define the 80% interval for a log-normal, with resulting parameters μ= 6.75, σ=0.27.

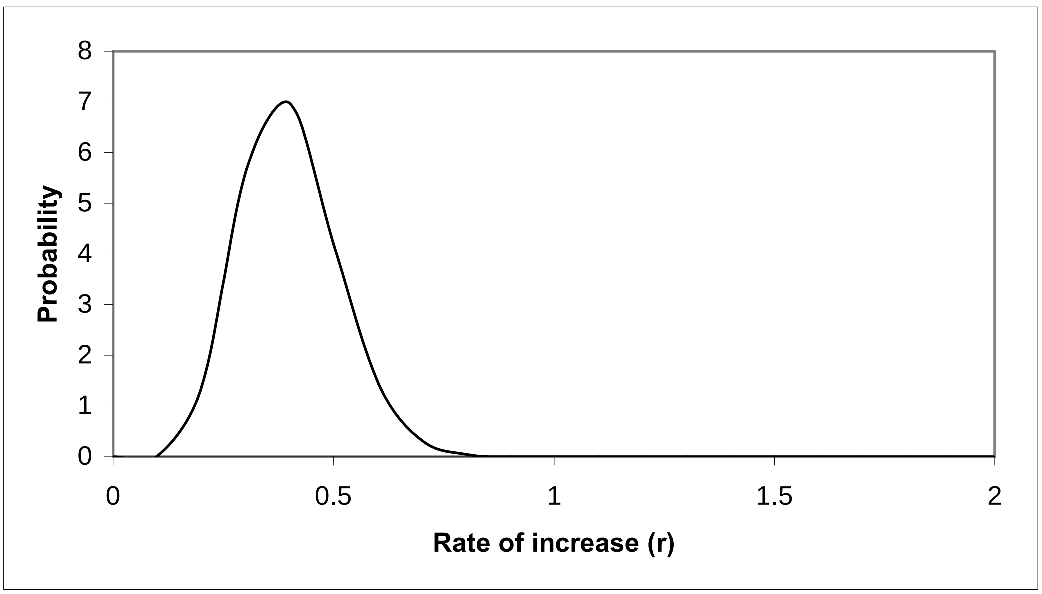


Figure 5 Beta distribution for the rate of increase (*r*) prior fitted to bootstrap estimate frequencies from the 2003 Turks and Caicos Islands assessment (α=40, β=10, μ=0.2; x values are multiplied by 2.0 to get the *r* parameter). The value is limited to exist only between 0 and 2, outside this range the model becoming unstable and biologically unrealistic.

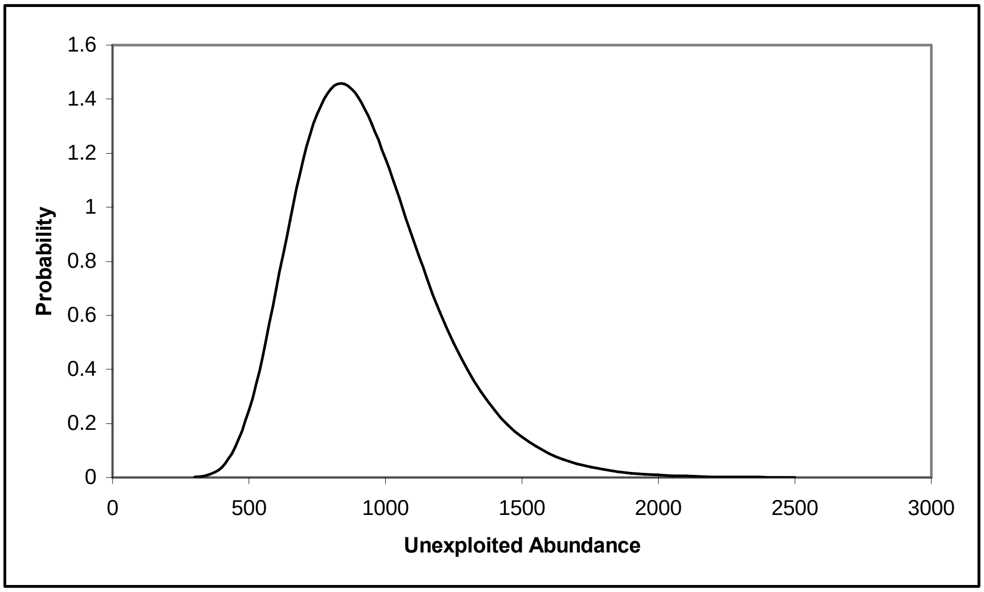


Figure 6 Log-normal probability density for the unexploited stock size. The prior was designed so that 80% of the probability mass was between the minimum and maximum values derived from the Turks and Caicos Islands and Jamaica assessments corrected for the smaller Saint Lucia shelf area, and further subjective precautionary correction.

The priors are provided as independent parameters. In the case of Turks and Caicos for example, the r and B_∞ parameters are correlated and a prior based on this stock assessment, it could be argued, should reflect the correlation in the estimates. While this issue could form the basis for an exploratory analysis, it may be considered an over-interpretation of a prior as the posterior from another stock assessment. A prior should be general, and not so prescriptive that it obscures any information in the data specific to the fishery.

Likelihood

The likelihood for the observations was the normal (Gaussian) probability density function fitting between the observed and expected CPUE index. The expected CPUE index is calculated as the catchability parameter multiplied by the biomass abundance. The variance (σ) parameter was not fitted using Bayesian methods, but fixed at an estimated value. The parameter was estimated from the squared residuals between the observations and a smoothed CPUE series (moving average).

The catches also were not fitted, although they could have been if the sampling error was to be included. This source of error was small, and least squares fitting suggested allowing for this sampling error would make little difference to the assessment.

Fitting Method

When fitting models using Bayesian techniques, there are limited options available. As in almost all cases the posterior probability density function (pdf) cannot be integrated directly, methods rely on being able to draw random samples from the posterior for Monte Carlo integration to calculate statistics of interest for Saint Lucia.

For high-dimensional problems (many fitted parameters), the favoured choice is Monte Carlo Markov Chain methods (MCMC). This set of methods is flexible and generally works under most circumstances, but requires some skill to implement and does not necessarily work for "difficult" models. Detecting when the method produces poor results is not necessarily easy, and may be difficult to see how to adapt the algorithm to deal with problems when they arise. The logistic model can behave in a complex and difficult manner which belies the small number of parameters taken to fit it. Because of these and similar problems encountered when fitting this and the standard biomass dynamics model, an alternative approach was used which allows either rejection sampling or sample-importance-resample (see Gelman *et al*. 1995):

1. Rejection sampling takes random samples from the approximating distribution and rejects each sample with a probability based on the difference in height between the approximating and target function. The rejection step applies a correction which guarantees the final set of accepted values will essentially be drawn at random from the underlying posterior if the approximating function covers the target function (i.e. The approximating function is greater than the target function across all parameter space). This is the preferred method as checking is straightforward and numerical fitting errors can be minimized.

2. Sampling importance takes random samples from the approximating pdf and calculates a weight based on the ratio between the approximating function value and the target function. These weights can be used to apply a correction to the integration, as well as form the basis of the resampling step of the SIR algorithm. The SIR algorithm attempts to generate a draw of parameter values from the target function with equal weight. The sampling importance has the advantage over the rejection algorithm in that the approximating function need not cover the target function. It is generally not possible to guarantee that the target function is covered across its whole range in a large number of dimensions, so SIR may be the best option for difficult cases. The problem with the method is that the accuracy can be poor, as indicated by a wide range of weights, a problem which can only be addressed by an improved approximating function.

If a good approximating pdf can be obtained, both these methods work and can be verified by checking the ratio of the approximate to the target pdf and/or the rate of rejection.

The method used here builds an approximate pdf from repeated sampling from the target posterior function. An ideal approximating function should be proportional to the target pdf, and easy to draw random values. The method used here makes use of methods for representing normal mixture approximations to multimodal densities (Gelman *et al.* 1995) and fitting kernel smoothers to approximate densities when a random draw is available (Silverman, 1986).

The method is applied as follows:

1. Make a random draw of the variables from the current approximate density.
2. Calculate the approximate and target function values and the difference between the two.
3. IF the approximate function is greater than or equal to the target function, THEN accept the values with probability (Target F)/(Approximate F), otherwise reject them OR accept the importance sample recording the importance ratio if the importance ratio is not too high
4. ELSE the approximate function is less than the target function OR the importance ratio is too high, so add another normal kernel to the approximate density:
    a) Find the mode of the difference function being the target minus the approximate function.
    b) Calculate the kernel weight as the ratio of the height of the kernel normal to the height of the difference function.
    c) At the mode, calculate the hessian matrix (partial differential matrix) and invert it. The inverted hessian matrix is covariance matrix for a multivariate normal distribution. Adjust the estimated matrix to best fit the local difference function and ensure the matrix is a valid covariance matrix (positive definite).
    d) Add a "kernel" multivariate normal to the approximating mixture pdf with mean equal to the mode and covariance matrix to the estimated matrix above.

e) Repeat actions a) and c) until the original point is covered (target F – approximate F < 0 OR importance ratio is acceptable)
f) Discard all the draws from the target function to restart.

5. Repeat actions 1 to 4 until the required number of draws have been made.

The method has several advantages and one important drawback. The main advantages are that the algorithm should cover even very complex target posterior pdfs (albeit this may require adding a relatively large number of normals) and the method is easier to improve and manipulate manually. As an example of the latter, if any uncovered volumes are suspected, they can be pointed out manually to the procedure, which can then fill out these volumes in the approximate pdf if necessary without affecting the approximate distribution at other points. Therefore, as it proceeds, the fit becomes more and more accurate, and at any time a volume of uncovered probability is found it can be added to the approximate pdf. Once a good approximate pdf is estimated, draws can be repeated very rapidly.

The only drawback is that very large numbers of kernel normals may be required depending on the shape of the underlying target function. If the shape is close to normal, only a few kernel normals will be required. For most real-world problems this is not the case, and for fitting the logistic population model, this is almost guaranteed not to be the case. While with only a 1-3 parameters even complex shapes do not present too much of a problem for the technique, 4-6 parameters (i.e. dimensions) can become a problem, as the pdf shapes in the hyper-volume can become very complex indeed. Beyond 6 parameters, in its current form the method may require so many kernel normals to adequately describe the target pdf that it becomes impractical to use rejection sampling, but the SIR algorithm can still be used.

As in any of these Monte Carlo techniques, including MCMC, it cannot be guaranteed that all probability mass is covered, and therefore some inaccuracy may result. By judicious choice of initial values and systematic searching across the parameter ranges, significant problems can be avoided. These methods should cover all contiguous probability mass, the only problems arising through isolated modes. The longer the method above is applied (i.e. draws are made) the more likely it is that such probably masses will be found and the approximate pdf adjusted accordingly.
The method has been implemented using Visual Basic in an MS Excel spreadsheet. While this implementation is numerically slow, it was considered useful in developing the method to use spreadsheet based functions and data storage as these are most flexible in setting up models and monitoring the behaviour of the fitting algorithm. The full code and spreadsheet are available on request (paul.medley@virgin.net).

3.8.4.3b Results
The fitting method worked well, and the model was able to apply the rejection sampling method. The results are therefore a reliable representation of the posterior, but all uncertainties with respect to model and data still apply.

The marginal probabilities of various performance indicators were obtained from the posterior. These are true probabilities and can be interpreted as such. The main performance indicators were (1) biomass relative to biomass at MSY, (2) the replacement yield, (3) the maximum sustainable yield and (4) current fishing mortality relative to fishing mortality at MSY.

These results suggest that it is likely that the stock is overfished (Figure 7), and that overfishing occurred in 2007 (Figure 8). The 2007 catch of 41t is likely to be above the replacement yield (Figure 9). The MSY suggests the fishery will be small, but that catches could be allowed to increase once the stock has recovered (Figure 10). The CPUE abundance index shows a continuous decline since 1996, suggesting that the stock abundance has declined over this period (Figure 11).

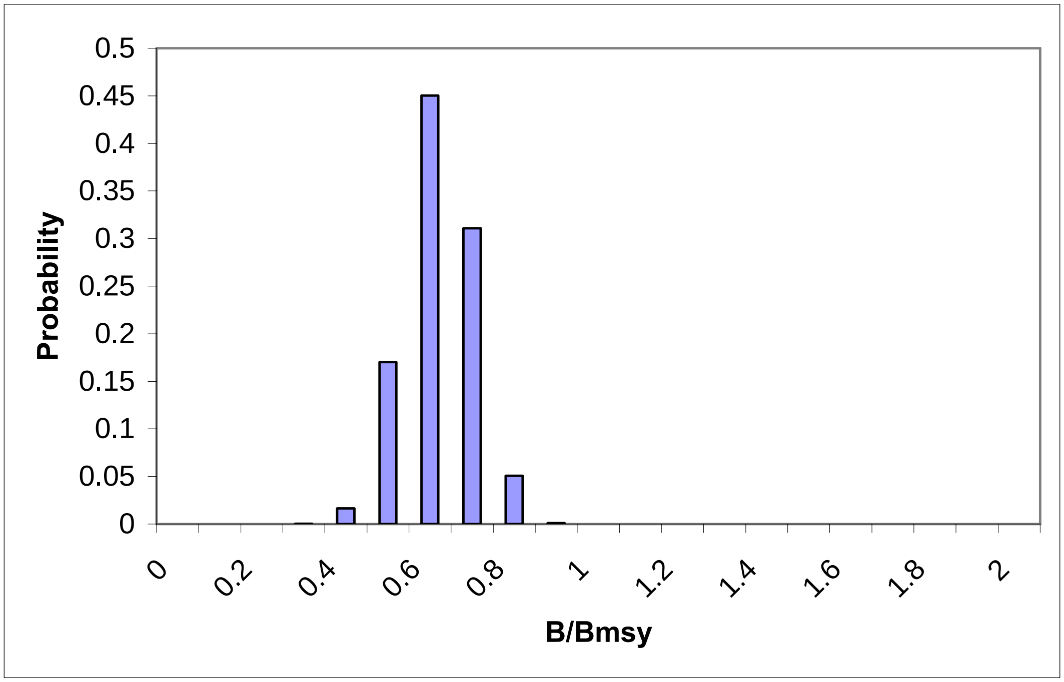


Figure 7 Stock status (Biomass / Biomass at MSY) for conch as a probability function based on the prior information on likely stock size and productivity, and the available catch-effort data. The results indicate that it is very likely that the current biomass is below the MSY reference point ($B/B_{MSY} < 1$).

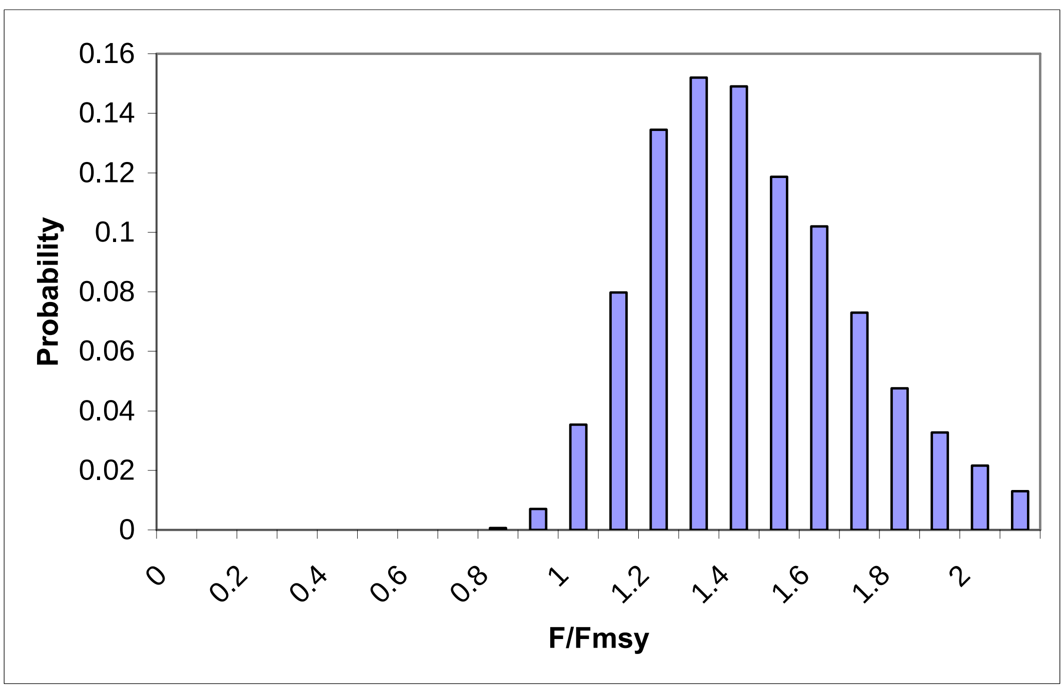


Figure 8 Overfishing status (fishing mortality / fishing mortality at MSY) for conch as a probability function based on the prior information and the available catch-effort data. The results indicate that overfishing ($F/F_{MSY} > 1$) based on a 2007 catch of 41t, is likely. This level of fishing mortality will drive the stock biomass to a low level so that the catches will reduce.

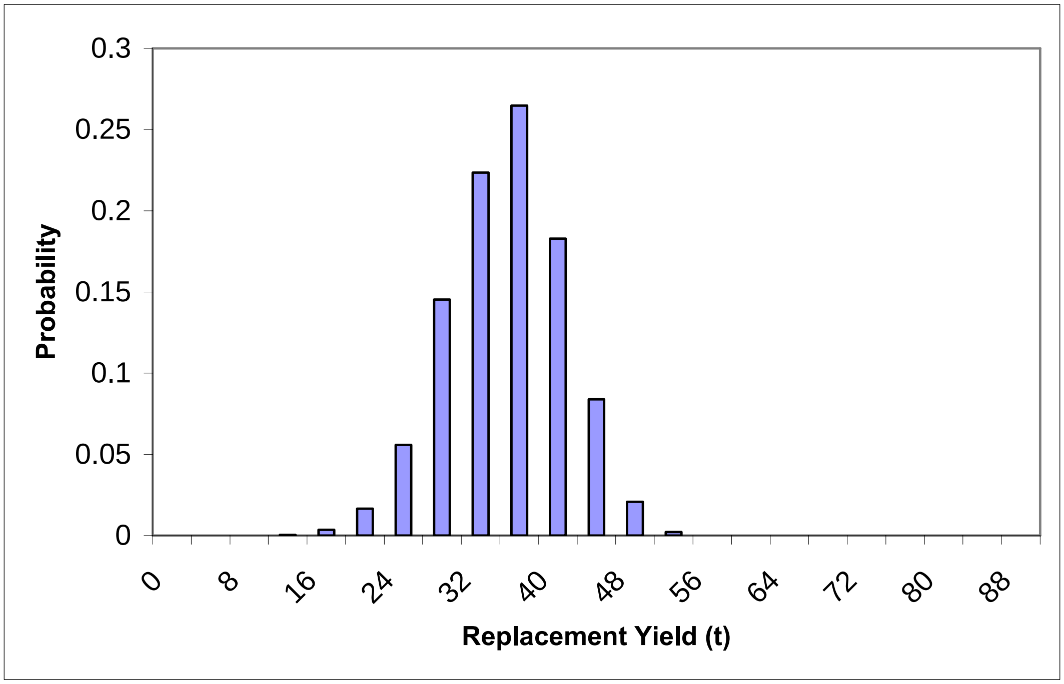


Figure 9 The replacement yield for conch as a probability function based on the prior information on likely stock size, productivity, and the available catch-effort data. The replacement yield is the current production from the stock, so that exceeding this yield will result in the stock biomass falling. The results indicate that the 2007 catch (41t) is likely to be above the replacement yield so that the stock, and therefore CPUE, should decrease. Overfishing is likely to be occurring however (Figure 2), and if it is, maintaining the current catch may not allow the stock to recover above MSY.

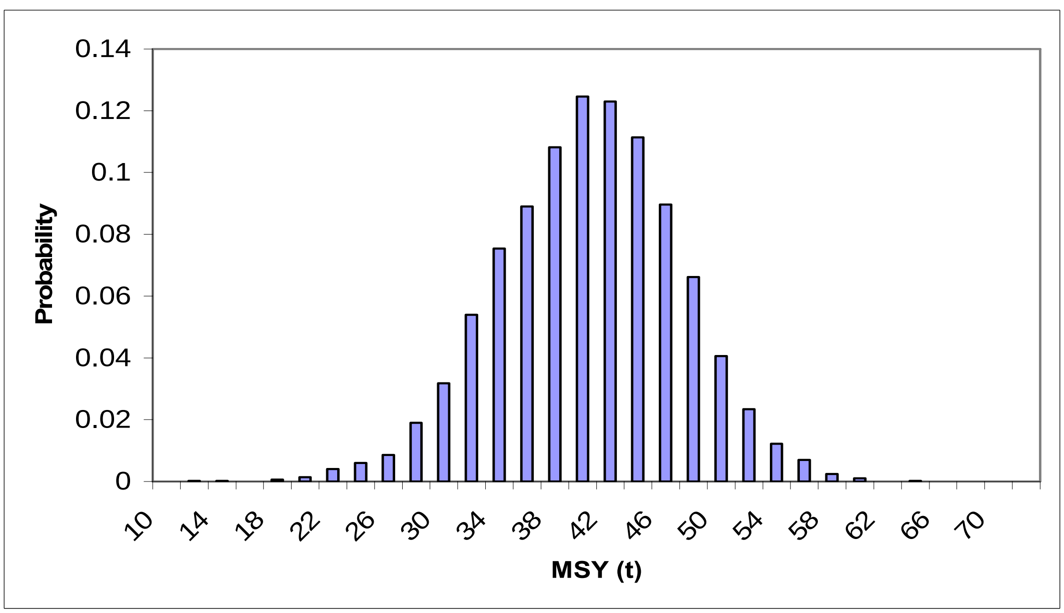


Figure 10 The estimated maximum sustainable yield suggest that yields above 50t are unlikely to be sustainable, and catches in general should be kept below this level. Lower catches would be more precautionary, and catches below 30t per year are unlikely to cause overfishing.

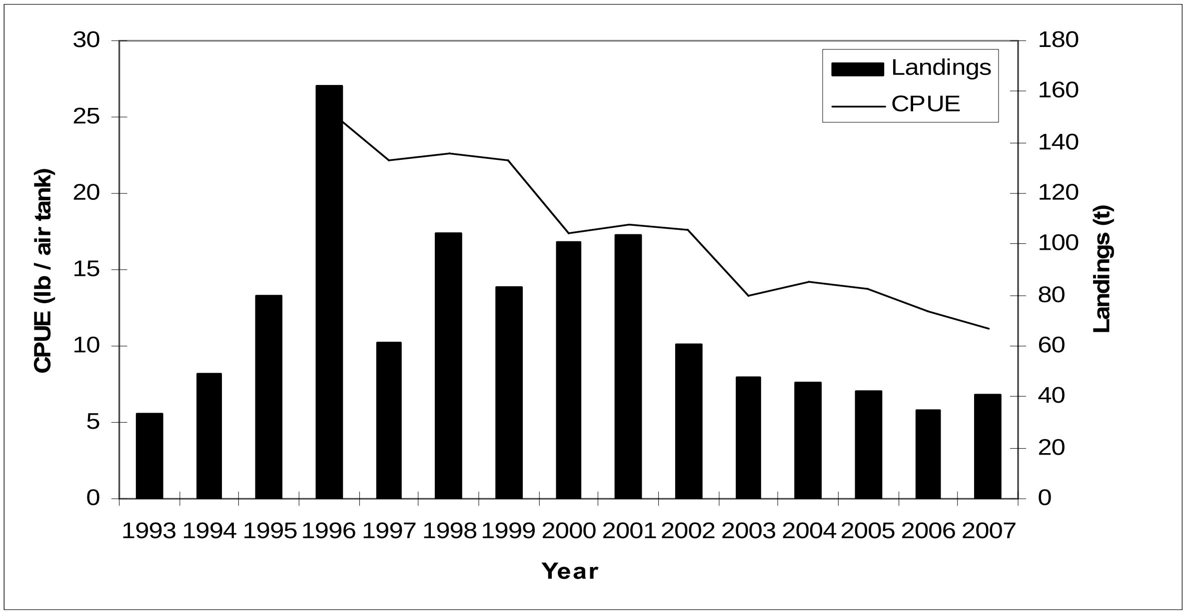


Figure 11 The CPUE shows a continuous decline with catches which the model is able to fit well. However, with only a continuous decline and no recovery the r and B_∞ remain confounded.

Table 3: Estimated current yield together with the median and 95% confidence interval for three indicators of interest.

Current Yield (t) (2007)		41	
	5%	**Median**	**95%**
B/BMSY	0.55	0.68	0.79
Replacement Yield (t)	28	37	46
MSY (t)	31	42	52

As B/BMSY is below 1.0 (MSY reference point), the stock should be designated as overfished. Catches are currently above the replacement yield, and may hinder the recovery of the stock. Reduction in catch should speed recovery and reduce the risk of further overfishing. If catches are kept below MSY, once the stock starts to recover, it should rise above the MSY level.

3.8.4.4 Discussion

The key assumptions of the stock assessment and source of uncertainty not represented in the probability density functions are:

1. The CPUE index is proportional to abundance.
2. The average depth of the fishing ground has not changed.
3. The biomass dynamics model is appropriate for describing the dynamics of the species.

4. Total catches are well estimated.
5. The information included in the priors is valid.

The MSY based reference points are assumed to be an appropriate target reference point defining the lower bound before additional management action is taken. This is an interpretation of the stated policy.

The results from the previous 2007 assessment indicated that the stock was overfished, but that the stock biomass should recover if catches remain constant at 34t. Unfortunately there was an increase in catches in 2007 to 41t leading to a worse prognosis for 2008. The assessment predicts that the stock will continue to decline unless catches are substantially reduced.

If the CPUE continues to fall, more drastic action by management will be required. The main focus of management for this fishery should be to obtain a detectable increase in CPUE. A detectable increase in CPUE would:

- Demonstrate that management is able to control the state of the stock and of the fishery.
- Move the state of the stock to a target where it is not overfished (above the MSY level).
- Support the assumption that the CPUE index is adequate for monitoring biomass and performance of the fishery.
- Greatly improve the stock assessment estimates of MSY.

3.8.4.5 Research Recommendations

Priors are needed to represent likely values for the productivity which could be used in these sorts of models. The results depend upon the prior information introduced. There is no generally acceptable way to design informative priors. An array of alternatives were used here, but were not definitive. Other methods, such as polling experts or using models of the life history and the ecology of the species, would require inter-sessional work to obtain the data and conduct the analysis.

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4. The Reef and Slope Fishery of St. Kitts and Nevis 2008 (Brief Overview Only)

Rapporteur: Kishmo Clarke

4.1 Management Objectives

The main management objectives for St. Kitts and Nevis are:

- To rebuild the reef and bank/deep slope fish stocks.
- To stabilize the net incomes of the operators in the fishery.
- To include as many of the existing participants in the fishery as is possible given the biological, ecological and economic objectives listed above.
- To promote co-management

In addition, management will focus on:

- Reduction in the catch of juveniles
- Regulation enforcement and conservation measures

4.2 Status of Stocks

The status of the stocks is unknown. However, declines in average fish size and algae overgrowth of some reefs suggest that shallow shelf fishes are over-exploited in most areas. A precautionary approach is warranted since fishing effort cannot be quantified, and some species are extremely vulnerable to over exploitation when these aggregate for spawning.

The fishing effort by spear fishers has increased over the past few years; the catches of these spear fishers have also increased while the catches of trap fishers have decreased. The catches of spear fishers are dominated by the parrotfishes (Scaridae), which constitutes one of the most important and heterogeneous groups of fishes and plays a very important role in this highly specialized ecosystem.

4.3 Management Advice

At present the data available are inadequate to make recommendations. The fisheries department should set up a data collection program at the Basseterre Fisheries Complex over the next year. Data such as catch and effort by species, fork length, total length and weight should be collected. This would enable some analysis to be done at the next meeting that could determine if it will be possible to have size limits included in our management plan.

4.4 Statistics and Research Recommendations

4.4.1. Data Quality

The fisheries department has two data collectors currently employed who collect catch and effort data at each landing site on a daily basis. Most of the spear fishers land their catch at one landing site and most of the landings are sold to the government complex there. Unfortunately, species are grouped by price and sold by weight, and so catch by species data are unavailable.

4.4.2. Research

Determine catch rates by examination of data on catch (lbs.) and effort (boat days and Man power)

- Improve understanding of size composition of catches by examination of data on fish size

4.5 Stock Assessment Summary
No stock assessment was conducted for this fishery.

4.6 Special Comments
None.

4.7 Policy Summary
The government of St. Kitts and Nevis is committed to the conservation and sustainable use of fisheries resources for the benefit of the people of St. Kitts and Nevis.

4.8 Assessments
No stock assessment was conducted for this fishery.

5. The Reef and Slope fishery of the Turks and Caicos Islands 2008/2009 Fishing Season

Rapporteur: Kathy Lockhart

5.1 Management Objectives

The overall management objective is to promote sustainable development of the fin-fish fisheries resources by adopting cautious conservation and management measures in conjunction with the 'Guidelines on the precautionary principle' (FAO *Technical guidelines for Responsible Fisheries.* No.2. Rome, FAO. 1996). More specifically, the main management objectives are:

a. Maintain high stock levels,
b. Develop management guidelines for the conservation and sustainable exploitation of the fishery,
c. Improve our understanding and knowledge of the stocks.

5.2 Status of Stocks

The reef and slope fishery resources also known as "finfish" in the Turks and Caicos Islands (TCI) are believed to be under-utilised, but healthy enough for commercial exploitation. Ninnes, 1990 as cited by TCI Government Department of Environment and Coastal Resources (2004) reported a potential yield of 70-140 kg/km of shelf perimeter of the Turks and Caicos banks (Caicos Bank, Turks Bank and Mouchoir Bank).

The belief of an under-utilised fishery is based on a poor catch history. Finfish are sold directly to hotels, restaurants and fish markets, which cater for local consumption. However, some of the catch is sold to processing facilities who report these data to fisheries department. The catch is not exported, but is sold locally to restaurants and hotels. In previous attempts, the TCI Government has been unsuccessful in collecting individual measurements of catch and effort data. In 2006, a program to collect individual measurements of finfish was started to support monitoring and assessment of these resources.

5.3 Management Advice

In order for management to meet the objectives of a sustainable development of the fin-fish fisheries, the TCI government must look to adopt cautious management measures (Department of Environment and Coastal Resources, 2006). The Turks and Caicos Islands are in a fortunate position that data collection can be started before these species reach full-exploitation. A better understanding and knowledge of the stocks requires that more data be collected on the catch and effort directed at these species, as well as individual fish measurements (total length, fork length and weight).

With the available information, the TCI can look at the potential of setting a minimum size for capture (U.S. Fish and Wildlife, 2008). Because the fishery is multi-species, there should be more than one minimum size. Based on currently available scientific information, the following minimum sizes are recommended:

- Minimum size for grouper set at 50 cm fork length (International reference range from 48-51 cm).
- Minimum size for snapper at 35 cm fork length (International reference range 31-61 cm).

5.4 Statistics and Research Recommendations

5.4.1. Data Quality

In 2006, catch and effort data commenced at the local processing plants. Individual measurements are also being collected from the processing facilities, local market buyers and local fishermen. The current data are limited, which does not allow for a full stock assessment to be conducted.

5.4.2. Research

There is a need to improve and enhance current data collection, specifically:

- Collect individual measurements of fin-fish: species, total length, fork length, and, where possible and appropriate, weight, sex, and eye diameter
- Collect catch (lbs) and effort (boat days and man power) from processing facilities and at dock side, to improve coverage and hence understanding of fishing activities.
- Determine the minimum size at maturity for fin-fish species.

5.5 Stock Assessment Summary

A full stock assessment of the reef and slope fishery was not possible because of the limited data. The objective of the present analysis of the data was to determine if a minimum size could be proposed, specific to the fishery. This involved producing a frequency of the available fork length sizes and comparing it to an established proposed minimum fork length based on maturity of the various species. The analysis provides management with an estimate of the impact of different minimum sizes on both the species conservation and the short-term catches (Figures 1 and 2).

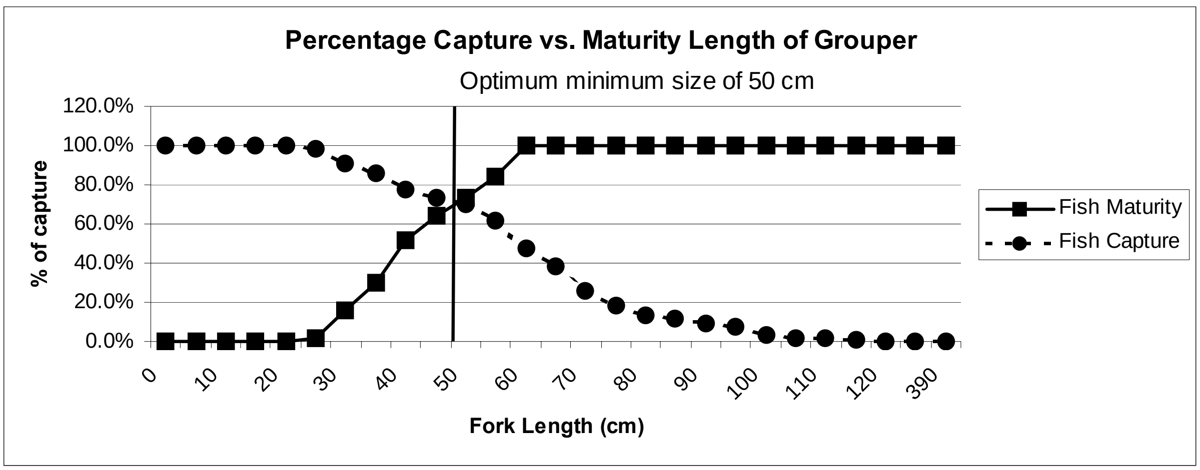


Figure 1. Optimum length for cost and benefit of Grouper.

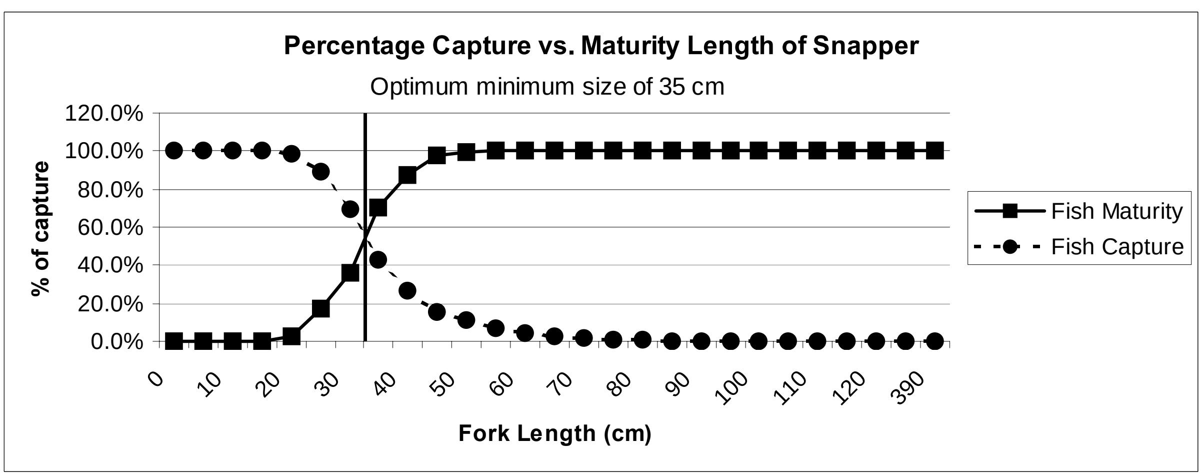


Figure 2. Optimum length for cost and benefit of snapper.

5.6 Special Comments

None.

5.7 Policy Summary

Although protection of fisheries resources is implicit in the overall development strategy of the TCI, the importance of the fisheries sector in present and future development and the fragility of the resource base warrant the establishment of a specific policy for the industry.

The Fisheries Policy aims to ensure the sustainable use of the living marine resources and ecosystems through increased cooperation and collaboration with all the stakeholders for the improved welfare of the people of the TCI.

Inclusive to the policy is the ability to promote sustainable development of the fin-fish fisheries resources by adopting cautious conservation and management measures. Developing specific management measures/ regulations, such as minimum size, can assist in the conservation and sustainable exploitation of the fishery.

5.8 Scientific Assessments

5.8.1. Background or Description of the Fishery

The Turks and Caicos Islands (TCI) commercially fishes primarily for both spiny lobster (*Panulirus argus*) and queen conch (*Strombus gigas*). In 2004, the TCI reviewed the Fisheries Management Plan and made modifications with a final version accepted by Executive Council in 2007, including all relevant fisheries within the TCI.

Finfish is now of increased interest, as more individuals are becoming involved in the fishery. The belief of an under-utilised fishery is based on a poor catch history. Ninnes, 1990 as cited by TCI Government Department of Environment and Coastal Resources (2004) reported a potential yield of 70-140 kg/km of shelf perimeter of the Turks and Caicos banks (Caicos Bank, Turks Bank and Mouchoir Bank).

Finfish are sold directly to hotels, restaurants and fish markets, which cater for local consumption. However, some of the catch is sold to processing facilities, which report data to the fisheries department. The catch is not exported, but is sold locally to restaurants and hotels. In previous attempts, the TCI Government has been unsuccessful in collecting individual measurements of catch and effort data (School for Field Studies, Center for Marine Resource Studies, 2006-2008). In 2006, a program to collect individual measurements of finfish was started to support monitoring and assessment of these resources.

5.8.2. Overall Assessment Objectives

The objective of the analysis was to determine if setting one or more than one minimum size for fin-fish species is appropriate. This analysis could also potentially provide information as to who would be most affected if a minimum size were legislated in regulations. Setting a minimum size is the first step to promote sustainable development of the finfish fisheries resources by adopting cautious conservation and management measures.

5.8.3 Data Used

Name	Description
Catch and Effort Data	Overall catch via family is recorded (sometimes via species) at each of the processing facilities (2 major, 1 minor) for their licensed vessels. Effort of each boat is recorded by the number of days at sea. Individual fishers that are not licensed to a specific plant tend to land fish at

	various points along the docks. The catch and effort data from these fishers is difficult to capture, unless physically done at the point of landing.
Individual length parameters	Species, total length, fork length, and, where possible and appropriate, weight, sex, and eye diameter are recorded during landings at both docks and processing facilities. Data have been collected from late 2006 until recently with the aid of a Non-profit student abroad program, School for Field Studies, Center for Marine Resources Studies. Length at maturity was used from www.fishbase.org A maturity length of 61 cm fork length was used for Misty Grouper because of unavailable information.

5.8.4. Assessment 1

5.8.4.1 Objective

The objective was to determine if setting one or more than one minimum size for finfish species was appropriate. This analysis provided management with an estimate of the impact of different minimum sizes on both the species conservation and the short-term catches.

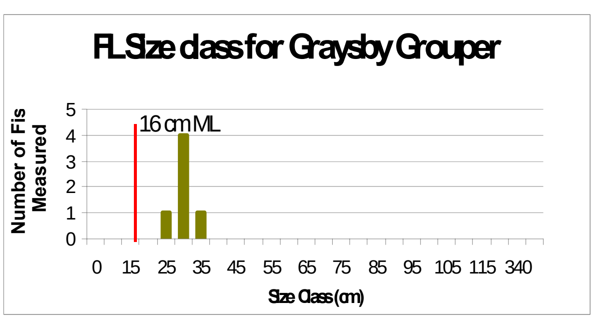
5.8.4.2 Method

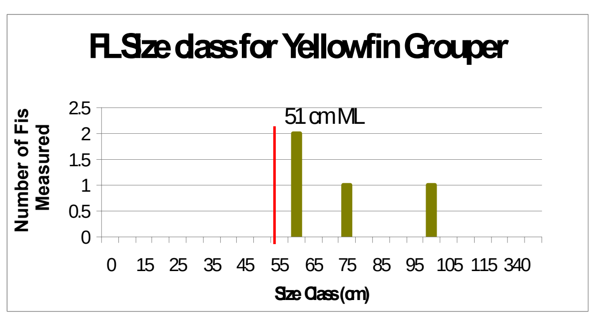
With a limited catch and effort data set, the analysis used individual measurements to attain a frequency of captures by fork length. Individual species were then plotted on a histogram with a documented length at maturity from www.fishbase.org and compared with other histograms of the same family.

The percentage of landings within a family was compared against both maturity and gear. The observation of this comparison provided potential impact from setting a minimum size/ length at capture. This comparison allowed management to determine which species would have the opportunity to achieve maturity. However, management needs to know the cost of setting a minimum size. The analysis provided an estimate of the impact of minimum size on both the species conservation and the short-term catches.

5.8.4.3 Results

Two main families were examined for the frequency of size (fork length) at capture. Both grouper and snapper are commercially exploited species. However, differences were observed within the snapper family, so snapper was then further divided into deep water and shallow water fish. Figure 3 shows size frequencies of three grouper species landings, together with the fork length at maturity for each species, obtained from www.fishbase.org.





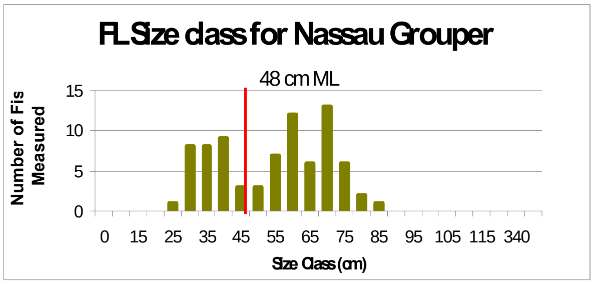


Figure 3. Size frequency of catches of three species of grouper, relative to the size at maturity given by www.fishbase.org.

Figures 4 and 5 show size frequencies of the landings of five deep-water snapper and four shallow-water snapper species respectively, together with the fork length at maturity for each species, according to www.fishbase.org and Cummings (2003).

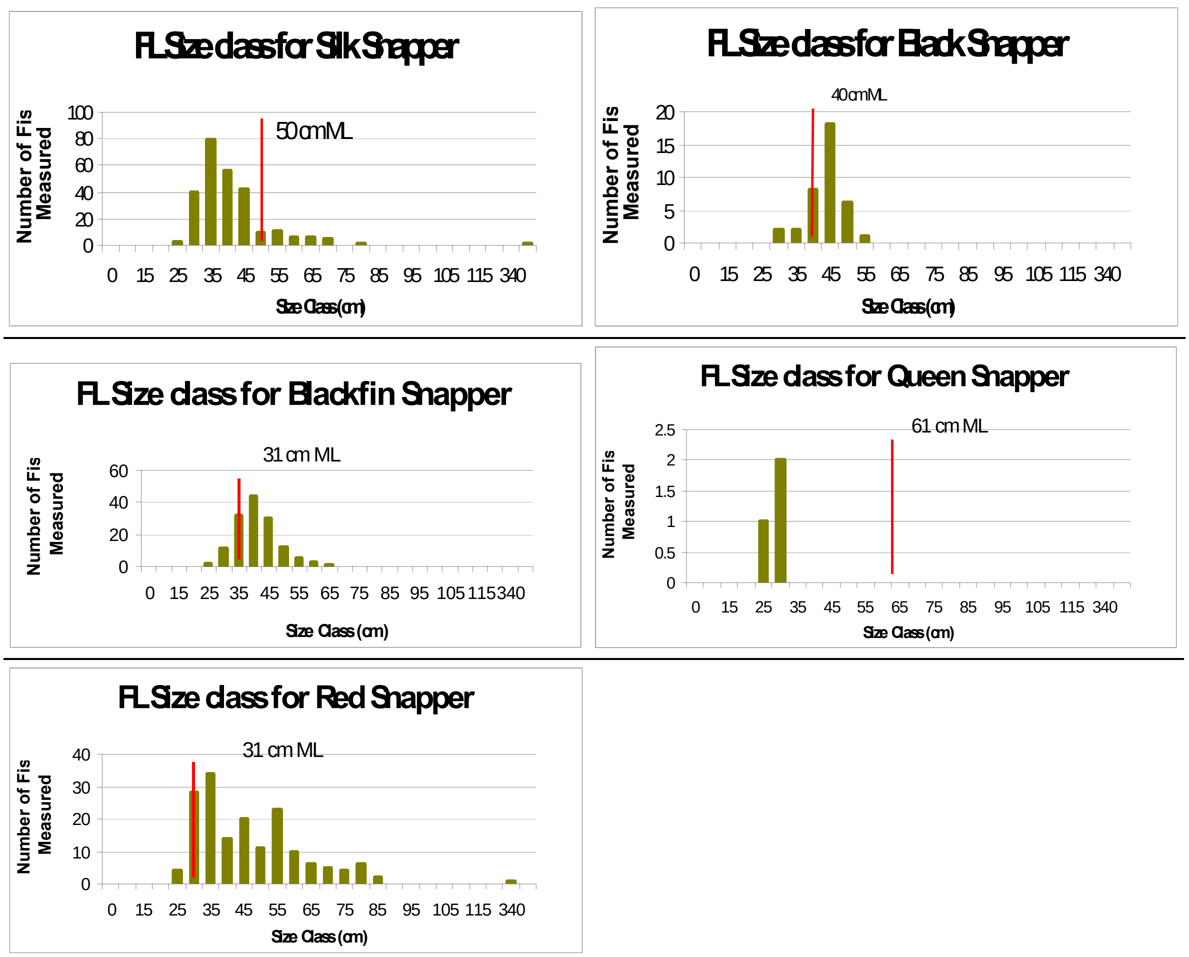


Figure 4. Size frequencies of the landings of 5 deep water snapper species, with the fork length at maturity quoted by www.fishbase.org and Cummings (2003) for each species noted in the corresponding template and indicated by a vertical line.

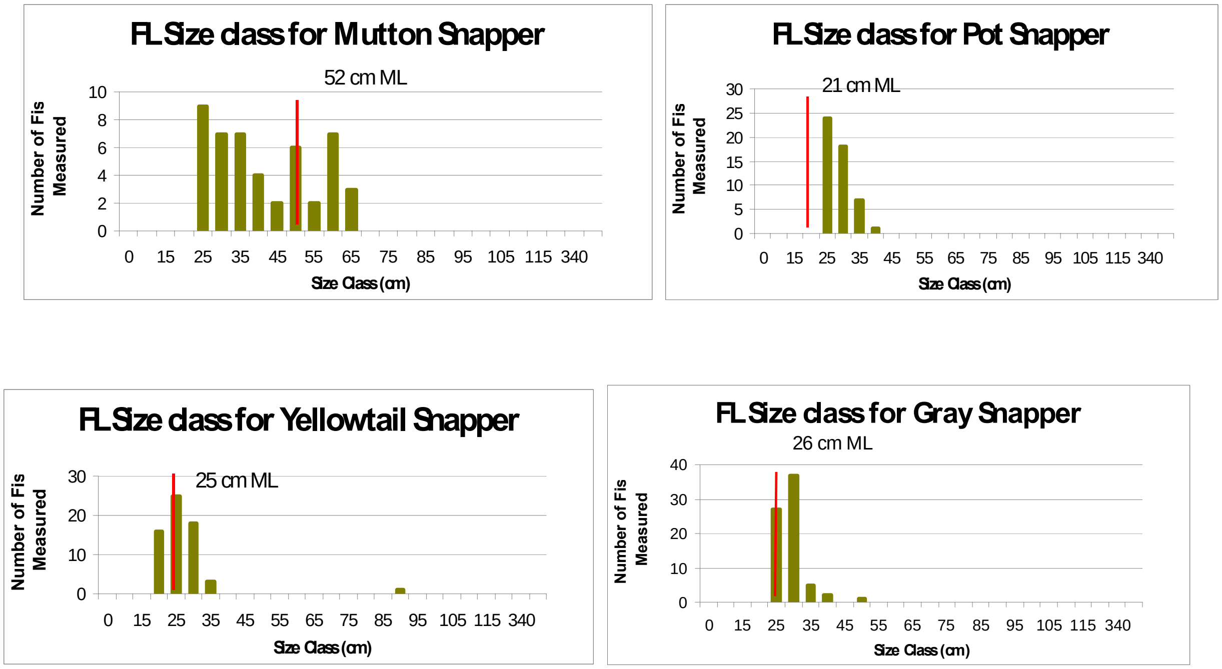
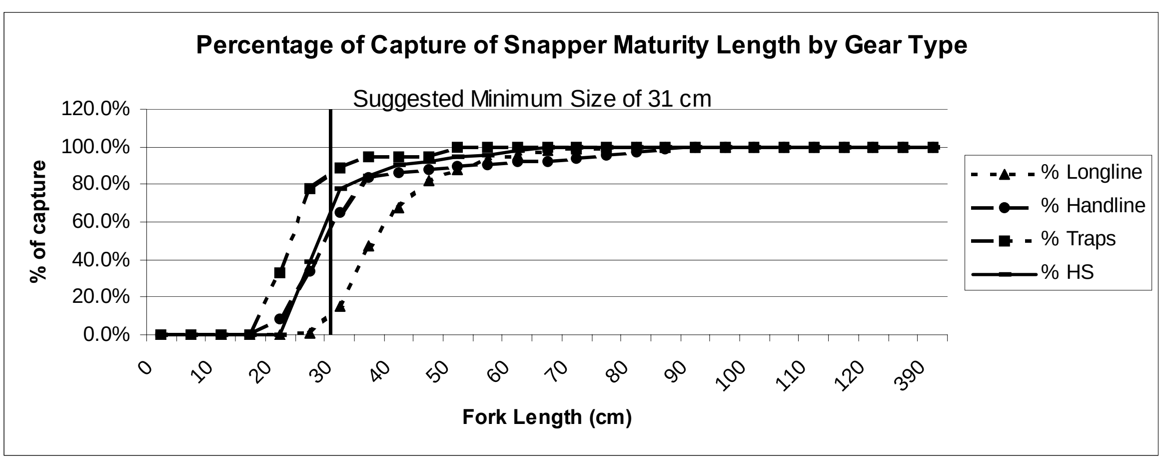


Figure 5. Size frequencies of the landings of 4 shallow-water snapper species, with the fork length at maturity quoted by www.fishbase.org for each species noted in the corresponding template and indicated by a vertical line.

A minimum size at capture can have impact on both the individual species as well as the fishers with different styles of gear. Capture with gear types was compared against setting a minimum size to determine what, if any, gear type would be impacted (Figure 6).



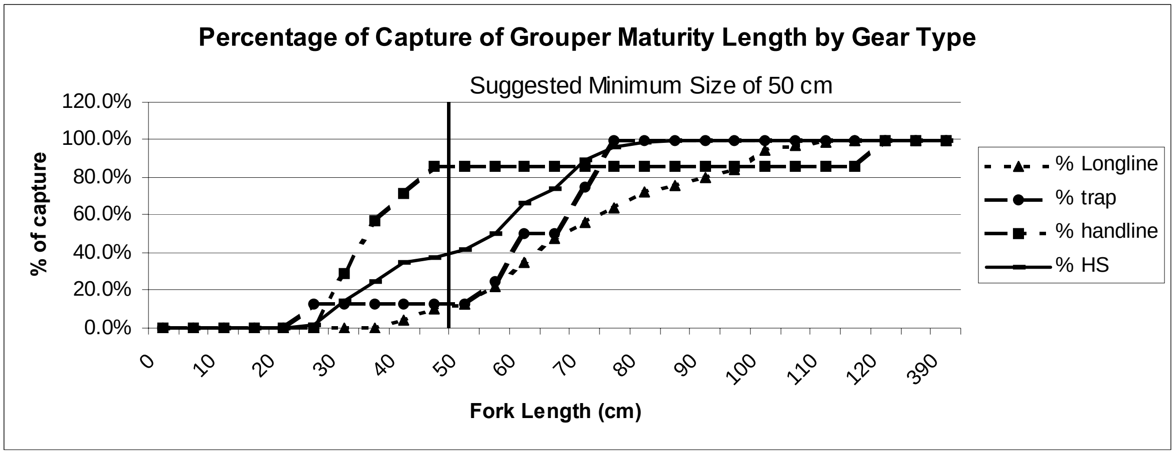
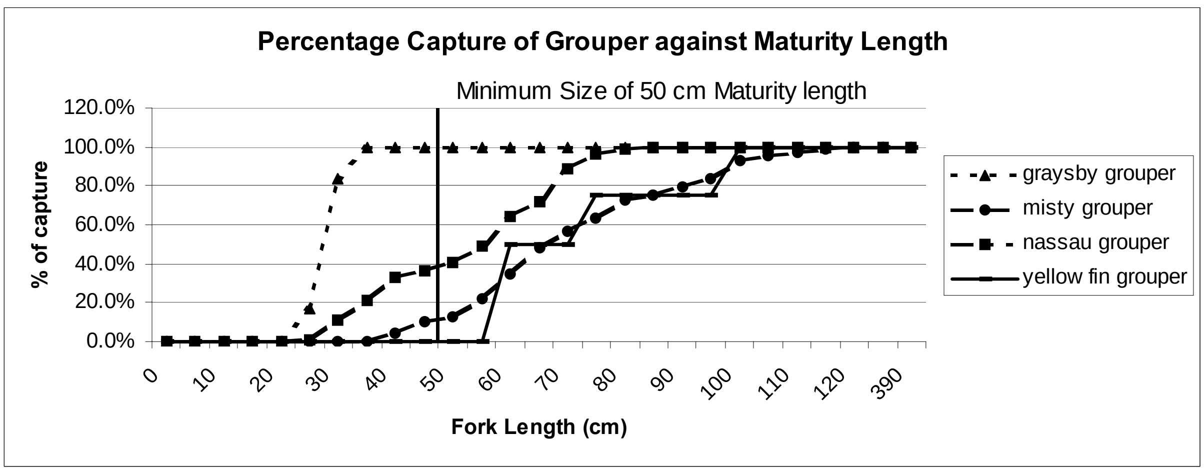
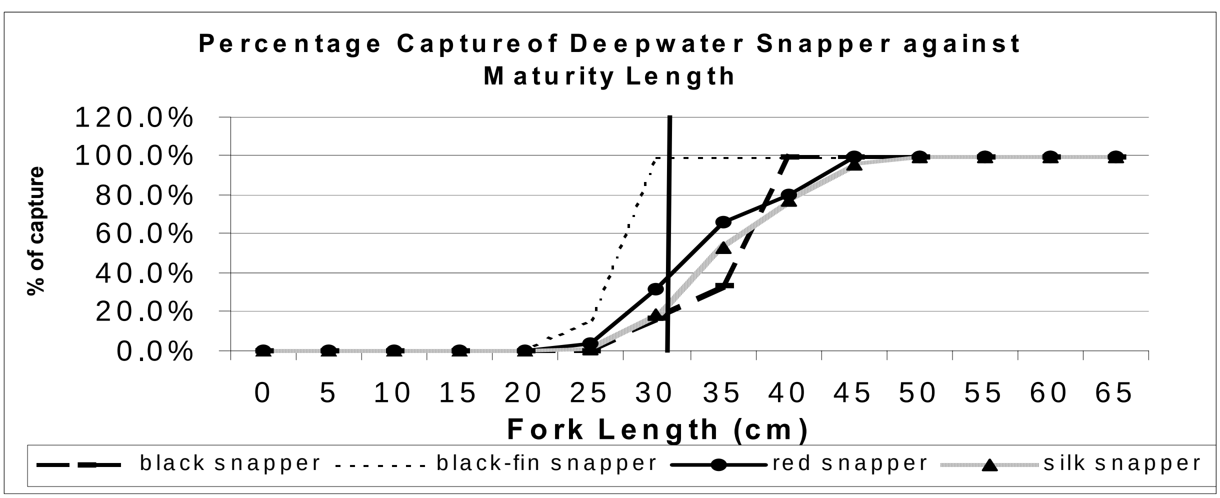


Figure 6. Potential impact on gear type if a minimum size is set. The vertical lines represent the proposed minimum size for the group.

Individual species have different maturity lengths. If a minimum size is set, individual species may be impacted by potential exploitation before maturity (Figure 7).





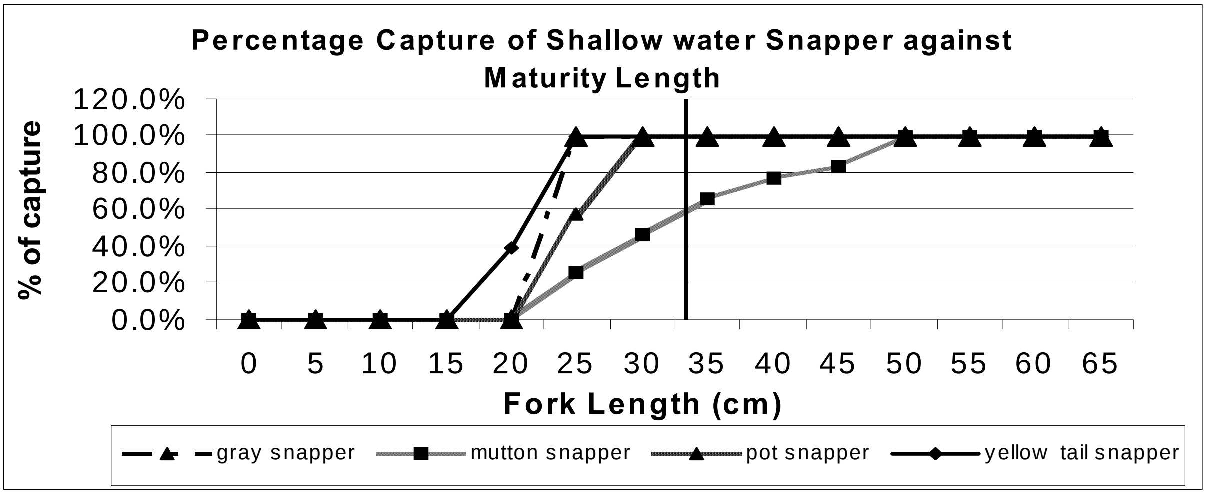
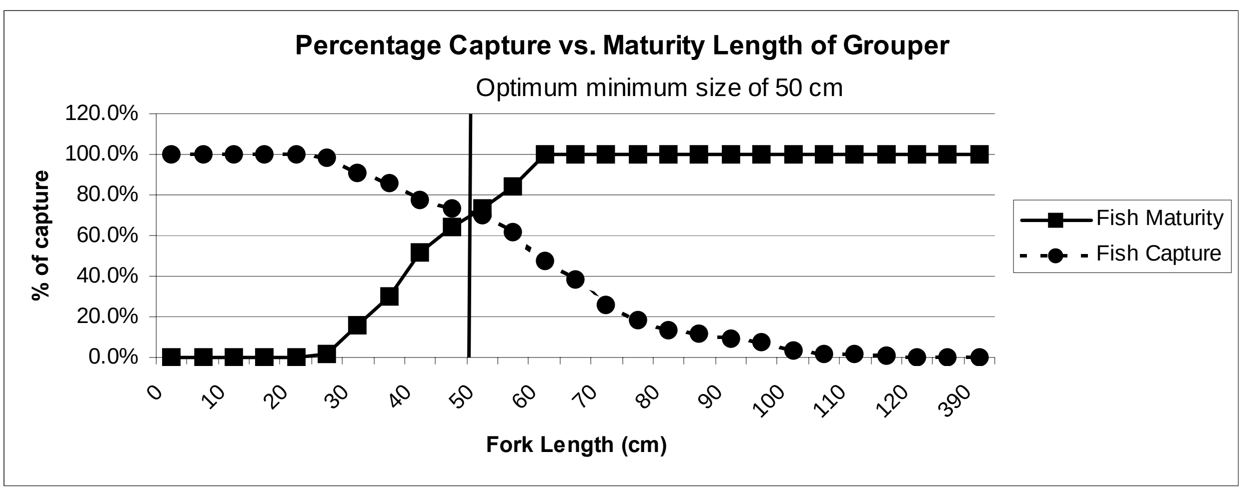


Figure 7. Potential impact on individual species if a minimum size is set independent of maturity level. The vertical lines represent the proposed minimum size for the group.

Finally, Management can easily observe from figure 8, the benefit and cost of setting a minimum size for both grouper and snapper. In this case, the immediate benefit from catch for the different fork length minimum sizes decreases as the minimum size increases (i.e. more of the catch will have to be returned to the sea). Conversely, the benefit to the population in terms of returning the proportion of mature fish to the sea increases with minimum size. If it is assumed that the benefits per fish are equal in terms of retained catch versus released mature fish, where these lines cross represents the maximum benefit (Figure 8). This is a crude approach, but in absence of more information, sets the principles for a clear decision.



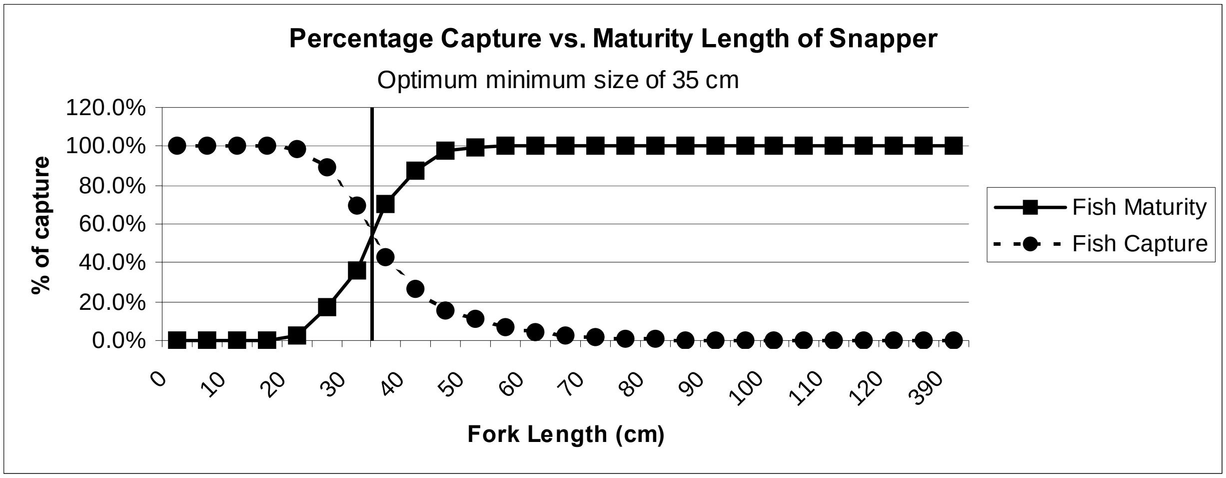


Figure 8. Optimum length for cost and benefit of grouper and snapper respectively.

5.8.4.4 Discussion

According to management objectives of the Turks and Caicos Islands, this meeting allowed for a small but important step to be addressed. Throughout the region, spiny lobster is in decline, and queen conch is managed via international trade. It is not expected for the abundance of those species to sporadically increase. Many fishers in the TCI are and will be looking at other fisheries to sustain his/her living style. The Turks and Caicos Islands are in a favorable state with its fin-fish fishery. However if not properly managed, that fishery can be exploited beyond sustainability. Now is the time at which proper controls can be set through legislation/regulations to promote sustainable development of the fin-fish resources by adopting cautious conservation and management measures. The results that have been obtained in this meeting can aid in determining one of many potential management measures.

Several recommendations have been made to the TCI management for the various fisheries to aid in management of the fin-fish fishery. This document has added validity to the recommendations based on the TCI data. The results obtained in this meeting can now allow management to set minimum size limits for at least two of the main targeted commercial species. Based on this analysis, management can also weigh its cost and benefit to the species and fisher. Setting a minimum length of 50 cm for grouper and 25 cm for snapper will not only allow the majority of the species to reach maturity, but will also allow fishers the opportunity to work in the fishery. Additional data gathered would refine these lengths, proposed if the Turks and Caicos Islands wishes to adopt cautious conservation and management measures in conjunction with the 'Guidelines on the precautionary principle' (Department of Environment and Coastal Resources 2006).

5.9 References

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Appendix 5

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

Chairperson: Suzuette Soomai, Trinidad and Tobago
Rapporteurs: Colletta Derrell, Guyana (Shrimp)
Ranjitsing Soekhradj, Suriname (Shrimp)
Suzuette Soomai, Trinidad and Tobago (Groundfish)
Consultants: John Hoenig (Virginia Marine Institute of Science)
Observer: Nadine Hoenig (USA)

A. OVERVIEW

1. Review of assessments conducted in 2007 and inter-sessional activities

At the 3rd CRFM Scientific Meeting in 2007, assessments were completed for three species of groundfish fished in Guyana: sea trout (*Cynoscion virescens*), bangamary (*Macrodon ancylodon)*, butterfish *(Nebris microps*). With regard to shrimp, one assessment was completed for the seabob (*Xiphopenaeus kroyerii)* fishery in Guyana and one assessment was completed for the penaeid shrimp fishery in Suriname using data for *F. subtilis.*

At the 2007 meeting it was recommended that the seabob fishery in Guyana and Suriname should be studied at the 2008 meeting based on morphometric data which should be collected during the inter-sessional period. One of the major goals was to evaluate whether the population dynamics of seabob in Guyana and Suriname were similar. If this was seen to be true there would be advantages to conducting a joint assessment; otherwise, the assessments for both countries would be conducted separately. A list of the types of data to be collected and a standard format for data files were developed to facilitate easy interpretation of catch, effort and biological data at future meetings. Of special note is that an offshore industrial fishing company, with plants in both Suriname and Guyana, has initiated a privately funded project to collect morphometric data for the seabob and the respective Fisheries Departments have been invited to participate in the analysis of the fishery.

2. Review of Fisheries to be Assessed at the 2008 meeting

At this 2008 workshop, two stock assessments for shrimp and one stock assessment for groundfish were completed. Guyana and Suriname each conducted a separate assessment for the seabob (*Xiphopenaeus kroyerii*) using data from their respective national fleets. Results from the morphometric data collection programmes were compared but the data were still of limited quantity. Trinidad and Tobago conducted an assessment of the whitemouth croaker (*Micropogonias furnieri*) exploited by local fleets. Guyana did not complete proposed assessments for groundfish since the species rapporteur for groundfish was unable to attend this meeting.

3. Recommendations

Specific recommendations with regard to the seabob and croaker are given in the respective assessment reports which were completed at this meeting. The following general recommendations are however considered to be of high priority and will impact greatly on the progress of work within the SGWG.

- The Working Group can progress more efficiently if training and/or assistance in data preparation can be completed in the inter-sessional period. It was recommended that new species rapporteurs within the working group can benefit from short-term, in-house training from more experienced species rapporteurs within the SGWG or other species working groups of the scientific meeting. It is recommended that the CRFM can assist countries with this activity through facilitating attachments and technical co-operation (TCDC) arrangements between countries.
- It is recommended that profiles for the shrimp and groundfish species of main commercial importance, which were initially listed as priority species for assessment, should be completed in the inter-sessional period. These profiles will compile bibliographic information, and extract relevant information on the distribution and biology of the various species being assessed by the SGWG. These profiles would also capture relevant social and economic information for the shrimp and groundfish species in the region. This will serve to better inform consultants and species rapporteurs and ensure that assessments proceed with the best available information.
- It is proposed that attempts can be made to conduct short national and/or bilateral meetings to discuss and review data collection. These activities should be given priority within national work programs and will facilitate the progress of inter-sessional activities. The Methods WG meetings have previously provided the opportunity for countries of the SGWG and consultants to overview progress of work.
- The species being assessed under this Working Group are shared by the countries on the Brazil-Guianas Continental Shelf. Many of these countries are not members of the CRFM (Venezuela, French Guyana, Brazil). However there is an urgent need to include data from the relevant countries in future assessments for shrimp and groundfish species. The Working Group aims to conduct joint analyses for shrimp and groundfish between and among countries on the Brazil-Guianas continental shelf. It is therefore recommended that CRFM enter into arrangements with these other states to facilitate their participation and exchange of data at future Scientific Meetings, as necessary, and during the inter-sessional period. It is also recommended that consideration be given to networking with the FAO/WECAFC ad hoc Working Group on Shrimp and Groundfish Resources of the Brazil-Guianas Continental Shelf. This recommendation was previously recorded at the 2006 and 2007 scientific meetings but is reiterated here since it remains relevant.

4. Proposed assessments for 2009

The participating countries within the SGWG were not able to make final decisions on the species to be assessed at the next Scientific Meeting in 2009. However both Suriname and Guyana are interested in continuing assessments for the seabob given the economic importance of the fishery and the strong involvement of the industry in management and data collection.

Specific activities with regard to shrimp assessments:

Suriname: Seabob

More length data and morphometric data will be collected in the inter-sessional period to be able to get better growth parameters. Suriname has VMS (vessel monitoring system) data which may be a source of effort data (hours fished). Technical assistance may be required in extracting these data.

Guyana: *Xiphopenaeus kroyerii* (seabob)

Attempts will be made to sample by market categories to be able to interpret data received by the processing plants which are recorded according to market categories.

Trinidad and Tobago: Assessment priorities are to be determined during inter-sessional period (*Penaeus spp, X. kroyerii*)

Specific activites for groundfish assessments:
Suriname: Assessment priorities are to be determined during inter-sessional period
Guyana: *Cynoscion acoupa* (acoupa weakfish)
Trinidad and Tobago: Assessment priorities are to be determined during inter-sessional period
A production model for whitemouth croaker is suggested for future analysis of the species. This can however be done during the inter-sessional period based on further refinements to the catch and effort database.

1. Guyana Seabob (*Xiphopenaeus kroyeri*) Fishery

Rapporteur: Colletta Derrell
Consultant: Dr. John Hoenig
Observer: Nadine Hoenig

1.1 Management Objectives

The Draft Fisheries Management Plan of Guyana states that the objectives for seabob management are:

1. To maintain the seabob stock at all times above 50% of its mean unexploited level.
2. To maintain all non-target species, associated and dependent species above 50% of their mean biomass levels in the absence of fishing activities.
3. To stabilise the net incomes of the operators in the fishery at a level above the national minimum desired income.
4. To include as many of the existing participants in the fishery as is possible given the biological, ecological, and economic objectives.

1.2 Status of Stocks

The current data are not sufficient to fully determine the status of the stock. However, there has been a concern that the seabob fishery is fully- to over-exploited. It was noted in a past assessment that the mean size of animals has decreased over the years suggesting increasing fishing mortality. In the 2007 assessment, the monthly mean lengths did not continue the trend of decline but were stable at the low end of the observed range of mean lengths. It was not possible to continue this analysis this year.

1.3 Management Advice

Currently, there is a closed season from September to October which has been decided on by members of the trawler association since 2003. The 2007 analysis suggested that the current closed season occurs at the least effective time for reducing fishing mortality and for protecting recruitment. It was recommended, based on the best available information, that the closed season be placed in May to protect the pulse of recruitment until it reaches the next market category in June. Further work needs to be done on growth rates and patterns of recruitment to verify and refine this advice. A new program of collecting biological data including length frequencies, maturity and catch rate data was initiated in December 2007, and it should be continued. However, these data are not available at present so the best information continues to be that the closure should be in May.

1.4 Statistics and Research Recommendations

1.4.1 Data Quality

1. Collection of length frequency data every month needs to be continued to be able to determine seasonal changes in size, sex and maturity compositions, and to determine growth rates. The landings by market category are too broad to enable determination of growth, recruitment patterns and appropriate placement of the closed season.

2. Data need to be recorded in a standardized form to ensure that it is easily interpreted and of sound quality. There is a need to revise the format of the data sheets used for recording catch and effort data. A standard spreadsheet or database for computerizing catch and effort and length data needs to be developed.

3. The landings and effort data from the processing plant need to be computerized for inclusion into future analyses. The effort data are not well documented and/or sparse, which makes evaluating impacts of the closed seasons difficult.

4. Morphometric data being collected by the processing plants are critical for the 2009 assessment.

1.4.2 Research

1. The observer program should be reinstated in order to monitor catch onboard vessels to get catch rate information, length-frequency data, and geographic information.

2. Economic data such as price per pound for the various market categories should be documented over the course of a year.

3. Analyses of length frequencies to determine growth; catch rates to determine abundance, and landings data need to be refined once the additional data specified in section 1.4.1 have been obtained. This will lead to improved understanding of the role of closed seasons in fisheries management.

4. If a major reduction in fishing effort occurs (due to high fuel prices or other factors) there will be an important opportunity to learn how the stock responds to changing fishing effort. To learn from such an opportunity it is essential that the fishery be monitored, including catch rates, fishing locations and size composition data.

1.4.3 Management

Further scientific studies on the seabob fishery need to be conducted to determine the most appropriate period in which to implement a closed season. The results of these studies will be incorporated into national regulations and should be included in the granting of licenses. Plans should be made to document the effects of a major reduction in fishing effort (should one occur) in order to learn about the response of the stock to changing fishing effort.

1.5 Stock Assessment Summary

In the corresponding 2007 assessment report, it was noted that there was a peak in recruitment in May (Figure 1) and this peak could be followed over time as the recruits grew into successively larger market categories. Thus, it was suggested that a closed season be placed in May to protect the recruitment until the shrimp achieved a larger and more valuable size and thus increased the value of the landings.

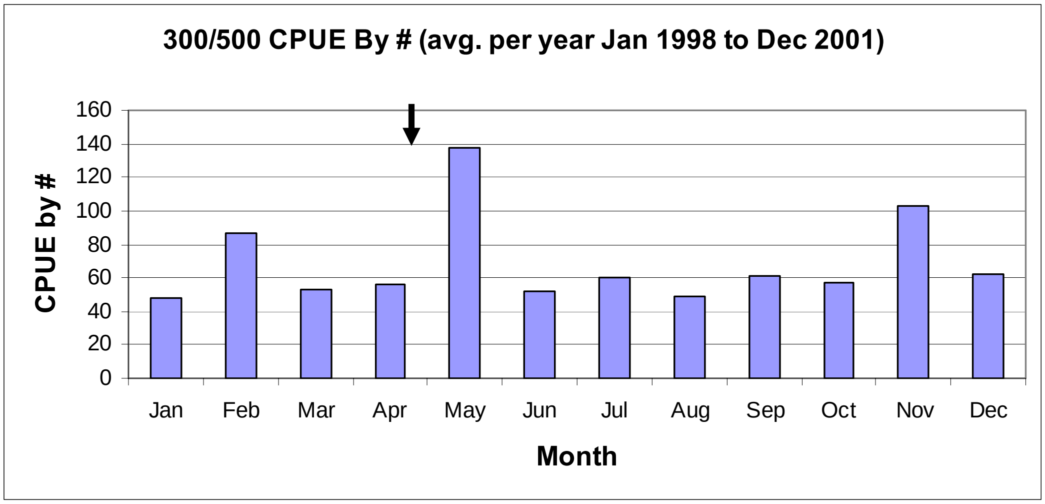


Figure 1. Trends in CPUE by number for commercial size 300-500 tails/lb by month of the year.

The suggestion in last year's report was based on uncertain growth and recruitment information from market category data. It was suggested that detailed biological data should be collected, and such a program began in December 2007. It is too soon to estimate growth rates and recruitment patterns from this program.

Examination of size-maturity relationships is also important because it sheds light on how harvesting shrimp affects spawning biomass, and because seasonal changes in maturity can provide insight into recruitment patterns over time of the year. A maturity curve was generated from the December biological sampling data (Figure 2).

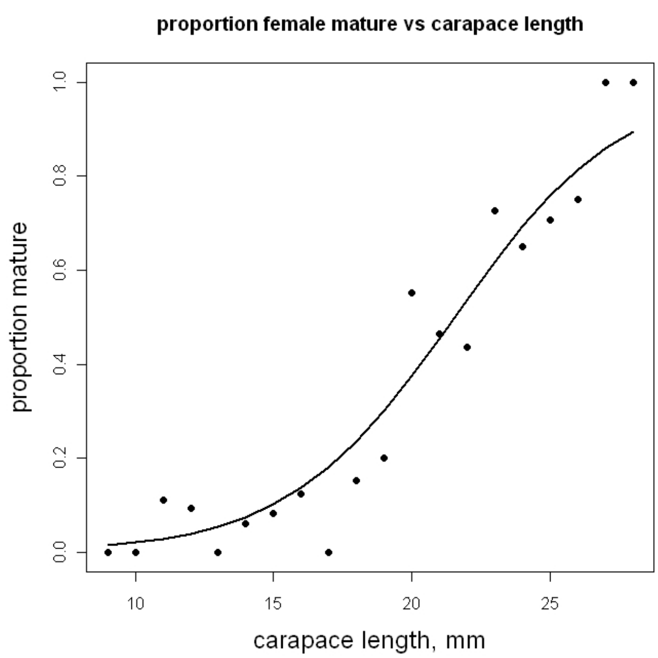


Figure 2. Logistic curve showing proportion mature versus carapace length.

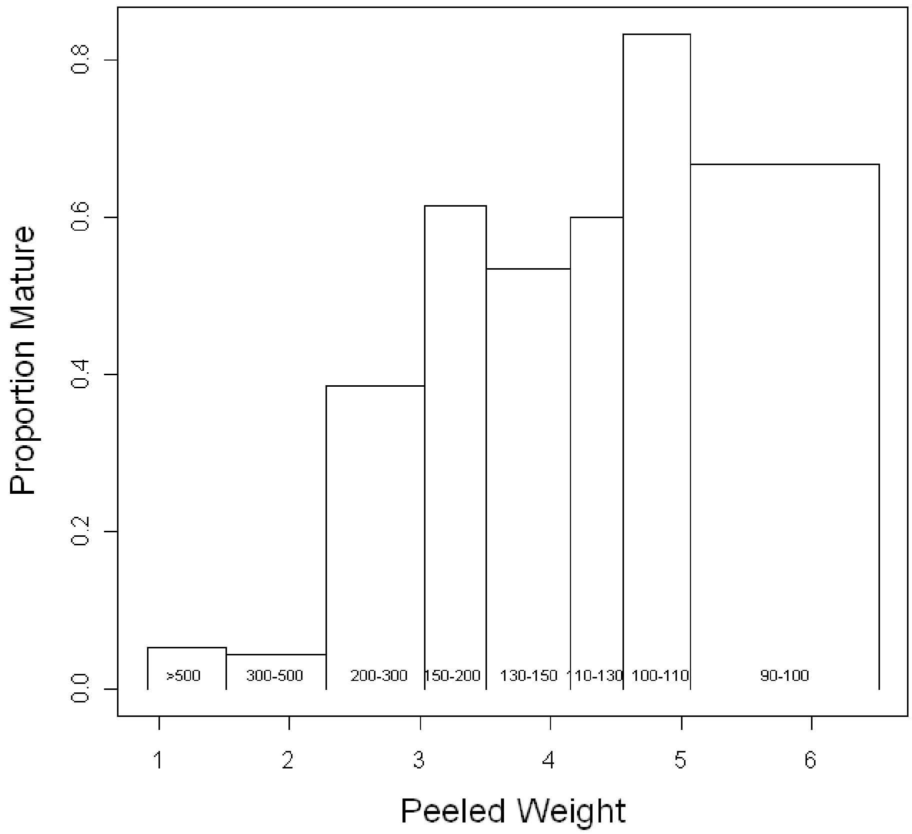


Figure 3. Proportion of female Seabob that are mature by weight (g). The weight bins correspond to market categories (tails per pound), as marked.

Figure 3 shows that the three smallest market categories harvest mostly immature Seabob. A number of analyses were done to develop conversion factors from one measurement to another.

1.6 Special Comments

Data on length frequency and growth parameters need to be collected to ascertain which month is best for the closed season. From the current data, May is the suggested month. This would protect the pulse of smaller recruits for the next month.

1.7 Policy Summary

To manage, regulate and promote the sustainable utilization of Guyana's fishery resources for the benefit and safety of all stakeholders in the sector and the nation as a whole.

1.8 Scientific Assessments

1.8.1 Background or description of the Fishery

The Offshore Industrial Fishery consists of 147 shrimp trawlers, five major processing plants, nine small processing plants, and a few wharves and dry docking facilities. Of the shrimp trawlers, 45 of them mainly exploit penaeid shrimp *(P. brasiliensis, P. notialis, P. schmitti, and P. subtilis)* with finfish and small amounts of squid (*Loligo spp.*) and lobster (*Panulirus spp.*). The other 102 vessels exploit seabob (*Xiphopenaeus kroyeri*) and various fin-fish species (*Macrodon ancylodon, Micropogonias furnieri, Nebris microps, Ariusspp.,Cynoscion spp.*,), with small quantities of penaeid shrimp as by-catch. These trawlers are all locally owned: about 85% of them are owned by the processing plants and the remainder is owned by private individuals.

The penaeid shrimp vessels spend an average of 30 days at sea for a single trip and conduct approximately 10 -12 trips per year. The seabob trawlers spend 5 - 9 days at sea, with an average trip lasting 7 days. A typical seabob vessel makes 2 - 3 trips per month, and an average of 30 trips per annum. (Fisheries Department, 2001).

The management unit is considered to be one or more stocks located over the continental shelf of Guyana. It was thought that these stocks are shared with Suriname. However, the available data showed differences between the two seabob stocks and as a result Guyana and Suriname were treated as separate entities for the purpose of assessment.

1.8.2 Overall Assessment Objectives

The morphometric data were examined to determine relationships between weight and length and between unprocessed seabob and processed product (in terms of weight and tail length). Logistic curves were fitted to data on proportion mature at each length to describe how maturity changes with length. The logistic curve was used to determine the proportion of females that were mature in each market category. The size of the processed shrimp was recorded as peeled weight.

1.8.3 Data Used/ Description

There were 497 observations (morphometric data) taken over a one month period (December 2007). The data were obtained from one of the five processing plants after a request from the Fisheries Department. The measurements were recorded by the employees of the plant in collaboration with a staff member from the Fisheries Department.

For each animal, the following measurements were collected:

i. Date of collection
ii. Total weight of sample
iii. Vessel name
iv. Sex
v. Maturity (presence or absence of green vein)
vi. Carapace length
vii. Tail length
viii. Total length
ix. Total weight
x. Peeled weight

Note: For these data, the shrimps were processed by hand. Therefore, the peeled weight would be slightly different (probably larger) than if it would be obtained after being processed in the machine.

1.8.4 Method/Data Results:

The female data were retrieved and classified according to the presence or absence of green vein as an indication of maturity. A logistic regression was fitted to the data with the following results.

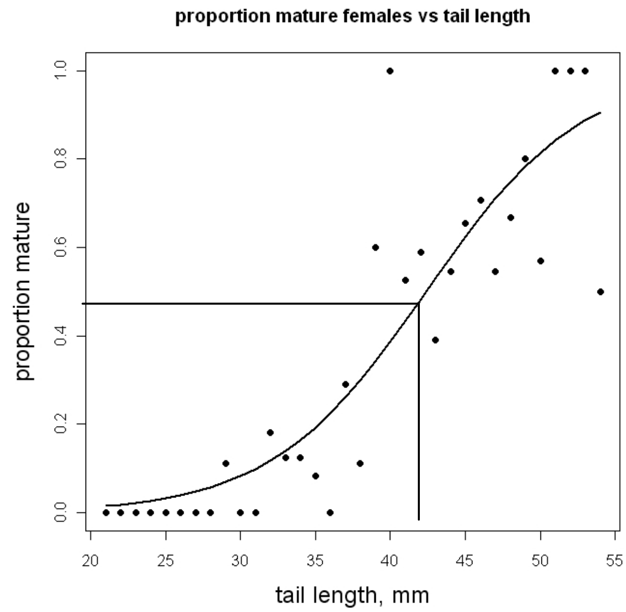


Figure 1. Logistic curve showing proportions mature females versus tail length (mm).

The fit is reasonably good showing that the length at which 50% are mature is about 42 mm tail length).

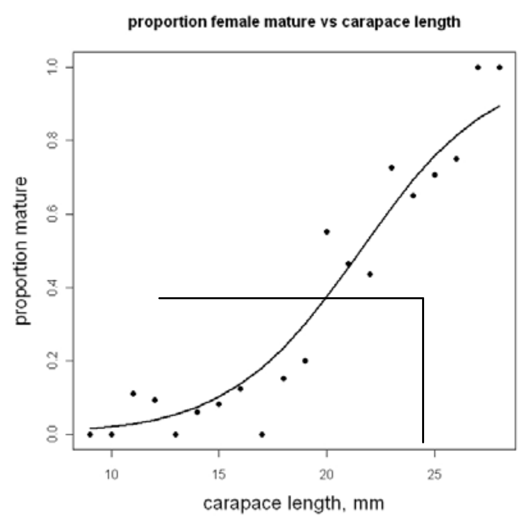


Figure 2. Logistic curve showing proportions mature versus carapace length.

Thirty-eight percent of female animals are mature at 20 mm in tail length.

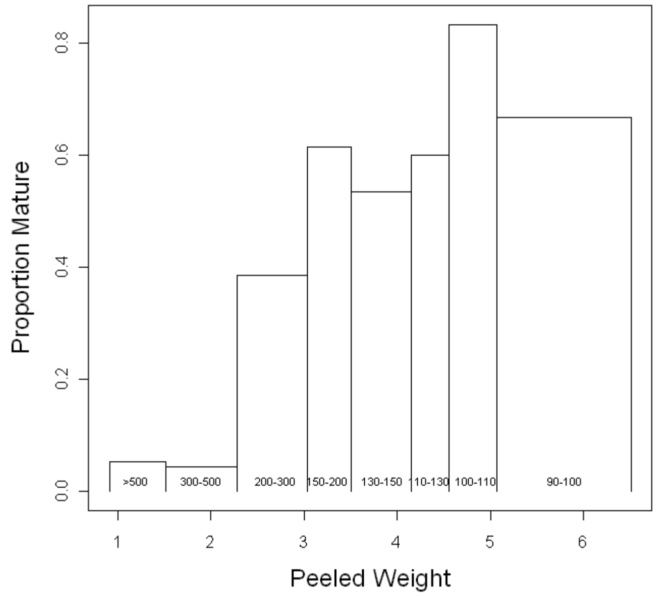


Figure 3 Estimated proportion of female seabob that are mature by peeled weight (g). The percentages were estimated by applying the logistic curve to the midpoint of the market size category. Bars are of unequal widths to reflect the size range of animals in the market category.

Figure 3 shows that the three smallest market categories harvest mostly immature seabob.

<u>Conversions among measurements: regressions involving length and weigh measurements</u>

Regressions were fitted to the morphometric data to determine equations for converting from one body measurement (length or weight) to another. Two kinds of regressions were fitted (Table 1): power functions and linear relationships. Power functions are of the form $Y = a X^b$ while linear relationships are of the form $Y = aX+b$. The fits were generally very good (see Figures 4 – 11) with R^2 values ranging from 0.80 to 0.98.

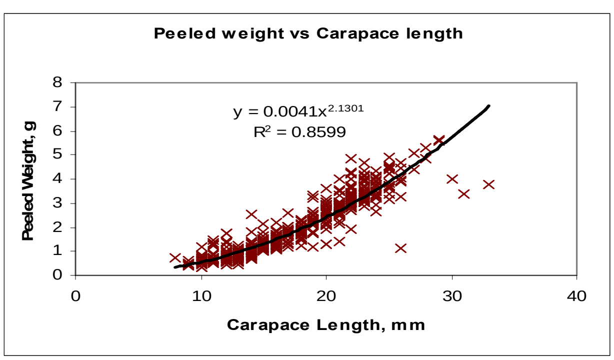


Figure 4

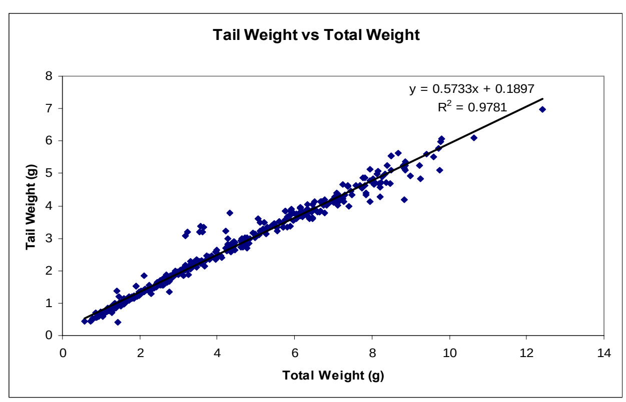


Figure 5

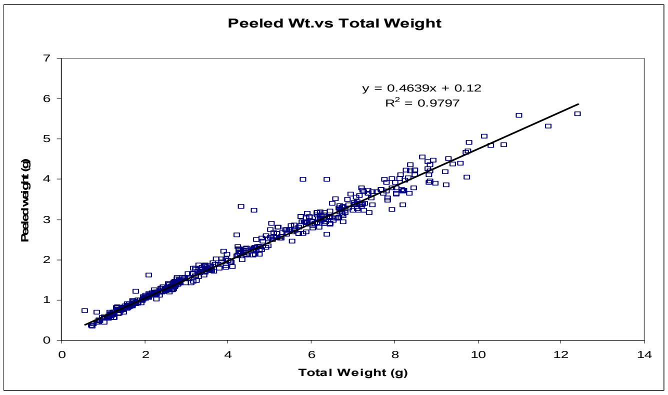


Figure 6

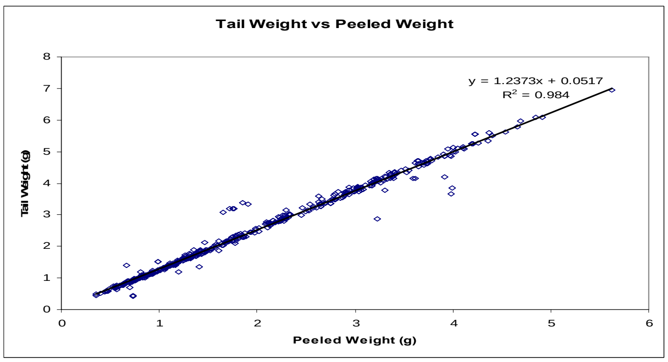


Figure 7

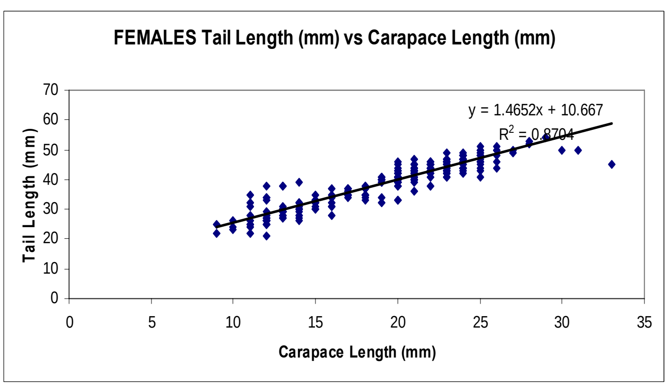


Figure 8

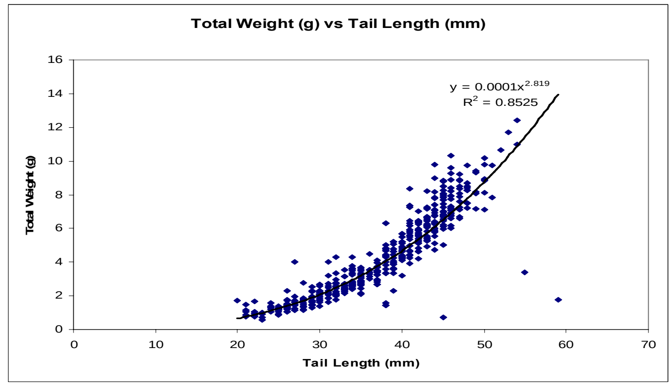


Figure 9

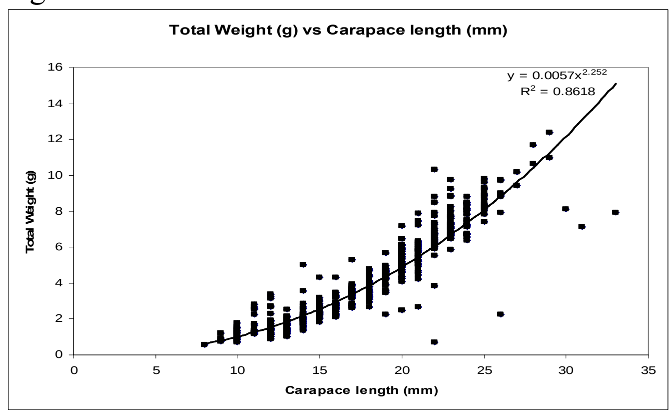


Figure 10

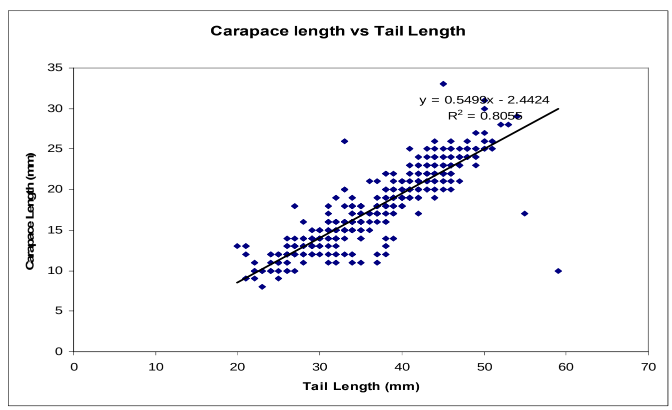


Figure 11

Table 1. Regressions relating various body length and weight measurements. Two kinds of regression models were fitted. Power relationships are of the form Y = a X^b where Y is the predicted value and X is the predictor. Linear relationships are of the form Y = aX + b

Figure	Sex	Predicted Y	Predictor, X	Model	a	b	r^2
Figure not shown	Both	Carapace Length (mm)	Peeled Weight (g)	Power	13.732	0.4037	0.8599
4	Both	Peeled Weight (g)	Carapace Length (mm)	Power	0.0041	2.1301	0.8599
5	Both	Tail Weight (g)	Total Weight (g)	Linear	0.5733	0.1897	0.7981
Figure not shown	Both	Total Weight (g)	Tail Weight (g)	Linear	1.706	-0.2337	0.9781
6	Both	Peeled Weight (g)	Total Weight (g)	Linear	0.4639	0.12	0.9797
Figure not shown	Both	Total Weight (g)	Peeled Weight (g)	Linear	1.706	-0.2337	0.9781
7	Both	Tail Weight (g)	Peeled Weight (g)	Linear	1.2373	0.0517	0.984
Figure not shown	Female	Female Carapace Length (mm)	Tail length (mm)	Linear	0.5941	-3.3251	0.8704
8	Female	Female Tail length (mm)	Carapace Length (mm)	Linear	1.4652	10.667	0.8704
9	Both	Total Weight (g)	Tail Length(mm)	Power	0.0001	2.819	0.8525
10	Both	Total Weight (g)	Carapace Length (mm)	Power	0.0057	2.252	0.8608
11	Both	Carapace Length (mm)	Tail length (mm)	Linear	0.5499	-2.4424	0.8055

1.8.4 Discussion

Detailed morphometric data have been collected by the industry in cooperation with the Guyana Ministry of Agriculture's Fisheries Department since December of 2007. Only one month of data were available for this meeting which severely limited what could be accomplished. However, maturity curves were constructed and regression analyses were done to derive equations for converting one body measurement to another.

The maturity data indicated that the three smallest market categories are comprised largely of immature shrimp while the remaining categories are composed largely of mature shrimp.

1.8.5 Management

At present, the best information is that a closure in May would protect a pulse of recruitment and increase the yield from the fishery; the current closure around September appears to be at the least effective time. More data are needed to confirm and refine these conclusions. Reinstatement of an observer programme and obtaining access to industry-collected morphometric data are needed to make further progress in the assessment of this resource. Thus, communication between the Fisheries Department and industry, including the staff at the processing plants, is highly advised.

1.9 References

Fisheries Department (2001). Guyana Report. In *Fisheries Management Data System Terminal Workshop "The Way Forward... A Review and Planning Session*, 25-28 November, 2000, Castries, St. Lucia. Fisheries Department, Guyana.

2. The seabob (*Xiphopenaeus kroyeri*) fishery of Suriname

Rapporteur: Ranjitsing Soekhradj
Consultant: John Hoenig
Observer: Nadine Hoenig

2.1 Management Objectives

- This fishery sustains a large number of families, and is also one of the few profitable occupations in some rural areas. Preservation of this source of income, and of the living standards of the population involved, are important objectives.
- The way fishermen themselves are managing their activities, adjusting effort in accordance with expected (net) benefits, can be seen as a way of optimising economic yield.
- Fresh and dried shrimp are traditional commodities for the local market, and also an indispensable contributor to the domestic protein supply.
- Frozen seabob flesh, produced by the seabob factory, is exported and dried shrimp might have export potential (not demonstrated yet). Generation of foreign currency must therefore be taken into account in management.

2.2 Status of the Stock

In a previous assessment of this stock (Babb-Echteld and Medley 2004), it was concluded that the status of the seabob stock was uncertain, but that the yield per recruit could be increased by reducing fishing effort. The current assessment indicates that effort has increased by approximately 2/3 (from 3000 to 5000 days at sea) over the period 1998 to 2006 (Figure 1). Landings have also increased so that catch rate has remained almost constant (Figures 2 and 3). There does not appear to be any cause for alarm; however, the suggestion that yield per recruit could be increased by decreasing effort remains a consideration.

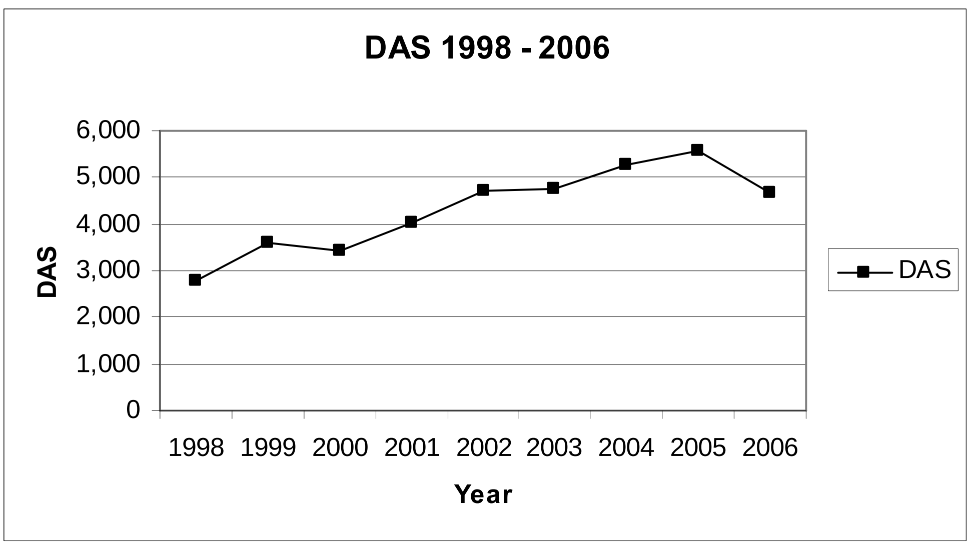


Figure 1. Fishing effort in days at sea (DAS) versus year.

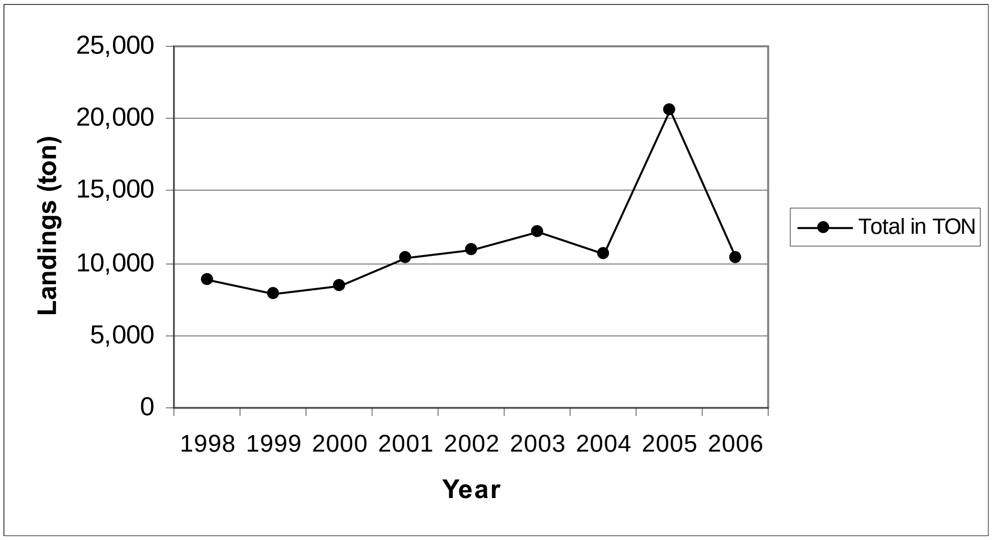


Figure 2. Landings (metric tons) versus year.

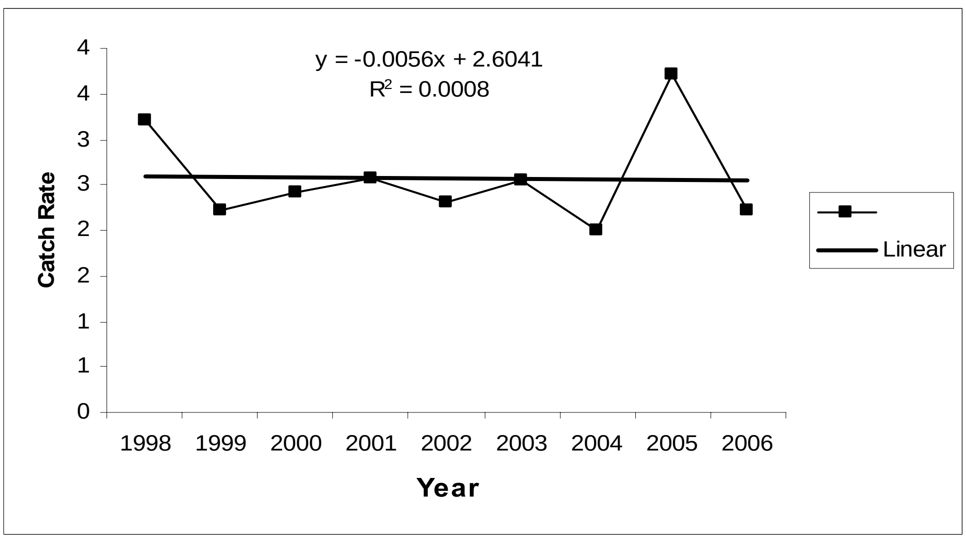


Figure 3. Catch rate (catch/effort) versus year, with linear regression line.

2.3 Management advice

Examination of landings data by market category by month failed to show peaks of recruitment and growth of cohorts over time. Similarly, examination of length-frequency sampling data over a six month period did not shed light on growth and recruitment. It may be that seabob spawn and recruit throughout the year, in which case a closed season may not be an effective tool for increasing yield. However, continued examination of biological data (lengths, sexes, maturity) and fishery data (catch rates, effort) over a period of at least one full year are advisable. This is because information on growth, reproduction and recruitment are needed to assess the stock and evaluate management options.

To address the loss of yield indicated by the yield per recruit analysis, it is necessary to reduce fishing effort or to harvest shrimp at larger sizes. A seasonal closure will reduce effort. This is especially effective if there are clear pulses of recruitment that can be protected. However, a time of year has not been identified for which a closed season will protect small, rapidly growing shrimp. No particular time of year can be recommended as the best time for a closure, based on the limited data collected to date. An option for increasing yield per recruit is to require a larger mesh size.

Data collection under the newly implemented sampling programme conducted by the industry in the processing plants should be continued. However, these data have not been made available for stock assessment through the CRFM and this limits what can be achieved. It is advisable to analyze the vessel monitoring system (VMS) data to quantify fishing effort and determine geographical patterns in effort.

Progress in determining the relationships between fishing effort, yield and recruitment would be greatly enhanced if observations could be made at fishing levels that differ from what has already been observed. For example, if fuel prices or other factors were to cause a reduction in fishing effort there would be an excellent opportunity to observe the response of the stock. However, the ability to gain insights into the stock dynamics is contingent on data being collected to document the nature of the catch before, during and after changes in fishing effort.

2.4 Statistics and Research Recommendations

2.4.1 Data Quality

Catch and effort data were available from 1998 to 2006. But the catch data for the different market categories were available from 2003 to 2006.

Length frequency and maturity data were available from June 2006 to December 2006. Thus, observations are not available for the first half of the year, and observations have not been made over years to provide information on year-to-year variability.

Detailed biological data (lengths, weights, maturity) collected by the industry in 2007 and 2008 have not been made available and consequently could not be examined for this report.

2.4.2 Research

More detailed information and data should be obtained on the life history of this species. Thus, length measurements of the different size categories, observations on unsorted catches, information on factors affecting productivity and price data should be obtained.

Growth parameters need to be estimated to improve assessment of the seabob stock. Growth parameters can be derived from length frequencies. Length data is the basis for construction of many population assessment models and for evaluating the effect of closed seasons.

2.5 Stock Assessment Summary

Landings, effort (days at sea) and catch rate (i.e., landings divided by days at sea) were examined for temporal trends. Both effort and landings have been increasing over the time series. Thus, the catch rate has remained quite constant over time.

Graphs of catch in number per unit of effort versus year were prepared for each market category. The goal was to examine patterns of recruitment over the year and to track growth of cohorts to create a growth curve. However, the patterns seen in this kind of analysis for Guyana seabob (Derrell *et al*., 2007) were not seen in the Suriname data. Length frequency data from monthly samples taken from June to December of 2006 were also examined and, again, they did not show the patterns seen in the Guyana data. It may be that recruitment in Suriname occurs throughout the year rather than seasonally. Further collection of data is essential because recruitment patterns are important for establishing closed seasons, and improved estimates of growth are needed for yield per recruit analysis (Babb-Echteld and Medley, 2004).

Maturity at length data were examined to try to establish maturity curves. Logistic curves were fitted to the data for each month but the fits were not good, with maturity rising only slowly with size and with many large animals being immature. The significance of the maturing and mature (green vein) conditions is not clear and needs investigation. It may be that signs of maturity are actually signs of imminent spawning and that between spawning events a mature female may appear immature.

2.6 Special Comments

To benefit from a joint assessment of the seabob fishery, Suriname and Guyana must have similar programs for collecting biological data. Thus, sampling programs should be coordinated by the two fisheries departments or through the CRFM or FAO.

2.7 Policy Summary

The role of the fisheries sector could be expressed as follows:

- Provides jobs (primary and secondary level). Creates more qualitative job opportunities and reasonable incomes. Diversity of the sector is also important
- Creates a balance of payment through export of fish and shrimp products
- Contributes to the GDP of the country
- Contributes to the national budget through fees and income tax.

The main policy is to manage the fish and shrimp resources in a sustainable manner to generate revenues on a long term basis.

2.8 Scientific Assessments

2.8.1 Background or description of the Fishery

Vessels that are licensed to fish for seabob are 18-36m in length. Seabob is exploited in the EEZ at depths of 11-24 m.

The seabob trawl fishery started in 1996 with one company, which owned 10 boats. In 1997, this company increased the number of vessels to 15, and a second company joined the fishery, with 3 vessels. At present, the seabob fleet is made up of 24 vessels owned by two companies, namely Guyana Seafoods N.V (GSF) and Namoona with 15 vessels and 9 vessels respectively. The catch is processed by two processing plants.

There is also an artisanal fishery for seabob with about 500 vessels; this fishery uses Chinese seines.

2.8.2 Overall Assessment Objectives

Using the current landings and effort data, we examined trends in effort, catch and catch rate as indicators of stability or change in the fishery. We also examined patterns in recruitment, attempted to estimate the growth parameters or create growth curves, and tried to evaluate options for improving yields through the use of a closed season.

2.8.3 Data Used

Name	Description
Catch and effort data	Catch and effort data from 1998 to 2006 were taken from the reports submitted by two companies (Namoona and Guyana Sea Foods) involved in this fishery. The data are submitted in electronic format, which makes correcting data before analysis much easier. The data consist of catches for each vessel per fishing trip, broken down by the commercial size categories as being used in the processing plant. Effort can be expressed in days at sea, or numbers of fishing trips in a month or year.
Length frequencies	These data were collected by observers placed on board seabob vessels. Samples of seabob taken were analysed in the laboratory. Each sample was first sorted by species, sex and maturity. Then, carapace length of each seabob was measured. The data were recorded in EXCEL and used to produce length-frequency graphs. Data were available from June 2006 to December 2006.
Maturity	Female maturity was recorded as A = immature, B = maturing (beginning signs of green vein), and C = mature (green vein)

2.8.4 Assessment

2.8.4.1. Objectives

1) To examine annual catch and effort data over time to determine if there are trends.
2) To analyze the CPUE of the market categories by month in order to determine when recruitment occurs during the year and to infer growth rates if possible. Additionally, the length frequency information from monthly samples taken from June to December in 2006 are analyzed for the same purposes.
3) To examine maturity versus length to determine maturity curves and to see if there are seasonal patterns in maturity-length relationships.

2.8.4.2. Method/Data

Landings, effort in days at sea (DAS), and catch rate (landings divided by effort) were summed over a year and plotted versus the year. A linear regression line was computed for the plot of catch rate versus year.

The landings in each market category per unit effort (i.e., landings/days at sea) were plotted as a bar graph versus the month of the year for each year. This was done separately for Namoona and Guyana Sea Foods data.

Length-frequency data were aggregated for all trips within a month and plotted as histograms. This was done separately for each sex. Data from the two companies were analyzed separately.

The proportion mature was compiled by 1 mm size groups for each month, and logistic curves were fitted to the data by the method of maximum likelihood using the glm function in R.

2.8.4.3 Results

Trends in catch, effort and catch rate are shown in figures 1, 2 and 3, respectively. Effort rose by about two thirds over the time series. Landings also rose so that the catch rate did not show a trend. A linear regression line fitted to the catch rate data had a slope of -.0056 with an R^2 value of 0.0008 indicating that year does not explain the variability in catch rate (i.e., there is no statistically significant trend).

Landings by Guyana Sea Foods boats per unit effort for market categories are shown in Figure 4 for each month. The same kinds of plots are shown for Namoona boats in Figure 5. Data are presented separately for each year and also as an average over all years.

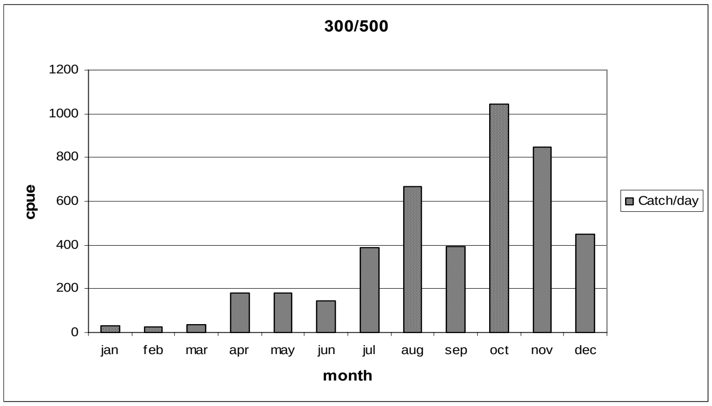
Length frequency data from monthly samples by onboard observers are shown in Figure 6 for females (left) and males (right).

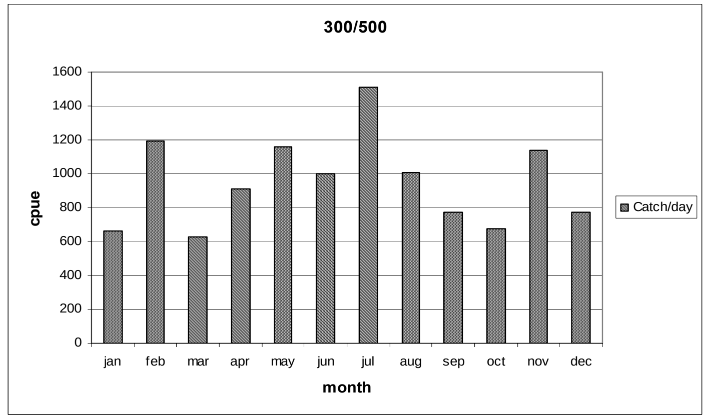
Maturity curves obtained from monthly samples by onboard observers are shown in Figure 7.

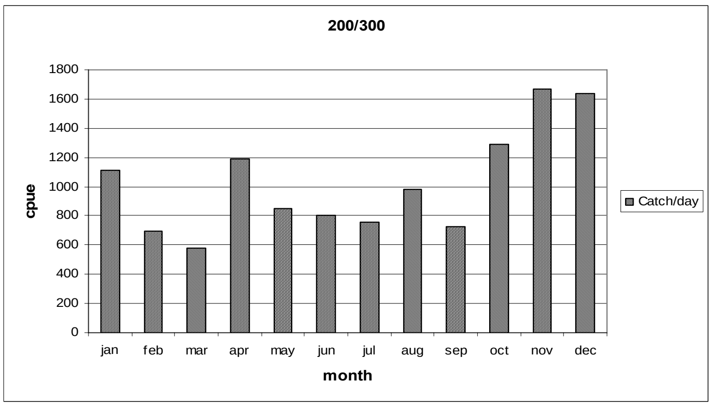
2003

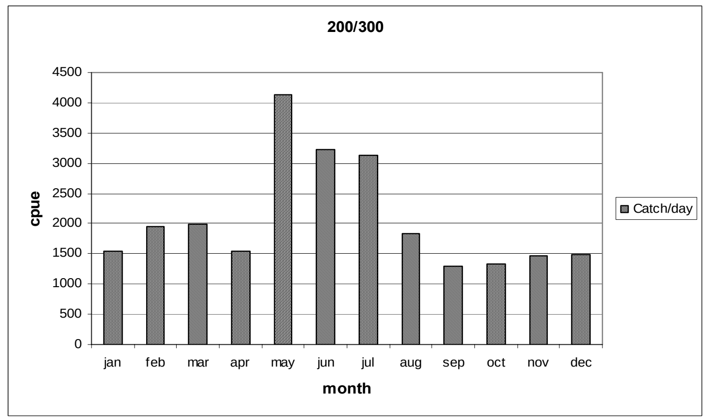
GSF

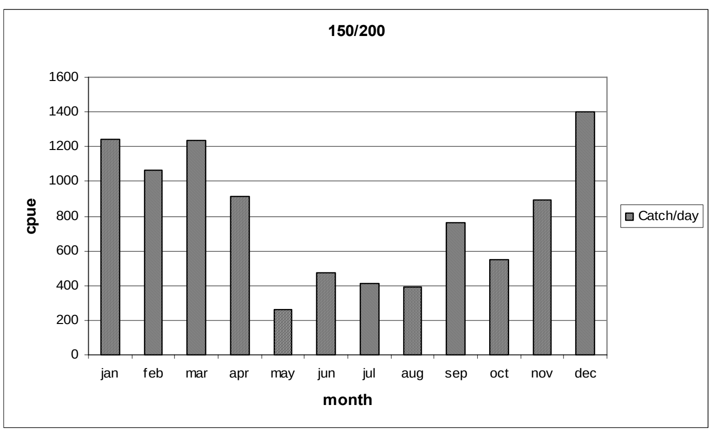
2004

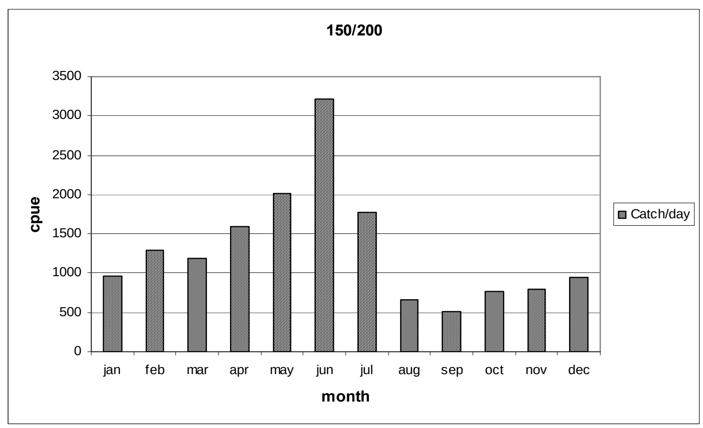


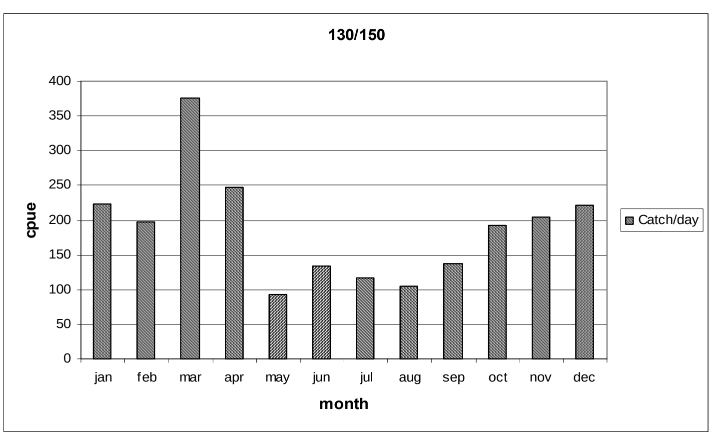


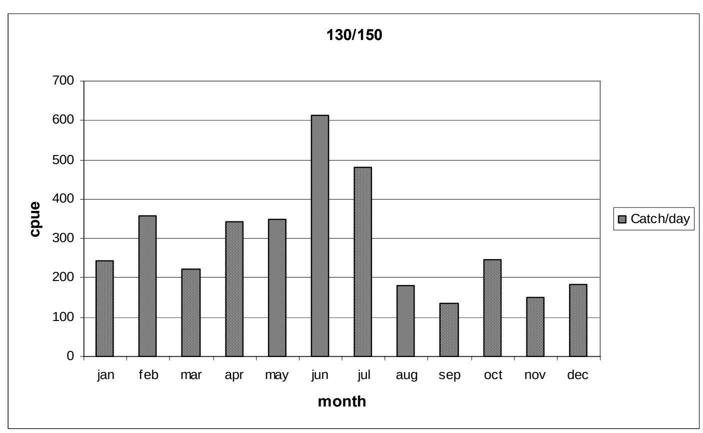






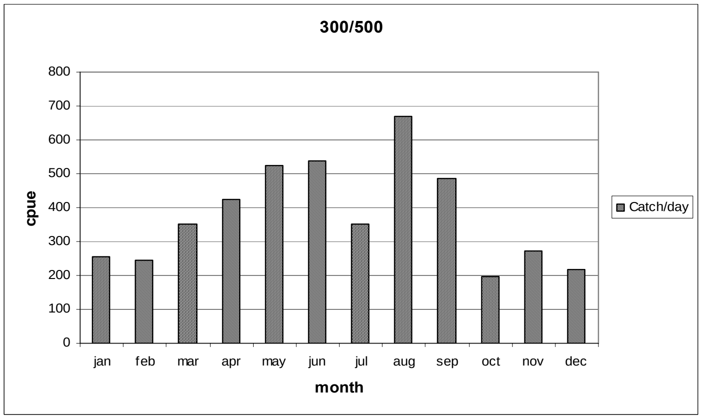


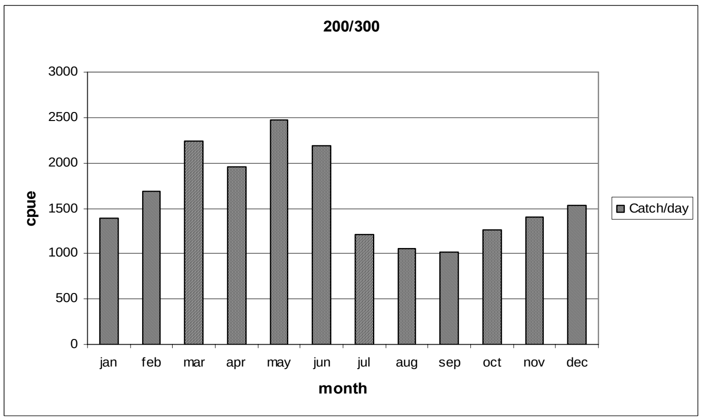


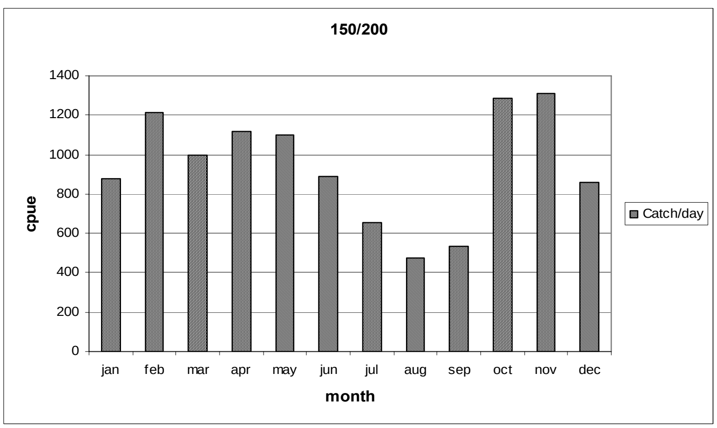


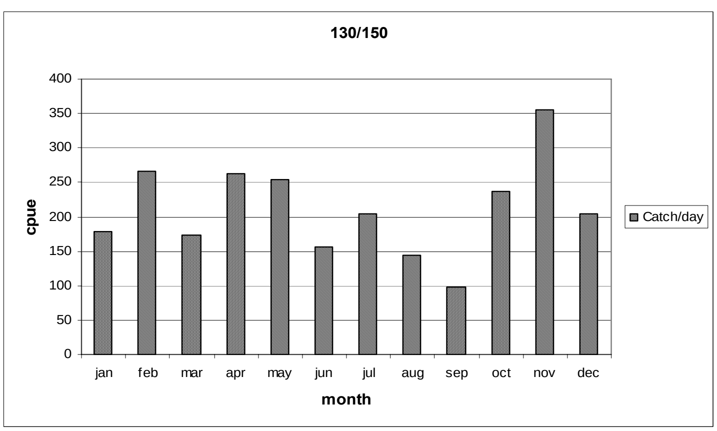
GSF

2005

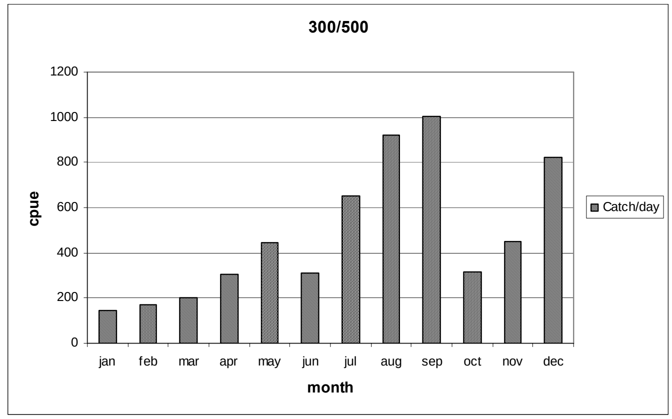


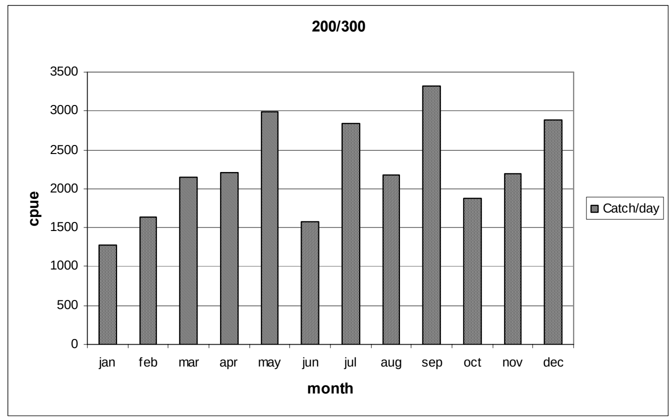


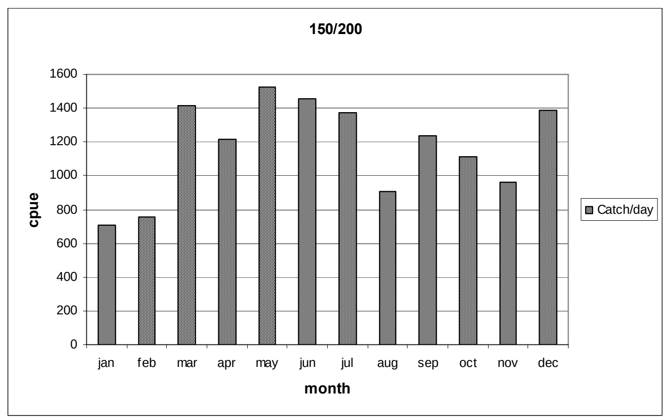


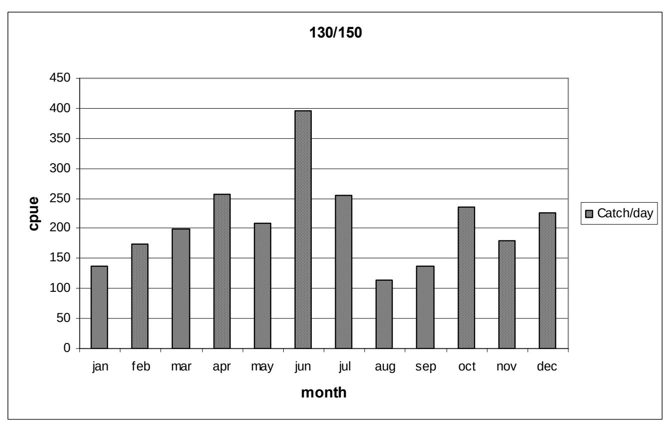


2006









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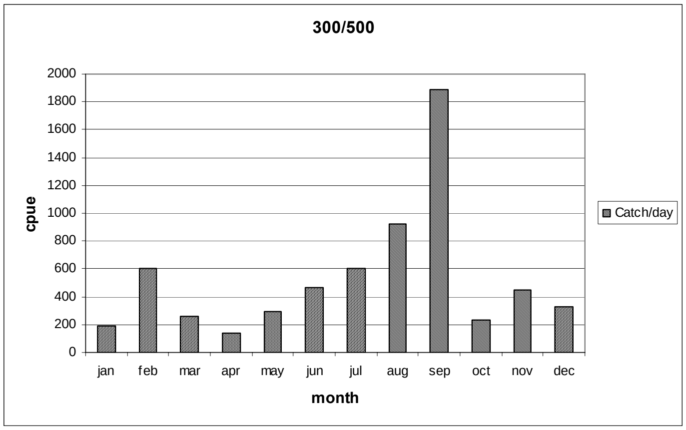
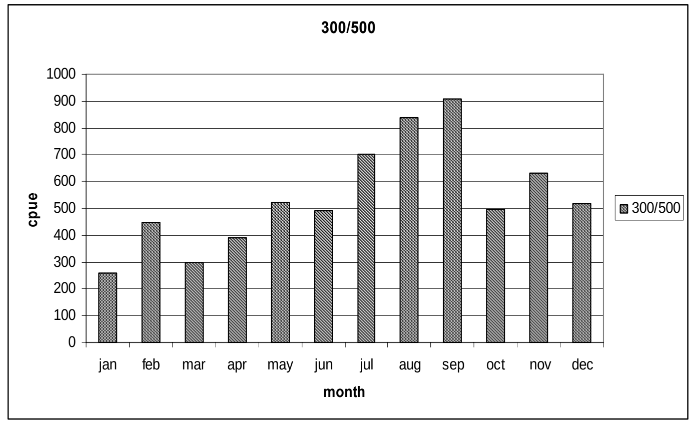
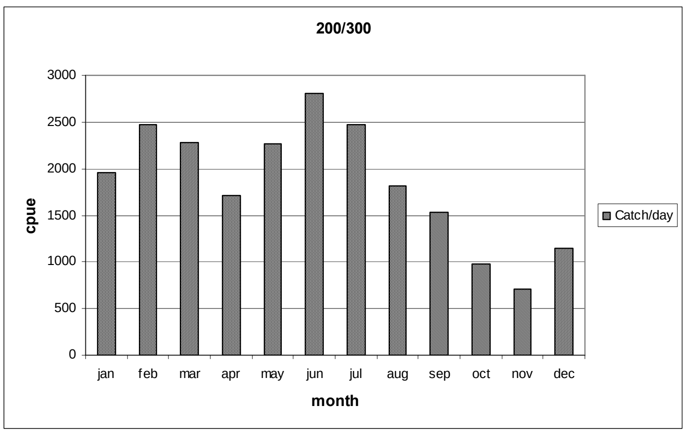
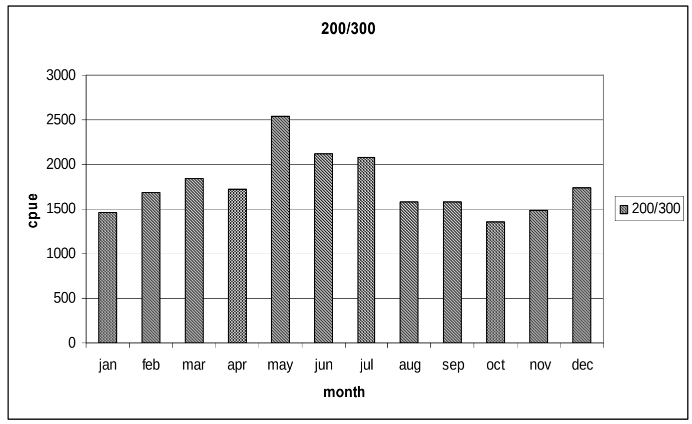
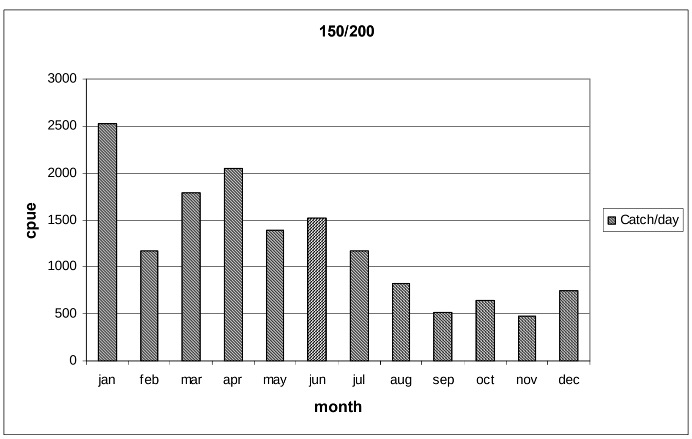
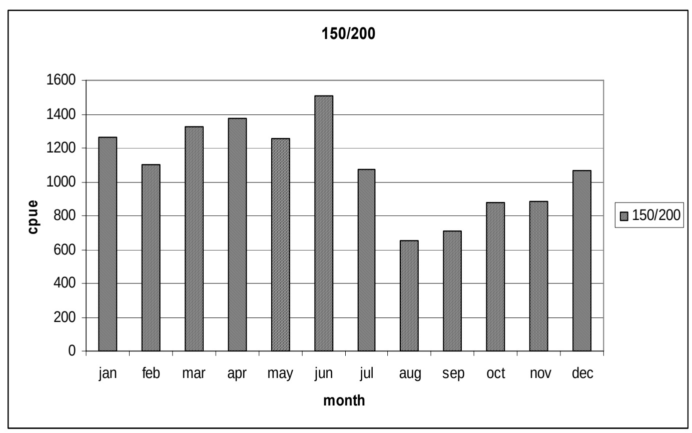


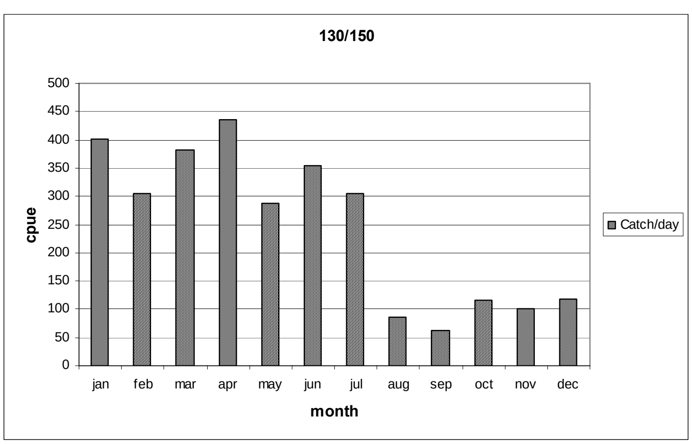


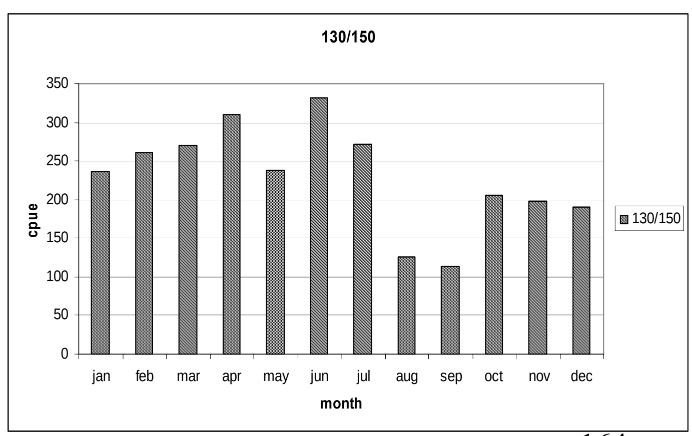












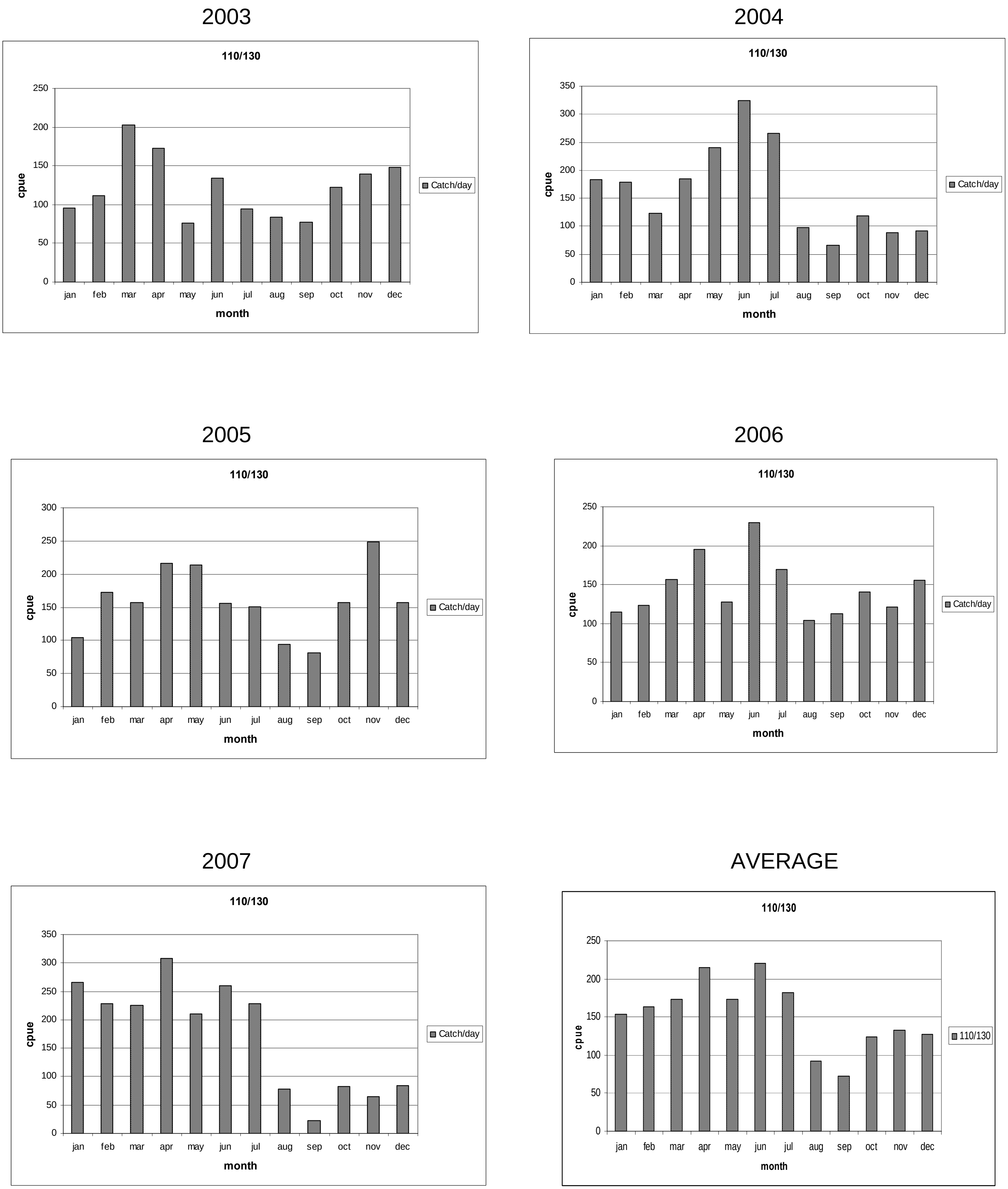
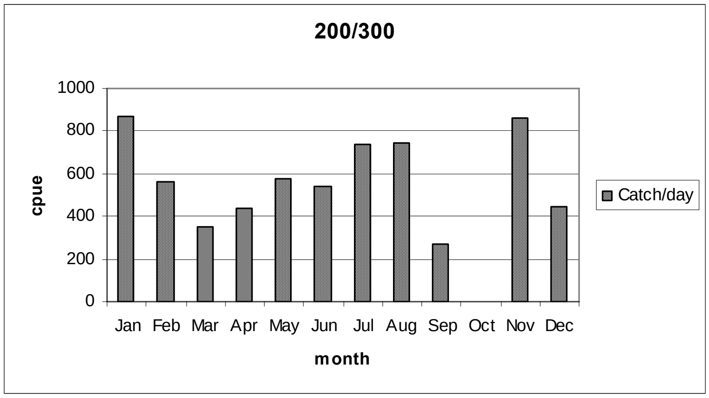


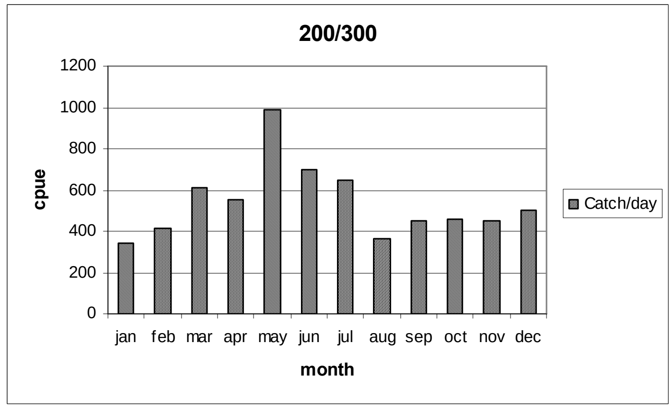
Figure 4. Landings by Guyana Sea Foods boats per unit effort for each market size category over the course of each year for which data were available.

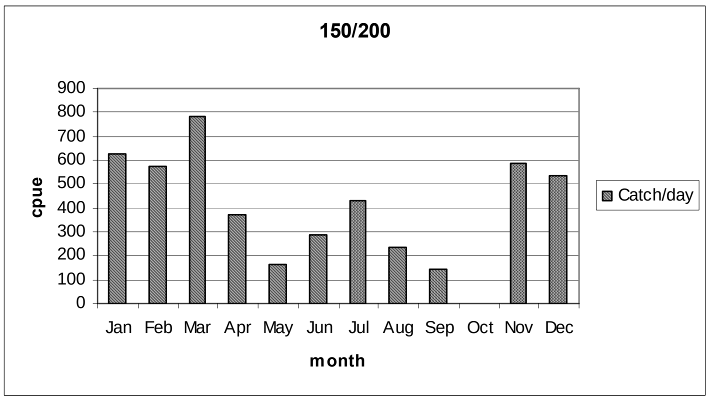
NAMOONA

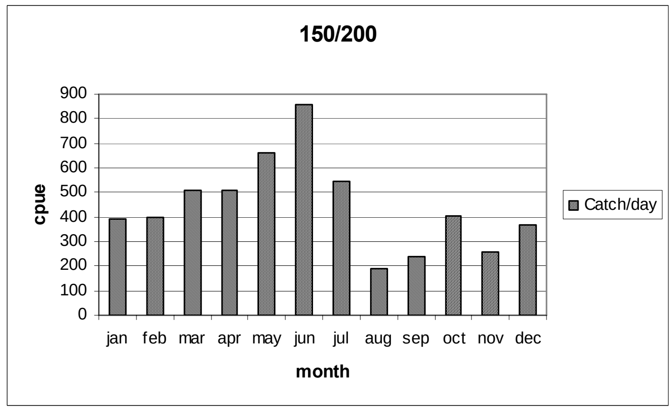
2003

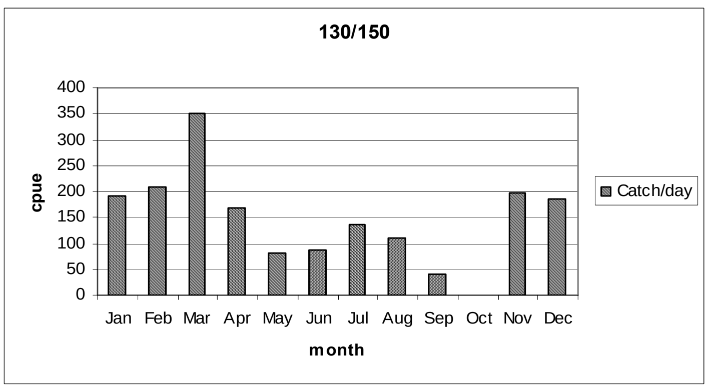
2004

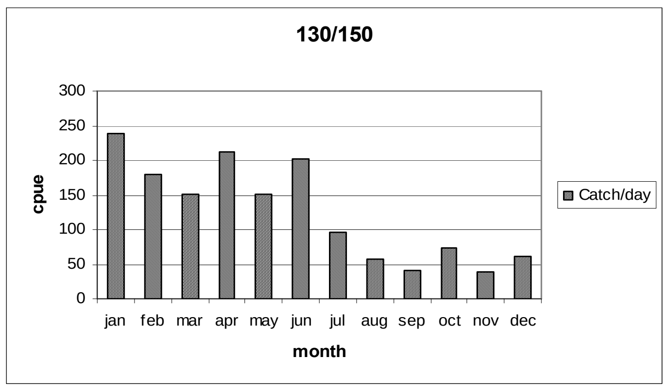


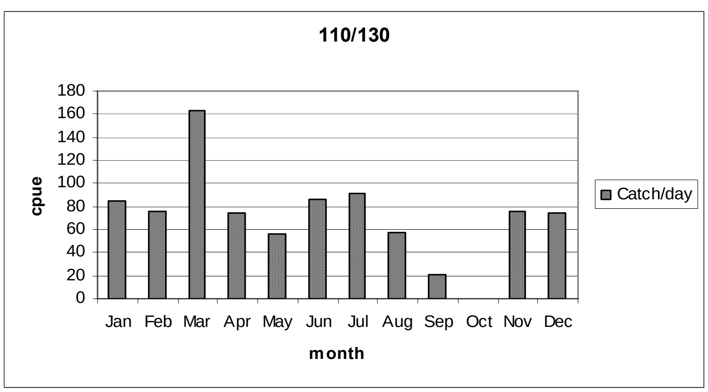


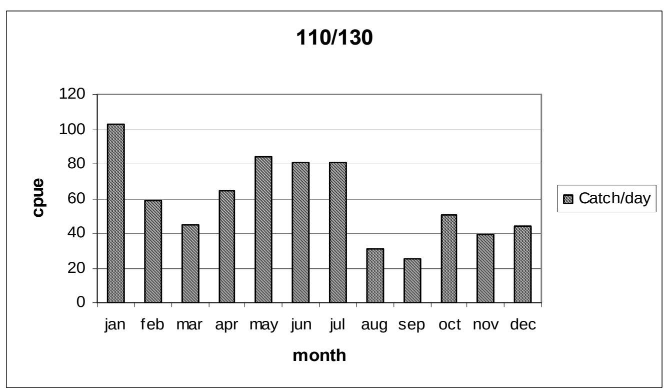








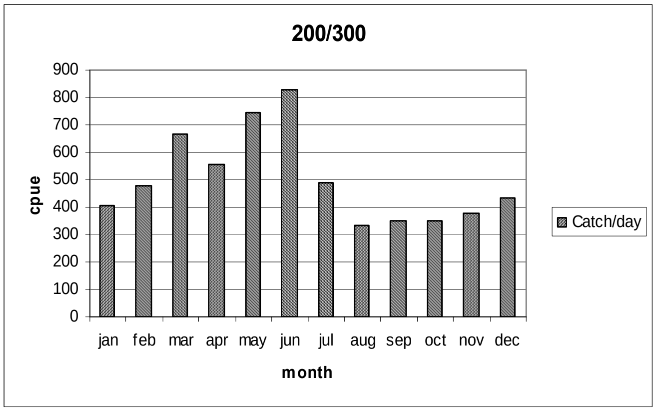


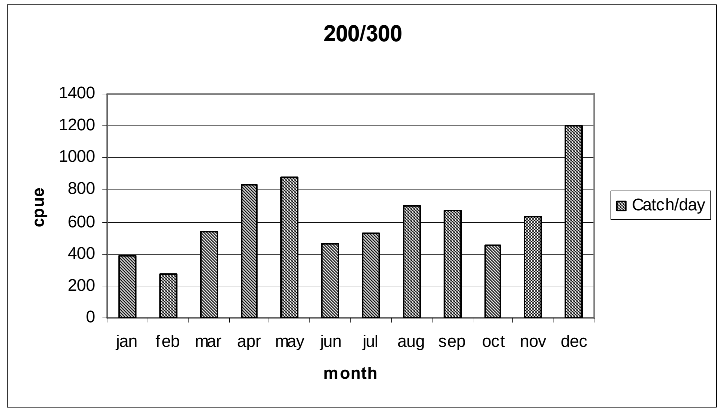


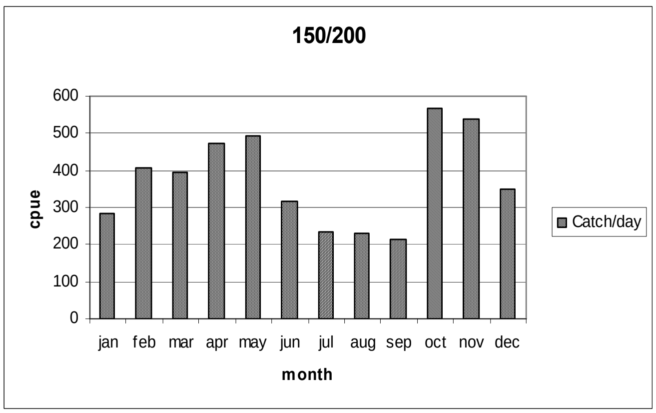
NAMOONA

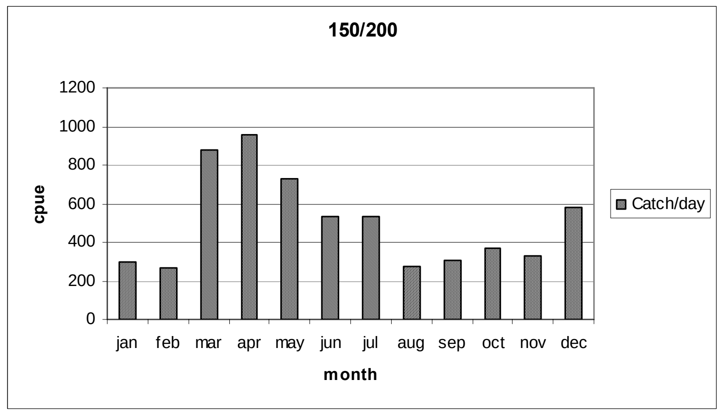
2005

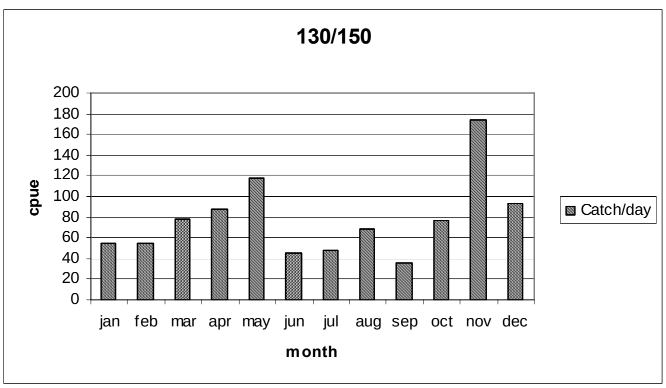
2006

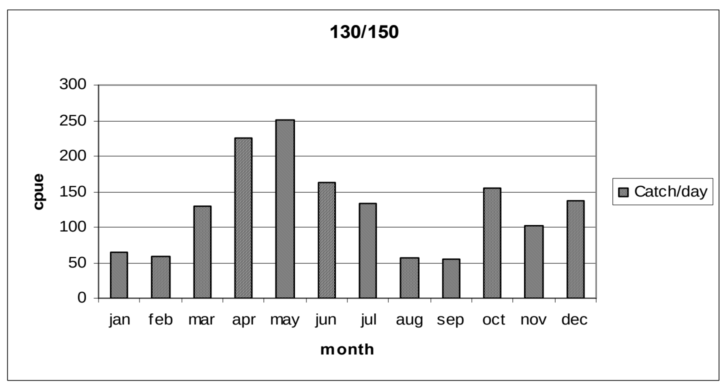


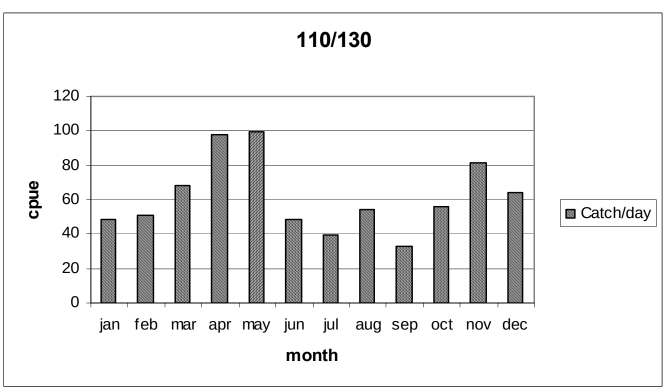


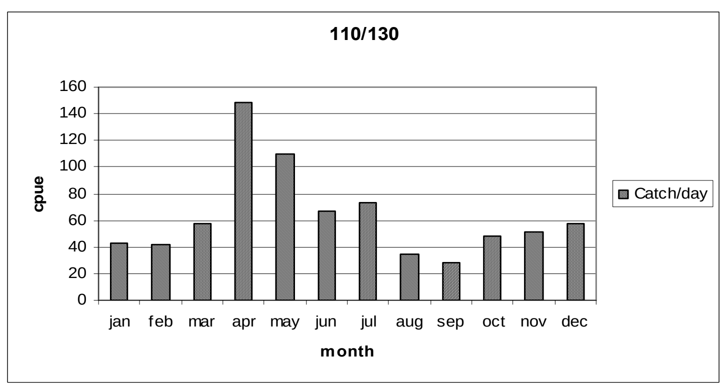












2007 **NAMOONA** AVERAGE

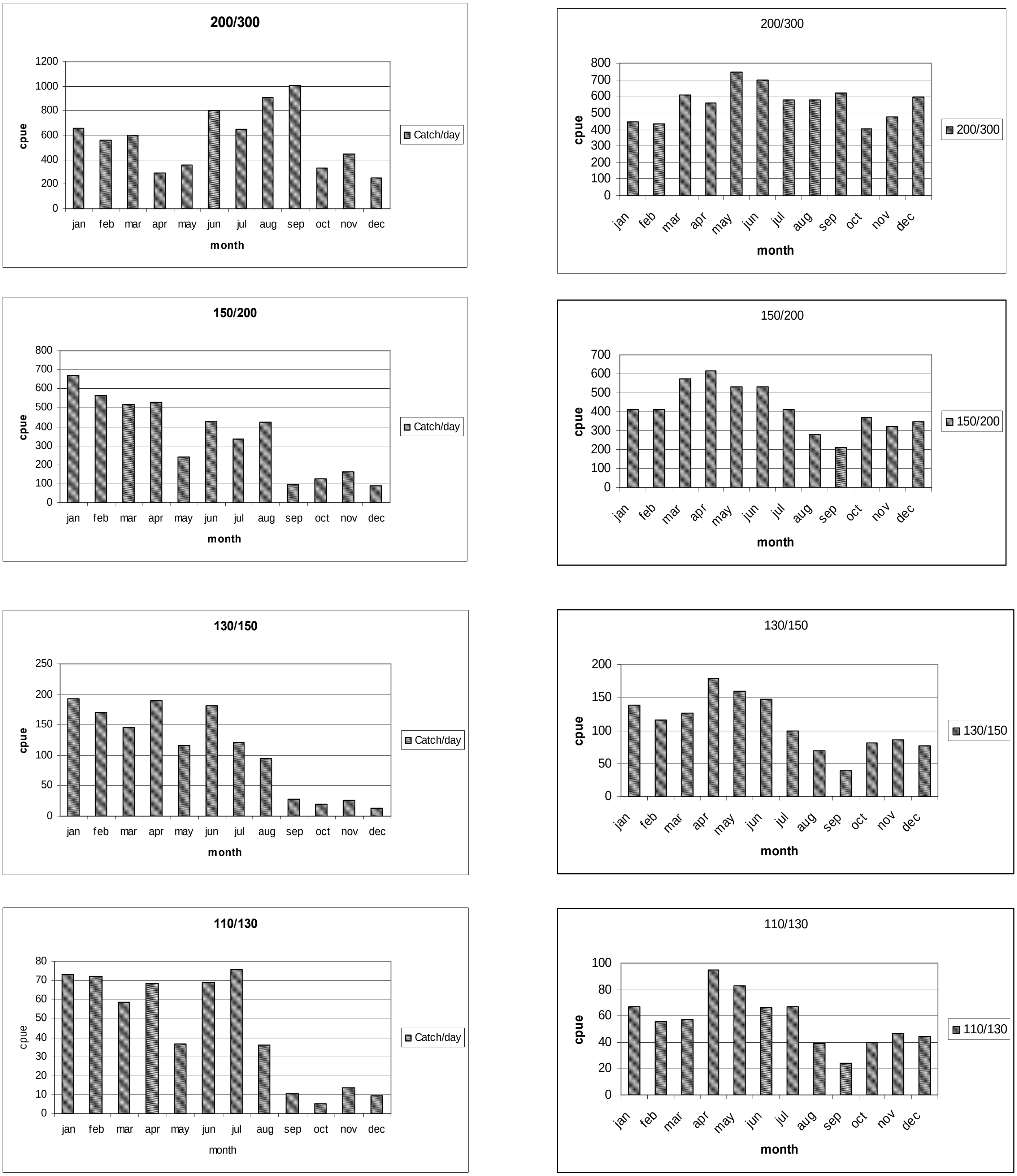
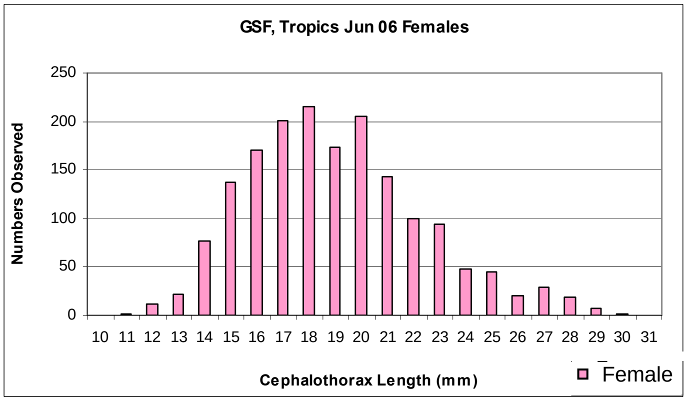
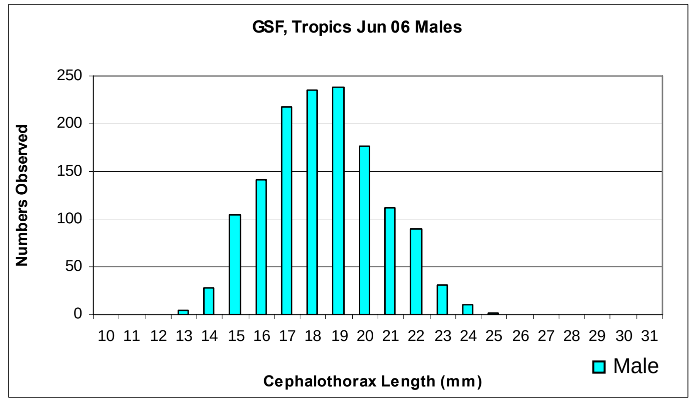


Figure 5. Landings by Namoona boats per unit effort for each market category over the course of each year for which data are available.

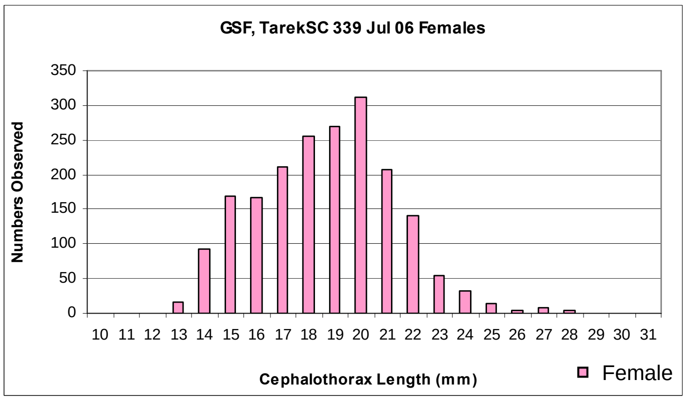
GSF



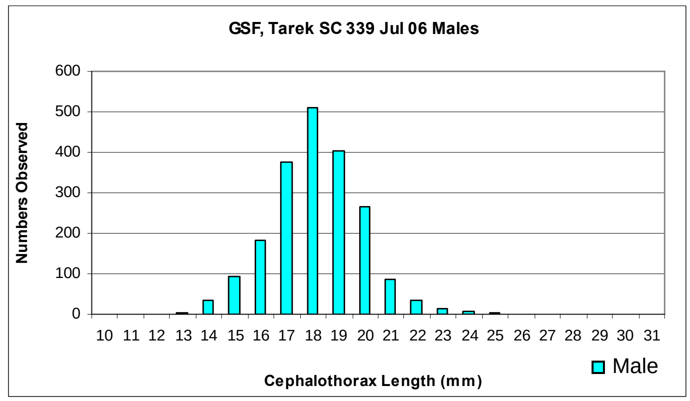
GSF, Tropics Jun 06 Females
Numbers Observed
Cephalothorax Length (mm)
Female



GSF, Tropics Jun 06 Males
Numbers Observed
Cephalothorax Length (mm)
Male



GSF, TarekSC 339 Jul 06 Females
Numbers Observed
Cephalothorax Length (mm)
Female



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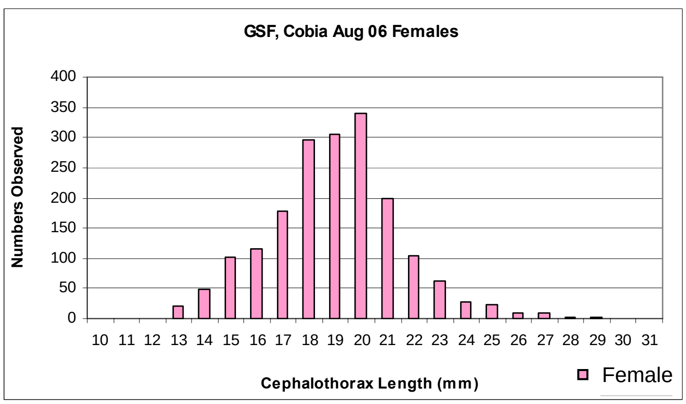
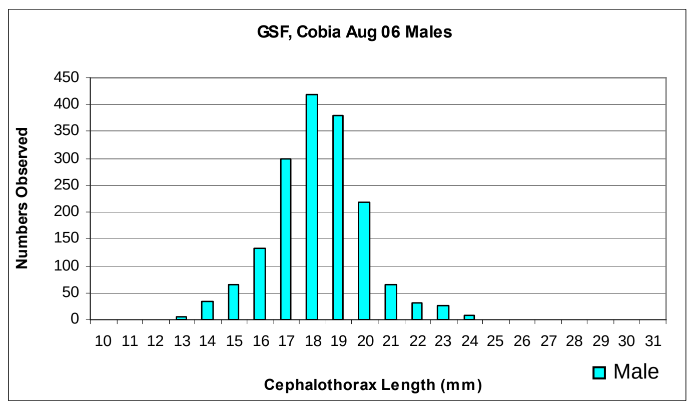
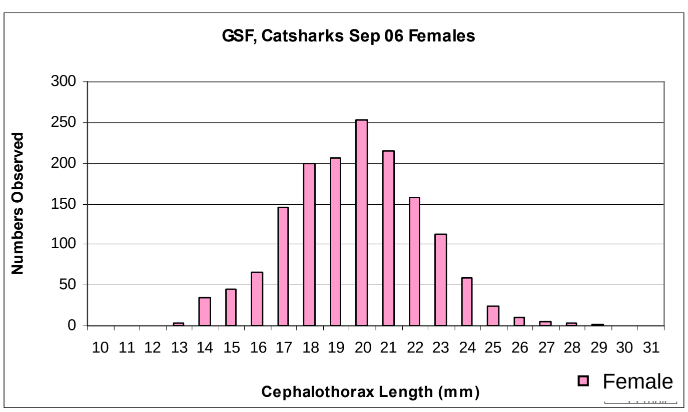
Numbers Observed
Cephalothorax Length (mm)
Male



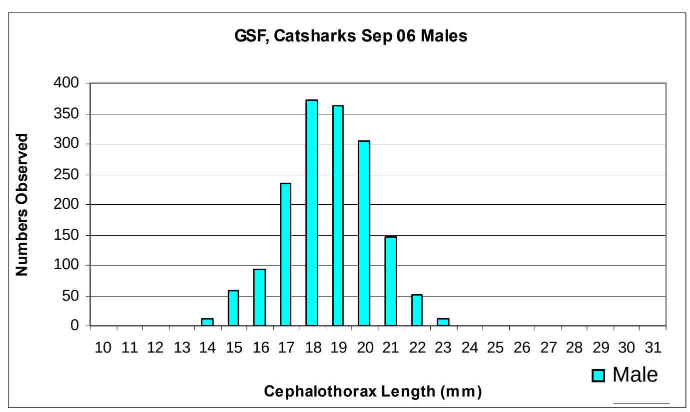
GSF, Cobia Aug 06 Females
Numbers Observed
Cephalothorax Length (mm)
Female



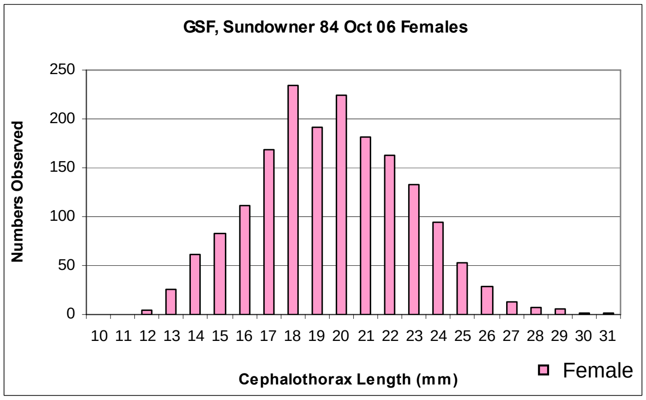
GSF, Cobia Aug 06 Males
Numbers Observed
Cephalothorax Length (mm)
Male

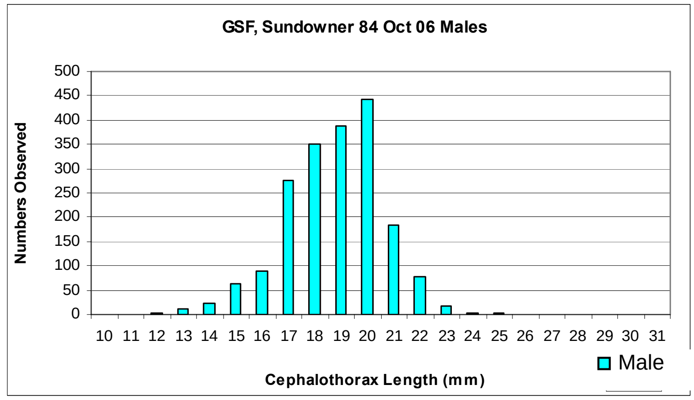


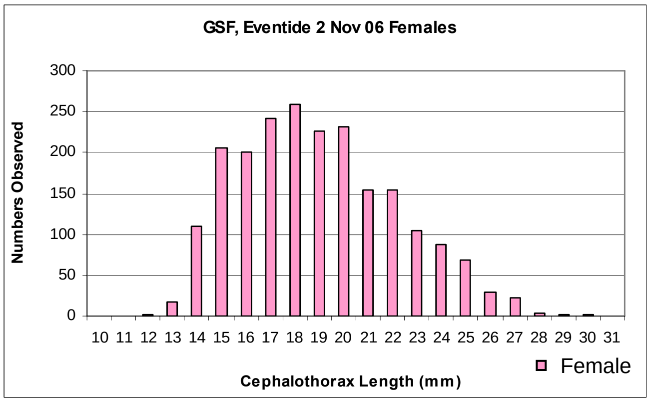
GSF, Catsharks Sep 06 Females
Numbers Observed
Cephalothorax Length (mm)
Female

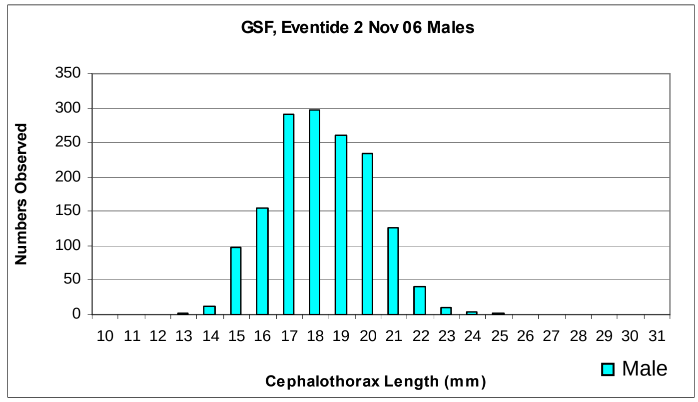


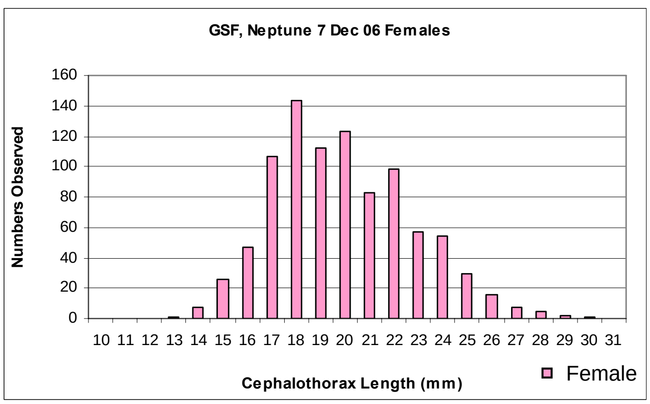
GSF, Catsharks Sep 06 Males
Numbers Observed
Cephalothorax Length (mm)
Male

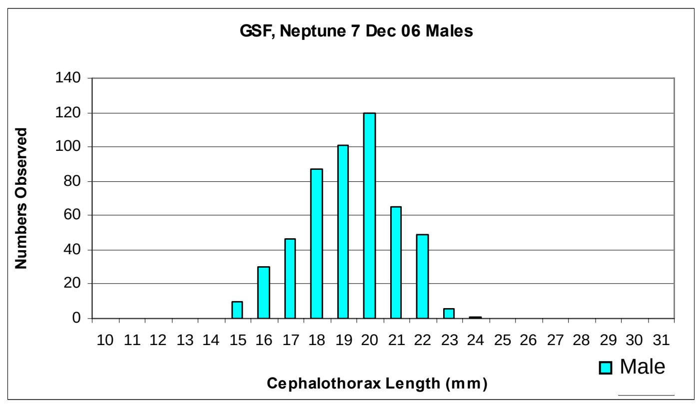


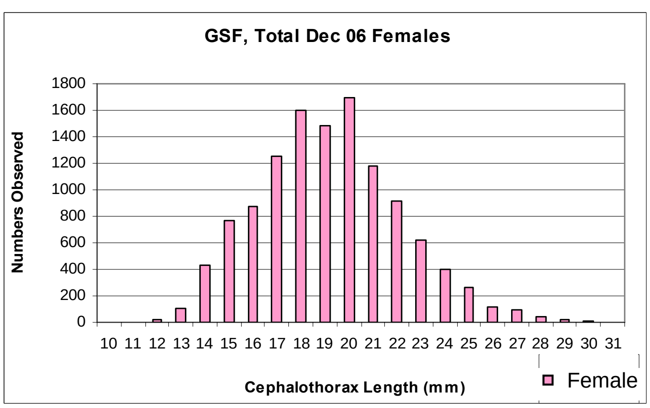












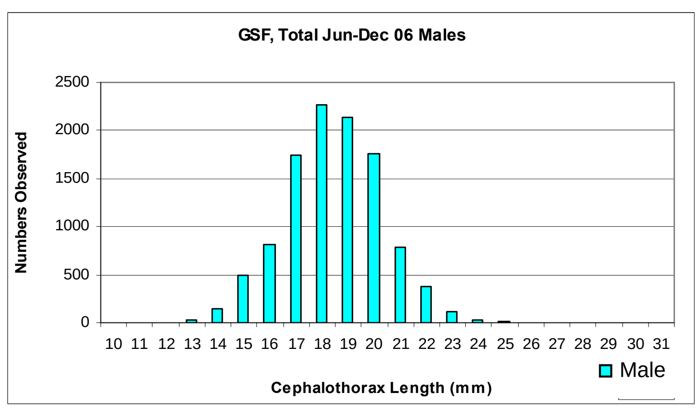


Figure 6. Length frequencies of females (left) and males (right) captured by GSF.

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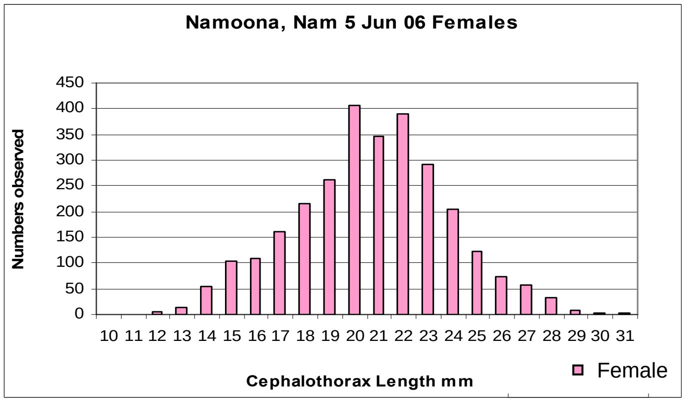
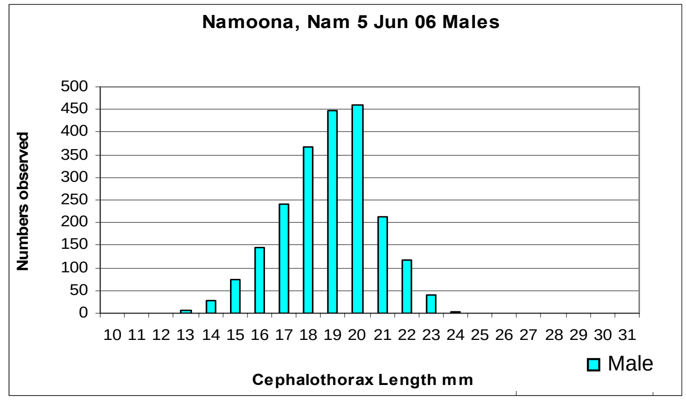
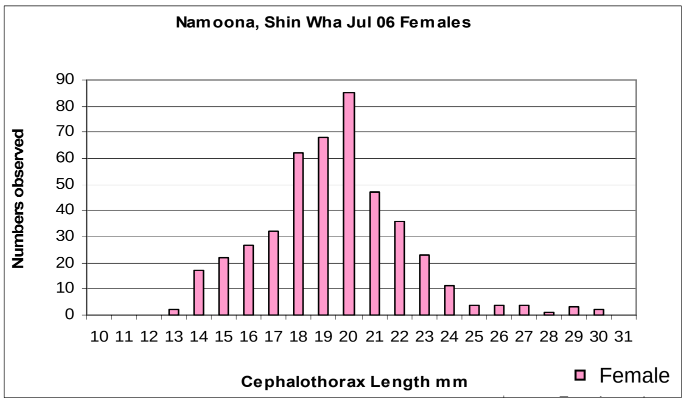
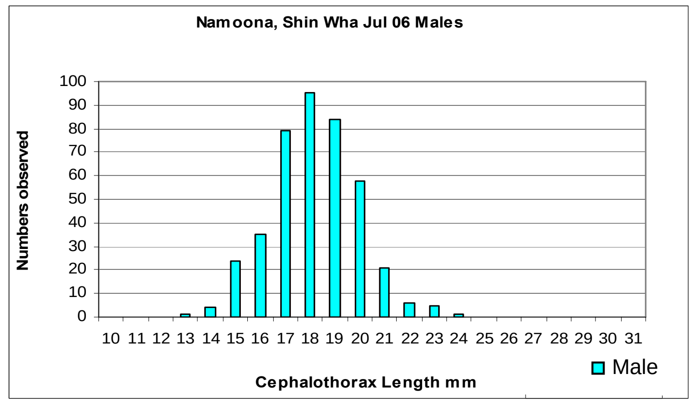
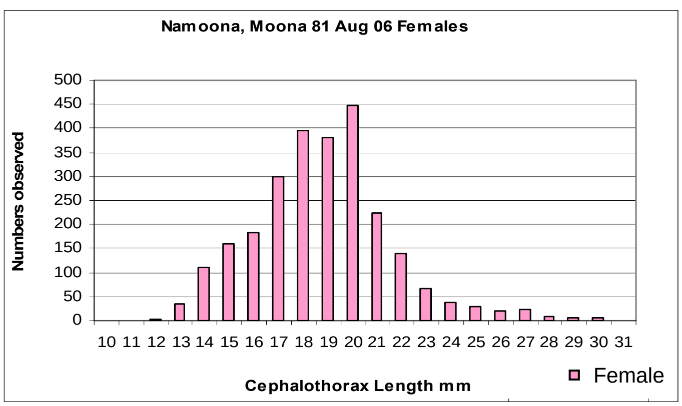
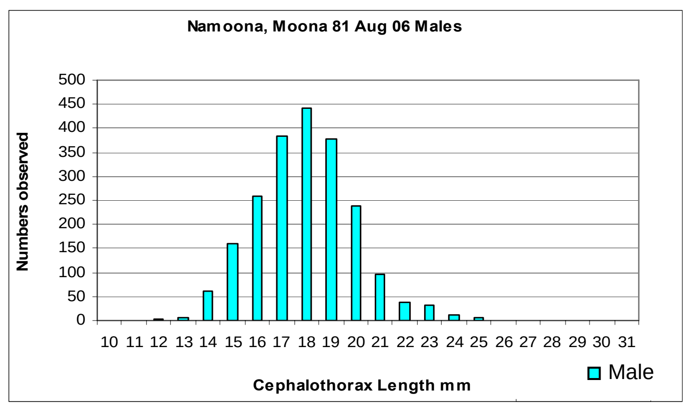

Namoona, Nam 5 Jun 06 Females
Numbers observed
Cephalothorax Length mm
Female


Namoona, Nam 5 Jun 06 Males
Numbers observed
Cephalothorax Length mm
Male


Namoona, Shin Wha Jul 06 Females
Numbers observed
Cephalothorax Length mm
Female


Namoona, Shin Wha Jul 06 Males
Numbers observed
Cephalothorax Length mm
Male


Namoona, Moona 81 Aug 06 Females
Numbers observed
Cephalothorax Length mm
Female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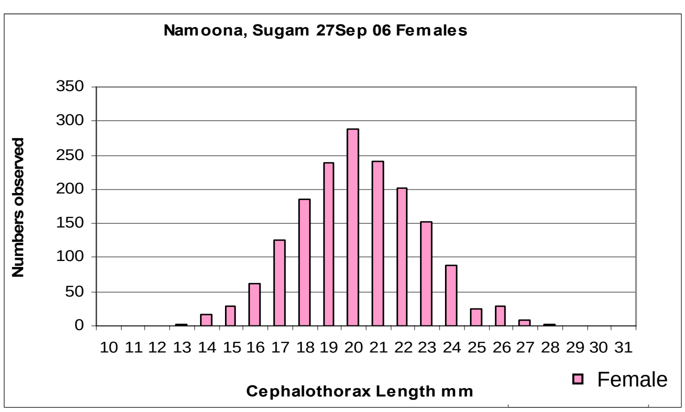
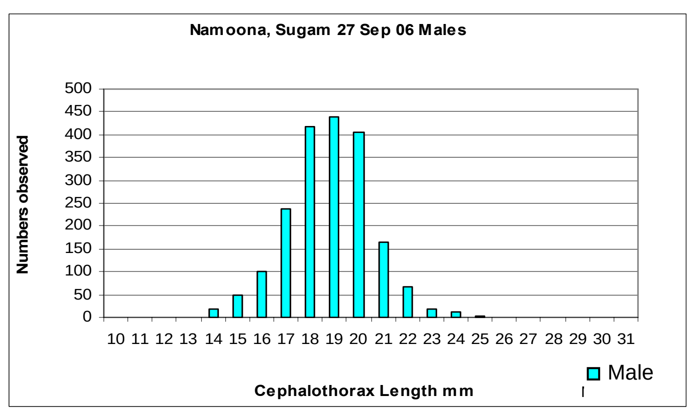
Numbers observed
Cephalothorax Length mm
Male


Namoona, Sugam 27Sep 06 Females
Numbers observed
Cephalothorax Length mm
Female


Namoona, Sugam 27 Sep 06 Males
Numbers observed
Cephalothorax Length mm
Male

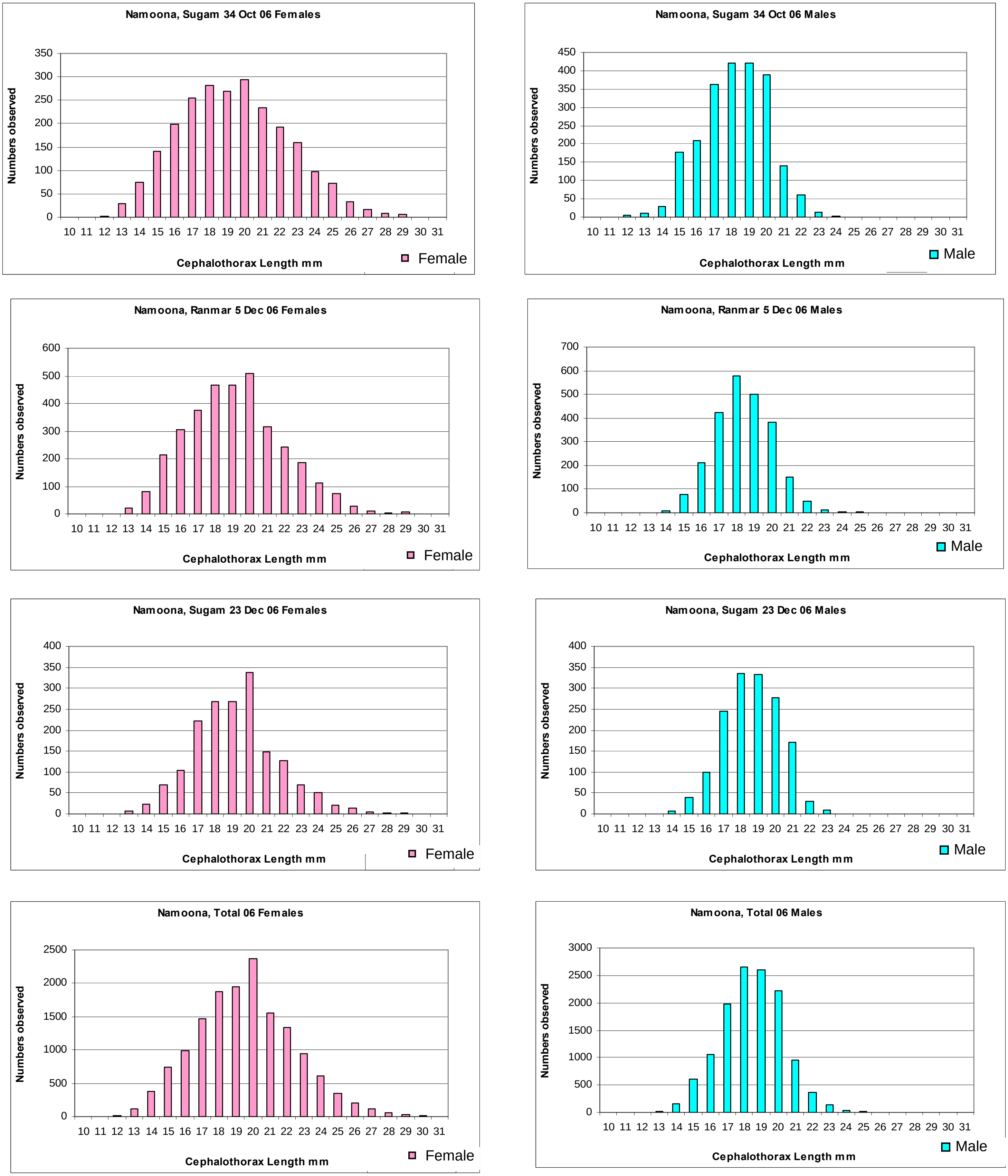
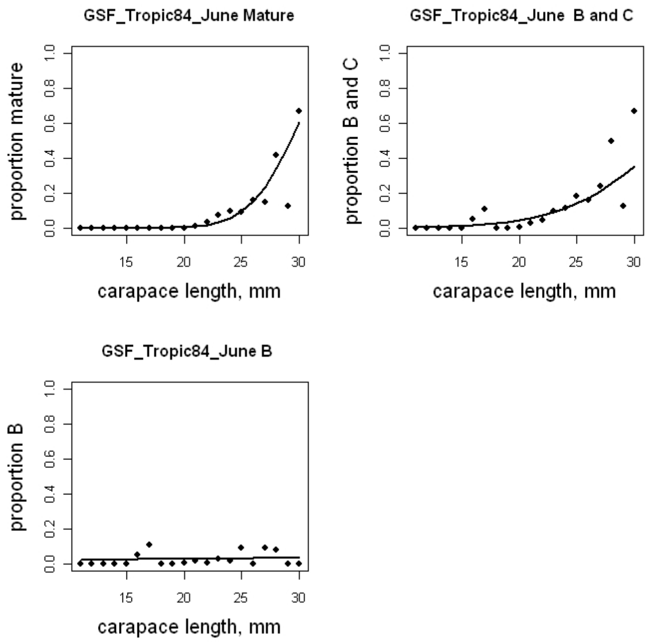
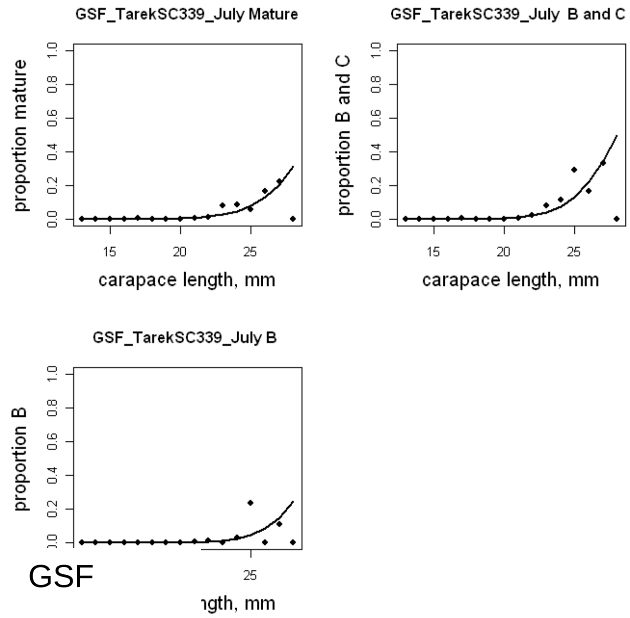
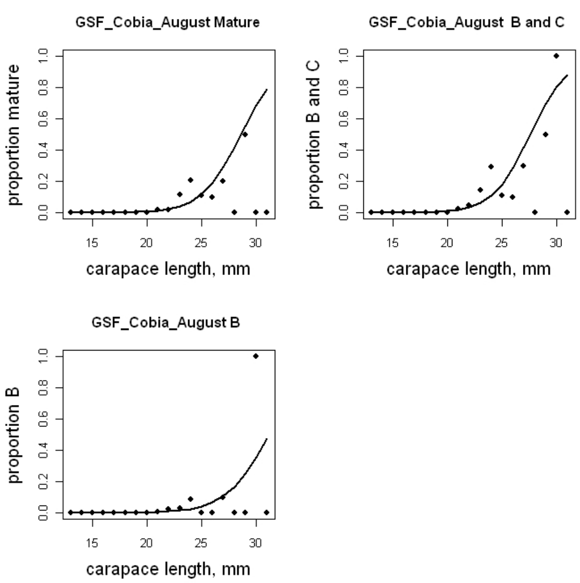
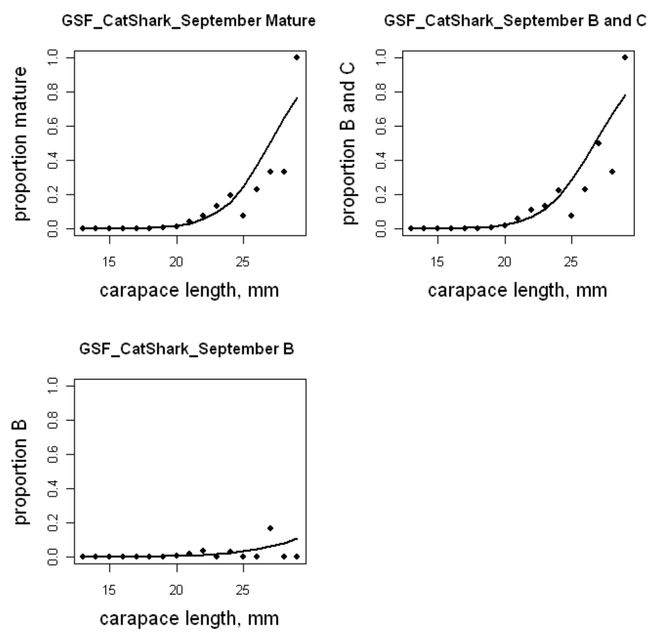


Figure 7. Length frequencies of females (left) and males (right) captured by Namoona.


GSF_Tropic84_June Mature
proportion mature
GSF_Tropic84_June B and C
proportion B and C
GSF_Tropic84_June B
proportion B
carapace length, mm


GSF_TarekSC339_July Mature
proportion mature
GSF_TarekSC339_July B and C
proportion B and C
GSF_TarekSC339_July B
proportion B
GSF
carapace length, mm


GSF_Cobia_August Mature
proportion mature
GSF_Cobia_August B and C
proportion B and C
GSF_Cobia_August B
proportion B
carapace length, mm


GSF_CatShark_September Mature
proportion mature
GSF_CatShark_September B and C
proportion B and C
GSF_CatShark_September B
proportion B
carapace length, mm

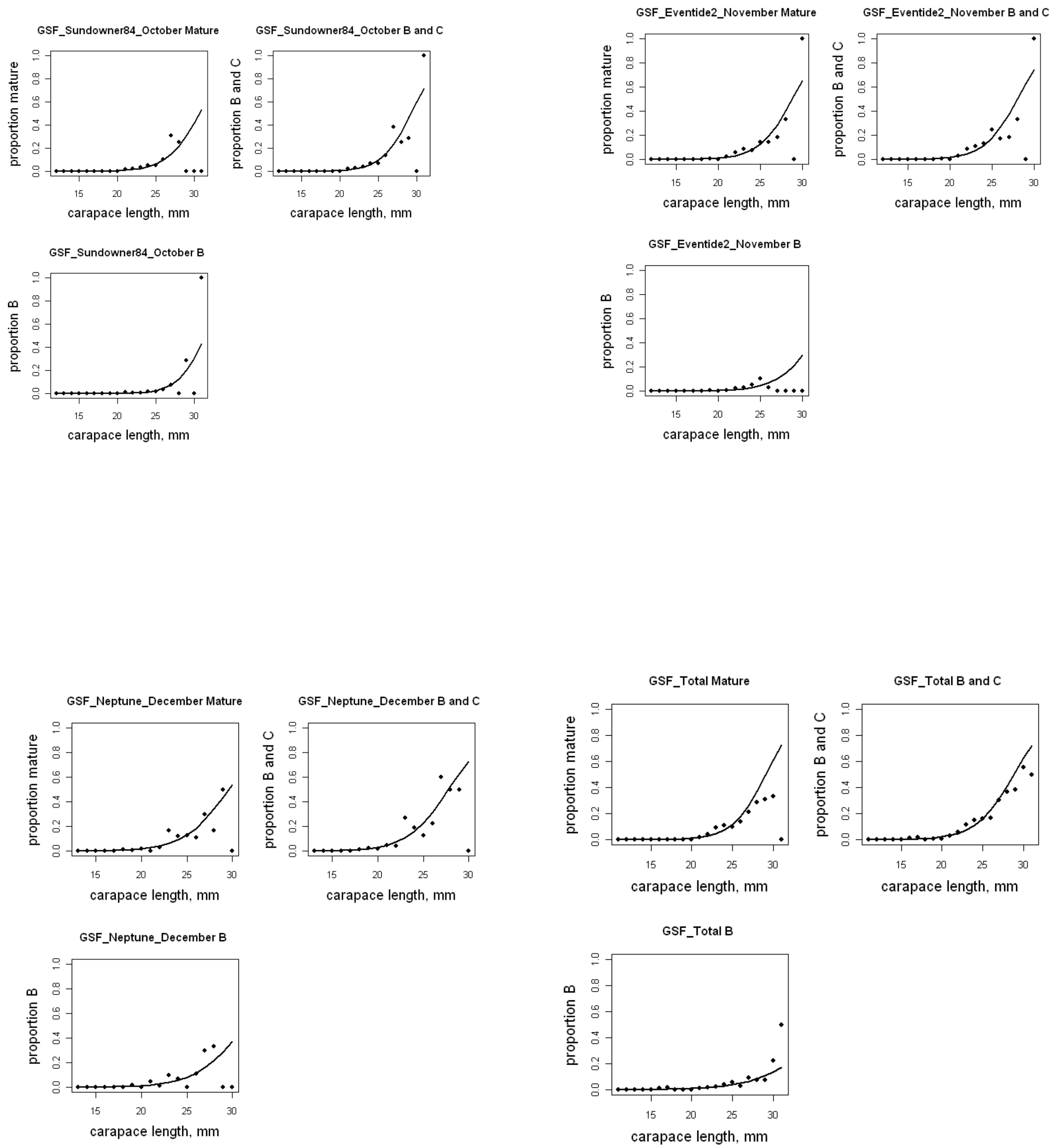


Figure 8. Relationship between proportion mature and length of shrimp by month of the year based on data from Guyana Sea Food. Category B is maturing; C, mature. Fitted lines are logistic regressions.

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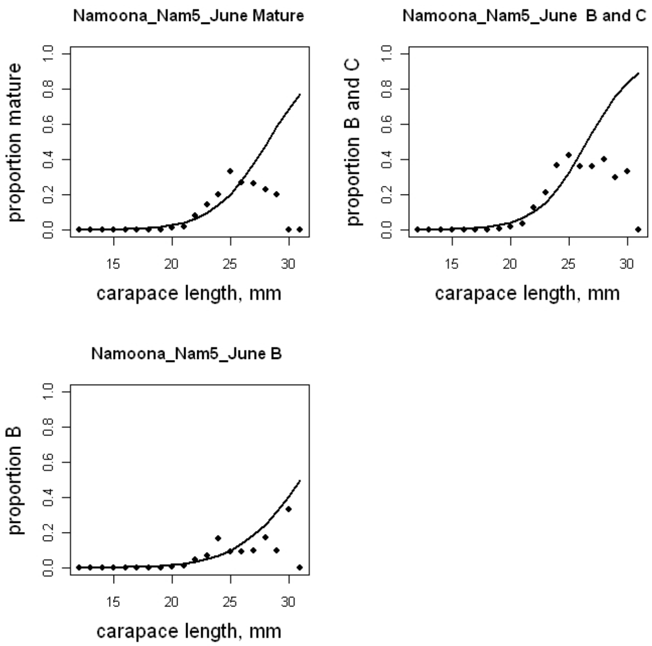
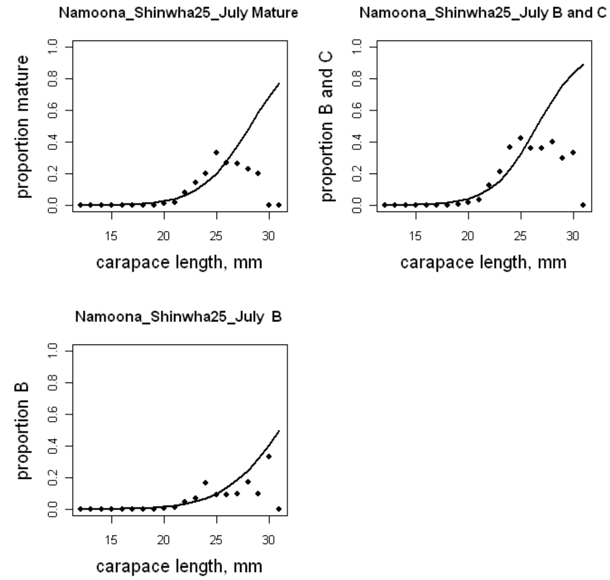
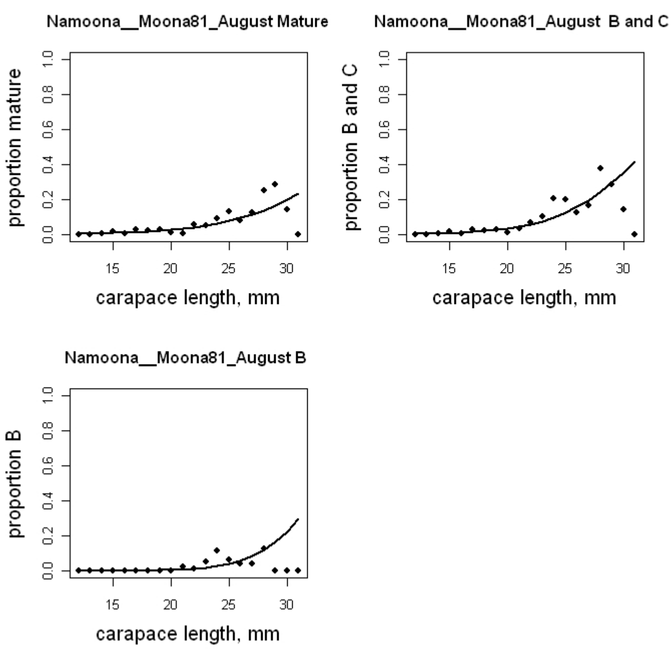

Namoona_Nam5_June Mature
proportion mature
carapace length, mm
Namoona_Nam5_June B and C
proportion B and C
carapace length, mm
Namoona_Nam5_June B
proportion B
carapace length, mm


Namoona_Shinwha25_July Mature
proportion mature
carapace length, mm
Namoona_Shinwha25_July B and C
proportion B and C
carapace length, mm
Namoona_Shinwha25_July B
proportion B
carapace length, mm


Namoona__Moona81_August Mature
proportion mature
carapace length, mm
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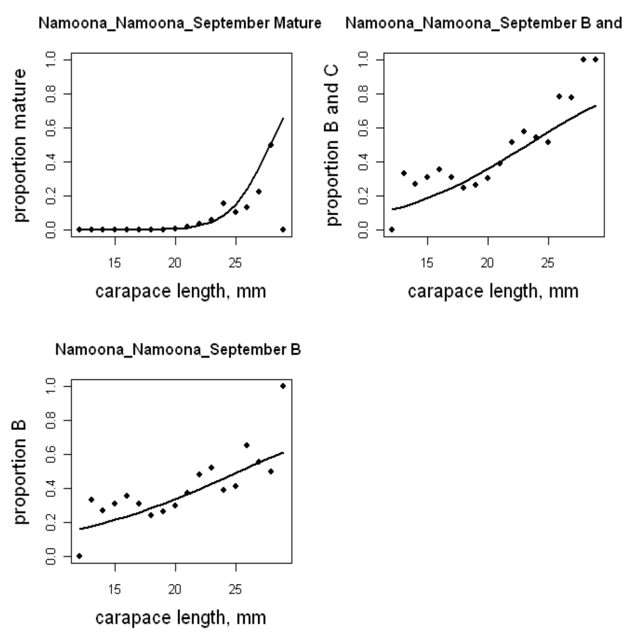
proportion B and C
carapace length, mm
Namoona__Moona81_August B
proportion B
carapace length, mm


Namoona_Namoona_September Mature
proportion mature
carapace length, mm
Namoona_Namoona_September B and C
proportion B and C
carapace length, mm
Namoona_Namoona_September B
proportion B
carapace length, mm

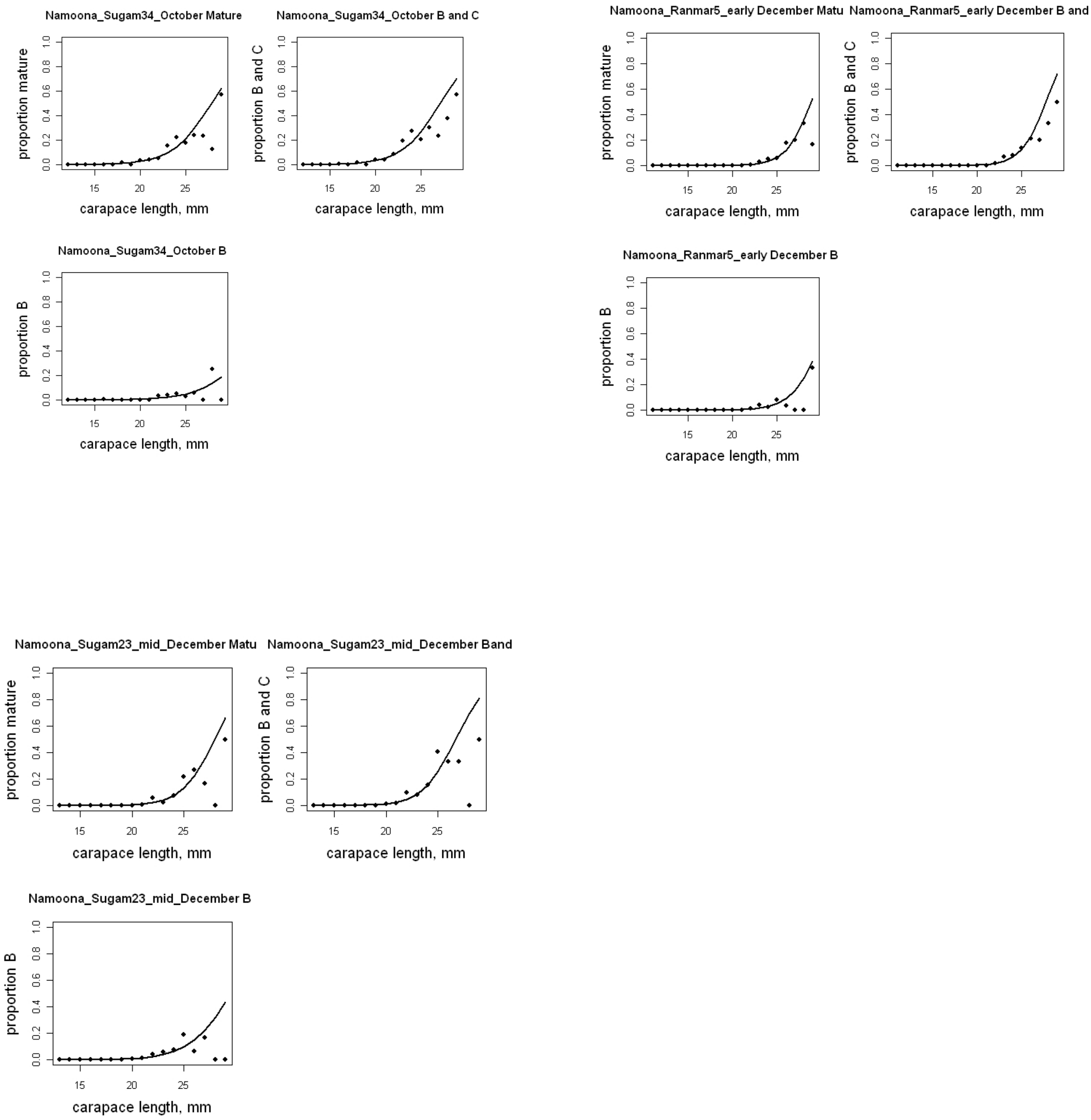


Figure 9. . Relationship between proportion mature and length of shrimp by month of the year based on data from Namoona. Category B is maturing; C, mature. Fitted lines are logistic regressions.

2.8.4.4 Discussion

The fishing effort rose by about two thirds over the period 1998 to 2006 (Figure 1). Landings also rose so that the catch rate remained quite constant over the years (Figures 2 and 3). This suggests the fishery is stable. However, we have no new data to determine if the exploitation rate is high. A previous assessment by Babb-Echteld and Medley (2004) indicated that fishing mortality is high and that increased yield per recruit could be achieved by a reduction in fishing effort. This concern remains. In addition, at present there is no information about the amount of spawning activity relative to any biological benchmarks.

Two types of data were examined to look for patterns of recruitment and growth. Neither type of data showed clear spikes in recruitment that could be followed over time. It appears that recruitment occurs throughout the year. This is in contrast to the pattern for Guyana seabob reported by Derrell *et al*. (2007). It should be noted that it is still possible that reproduction is seasonal, with two explanations for our inability to see clear seasonality. First, the data may be inadequate. The market category data are crude, lumping many sizes into one category. The detailed morphometric data are available for only seven months from a single year. The collection of monthly samples by the industry, which begun in 2007, should help clarify the situation with respect to seasonality of recruitment. Second, if the fishing mortality is low, then there may be several cohorts of shrimp present at the same time thus obscuring the dynamics of individual cohorts. If the fishing mortality were very high it is possible that a newly recruited cohort would be more noticeable because there is little else being caught.

The relationship between size and maturity was examined because a measure of stock status is the degree to which spawning is protected. The proper interpretation of the maturity data collected is not clear because among the largest size groups there are still numerous shrimp that appear immature. It may be that the green vein classification indicates imminent spawning activity rather than maturity such that many mature females may appear immature if they are not about to spawn. Further work is necessary to assess spawning biomass.

2.8.5 Management

The data suggest that the Suriname seabob fishery is stable and sustainable at the current level based on catch, effort and catch rate performance indicators. However, it is not clear what an optimally managed fishery would be like. Thus, it is not clear if fishing mortality is near a dangerous point where the stock could collapse or whether there is room for further expansion of the fishery. A previous report (Babb-Echteld and Medley 2004) suggested the exploitation rate may be high and that increases in yield could be obtained by reducing fishing effort.

For Guyana seabob, it appears that a closed season could be designed to protect pulses in recruitment. At present, there is no indication that this situation is mirrored in Suriname seabob. Thus, a closed season would reduce fishing mortality but it is not clear that there is an optimal time to schedule a closure. Further information could clarify this.

It appears that there might be reductions in fishing effort in the near future. This would provide an important opportunity to observe how the stock responds to a change in effort. However, if observations are not made before, during and after the closure then very little may be learned from the experiment.

2.9 References

Babb-Echteld, Y. and Medley, P. (2004). Suriname Seabob Fishery Report. In *Report on the shrimp and groundfish workshops conducted in Guyana (November 2003), Belize (December 2003) and Trinidad (January 2004)* (P. Medley). pp 61-67. Unpublished report submitted to Caribbean Regional Fisheries Mechanism, Belize City, Belize.

Derrell, C., J. Hoenig & Waterhouse, L. (2007). Guyana Seabob (*Xiphopenaeus kroyeri*) In CRFM Fishery Report – 2007 Volume 1. Report of Third Annual Scientific Meeting, 17-26 July 2007, Kingstown, St. Vincent and the Grenadines (In prep.)

3. Status of the whitemouth croaker (*Micropogonias furnieri)* resources of Trinidad and Tobago

Rapporteur: Suzuette Soomai
Consultant: Dr. John Hoenig
Observer: Dr. Todd Gedamke
Observer: Nancie Cummings

3.1 Management Objectives

General management objectives for the marine fisheries of Trinidad and Tobago were used as a guide to this assessment (Fisheries Division 2007). Of particular note were the objectives to ensure sustainable management and conservation of fisheries resources; to conduct any related activities consistent with the Precautionary Approach; to conduct research and implementation of related data collection systems; to investigate the impact of fishing activities on non-target species; to realize an economically viable and diverse industry and the achievement of nutritional self-sufficiency and food security.

3.2 Status of Stocks

Results of the assessment suggest a high but sustained fishing mortality rate which exceeds a sustainable level estimated in an earlier assessment of the species. The catch per day of gillnets, lines and trawlers has been stable since 1996, suggesting that the conditions of the fishery have generally remained constant.

3.3 Management Advice

The croaker population appears to be experiencing high levels of fishing mortality. Expansion of the fishery is not advisable. The risk associated with the current open access fishing regime has not been quantified and an analysis of spawning biomass per recruit is advisable. However, a precautionary approach is advisable and fishing effort should be maintained at current levels with a view to reduction in effort over time.

3.4 Statistics and Research Recommendations

3.4.1 Data Quality

This assessment used catch and effort data from 1995 – 2007. Apart from this time period, catch and effort data were collected at landing sites and markets prior to 1996. These records need to be reviewed and computerized since examining a longer time series will result in more informative assessments.

Catch per trip information for *M. furnieri* collected at mainly trawl landing sites is considered an under-estimate since small quantities of *M. furnieri* are aggregated with other bycatch and landed as broad market categories. Alternative data sources for monitoring trawls can be developed to assist with providing better estimates of total catches. A modified observer programme for all fleets, at a level that can be sustained over time, also needs to be established to collect information on the species while at sea. Additional review of the basic raw fisheries statistics needs to be done in the inter-sessional period to identify and remove data entry and/or recording errors.

A formal sampling protocol for biological data collection in Trinidad and Tobago should be established. For the croaker specifically, length frequency sampling from trawl gear has provided valuable insights;

continuing this time series, and possibly increased sampling to cover gillnet and line gears is recommended.

3.4.2 Research

Samples of whitemouth croaker from the landings of all gears need to be aged using hard parts, such as scales or otoliths (ear bones) to better characterize those ages that are being exploited and to develop an improved growth curve. This can be achieved through collaborative work with the Institute of Marine Affairs (IMA).

Collaboration with Venezuela in conducting stock assessments is essential since the whitemouth croaker is considered a shared stock between Trinidad and Tobago and Venezuela.

3.5 Stock Assessment Summary

The analysis utilized catch per unit effort (CPUE) levels for artisanal gillnets (monofilament and multifilament), trawl fleets (artisanal and semi-industrial) and artisanal line gear (banking, palangue, a-la-vive) operating in Trinidad and Tobago waters over the period 1995-2007. It also utilized monthly length frequencies from the artisanal, semi-industrial and industrial trawl fleets for 2005 and 2006 and length data collected in May 2007 from an industrial trawl survey. Biological parameters were obtained from a previous assessment on the whitemouth croaker using data collected over the period 1977-1982 (Manickchand-Heileman and Kenny, 1990).

The assessment involved the estimation of total mortality on the species based on (i) Beverton and Holt (1956, 1957) mean size mortality estimator (ii) length-converted catch-curve analyses (iii) standardized CPUE information.

(i) Mean size Model:

Mean lengths from the trawl samples showed that selection of fish began from a mean length of 32 cm. Natural mortality was taken as 0.36 yr^{-1} from Manickchand-Heileman and Kenny, 1990. Total mortality (Z), which is the sum of fishing mortality (F) and natural mortality (M), was estimated at 0.99 yr^{-1} in 2005 and 0.8 yr^{-1} in 2006.

(ii) Length-converted catch-curve Model:

The length frequency data from the trawl samples were converted to relative age using the growth parameters estimated in Manickchand-Heileman and Kenny, 1990 (K=0.145, Linf=74.1).

The results indicated mortality rates that were similar to the values estimated by the mean length method with a Z value of 0.92 recorded for the year 2005 and Z of 0.68 in 2006.

(iii) Standardized catch per day

An abundance index was developed to evaluate the stock relative abundance. The catch per unit of effort (CPUE) data from the commercial landings database were incorporated into a standardized index of abundance model for unbalanced data using the general linear model (GLM). Observations from 1995 to 2007 were included in the analysis. The final CPUE model included variables for 13 years (1995-2007), 12 months (January-December), 6 gear types (banking, palangue, a-la-vive, artisanal and semi-industrial trawl, multifilament gillnets, monofilament gillnet), and 9 fishing areas (east, north-east, north, north-west, west, south-west, south, south-east, Venezuela). The results indicated that abundance has not fluctuated greatly over the time series of observations.

There was an observed increase in landings over time. However both the observed and standardized CPUE trend does not reveal large changes in CPUE over the time series (Figure 1a, b, c). The analysis suggests the need for additional review of the raw data to investigate a disparity in the 2003 predicted point. In addition, the confidence intervals are large suggesting large uncertainty associated with the point estimates.

3.6 Special Comments

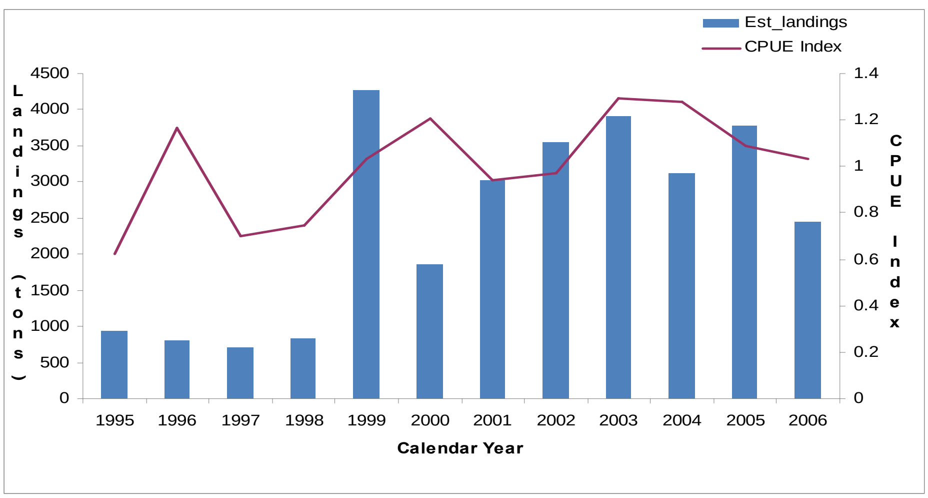
The present assessment includes new information (catch, effort and length data) since earlier assessments conducted for the whitemouth croaker in 1999 and 2000. The results of this current 2008 assessment support the results of previous national and joint assessments conducted by Trinidad and Tobago and Venezuela (see Alio *et al.*, 1999 and Soomai *et al.*, 1999).

3.7 Policy Summary

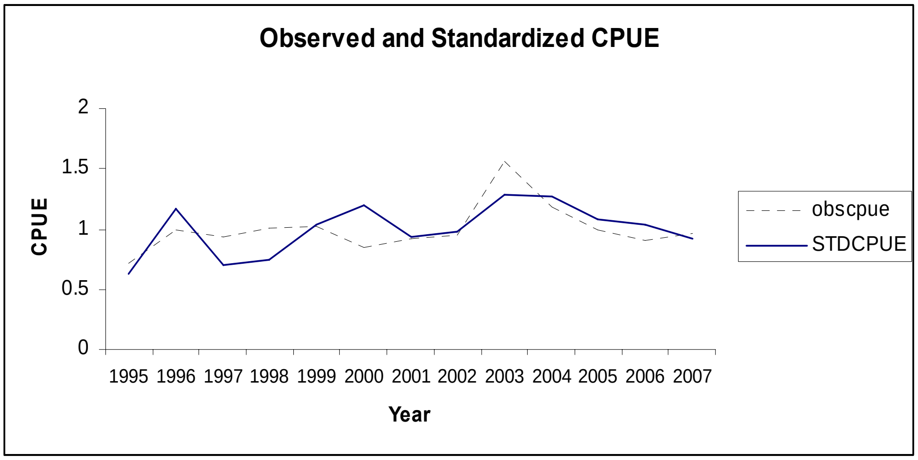
The present assessment is considered one of the implementation strategies in achieving the policy objectives with regard to the promotion of sustainable management listed in the draft Marine Fisheries Policy (Fisheries Division, 2007). These are:

- to promote research on the status of resources, socio-economic performance of the fisheries, gear selectivity and technologies; and
- to ensure that the productive capacity of marine habitats is increased or maintained, such that fish may be harvested for the benefit of present and future generations.

(a)



(b)



(c)

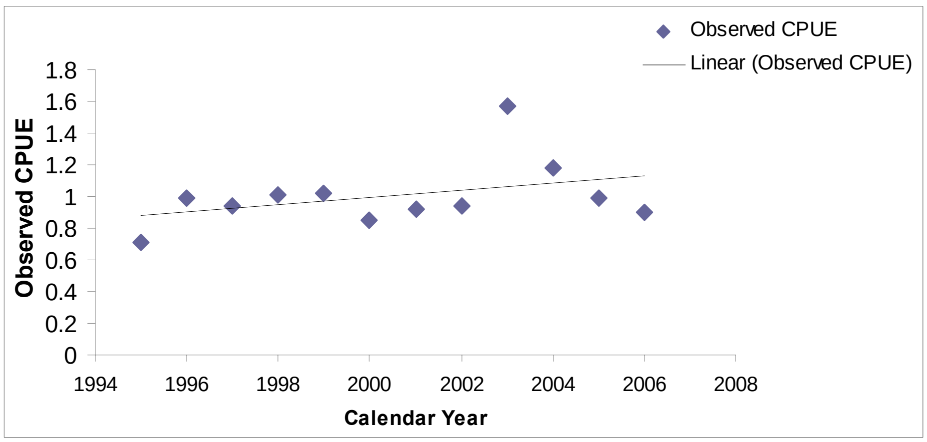


Figure 1. Annual landings and CPUE for croaker obtained from gillnets, trawls and lines for the period 1995 – 2007. (a) Landings of croaker and CPUE index for 1995 - 2006; (b) Observed and standardized CPUE in tonnes per day for 1995 - 2007. (c) Observed CPUE showing a trend line over the period 1995 to 2006.

3.8 Assessments

3.8.1 Description of the fisheries

The whitemouth croaker, *Micropogonias furnieri*, also known locally as croaker, is a soft-bottom demersal or groundfish species. *M. furnieri* (croaker) is one of the main species of commercial importance in the groundfish fishery in Trinidad and Tobago and is mainly landed by vessels operating in the Gulf of Paria on the west coast and in the Columbus Channel on the south coast of Trinidad. The croaker stocks are considered to be a shared resource with Venezuela. In Trinidad and Tobago, it is landed predominantly as by-catch from shrimp trawlers and from the artisanal multi-gear fleet targeting mackerels. The trawl fleet comprises artisanal, semi-industrial and industrial vessels as described in Kuruvilla *et al*., (2000). The main gear for groundfish in the artisanal multigear fleet are gillnets (monofilament and multifilament), handlines (banking), demersal longlines (palangue), and live-bait lines (a-la-vive) and, are described in Chan A Shing (2002) and Ferreira and Martin (2004).

The Fisheries Division Vessel Census conducted in 2003 identified 743 vessels operating gears that capture groundfish in Trinidad. Of this total, the census recorded 133 vessels using monofilament gillnets, 133 using multifilament gillnets, 65 using handlines, and 41 vessels using demersal longlines in the Gulf of Paria and Columbus Channel. The trawl fleet currently consists of approximately 137 vessels within which there are 102 artisanal, 10 semi-industrial and 22-25 industrial vessels. In 2006, *M. furnieri* accounted for 12% (854 t) of the total landings of fish and was approximately 8% (TT$6.9M) of the total value. The landings for *M. furnieri* were estimated at 41% of the total groundfish landed in 2006. *M. furnieri* is a relatively cheaper fish compared to the mackerels and other pelagic species. In trawl communities, croaker bycatch from trawlers plays an important role in the diets of persons in these rural communities (Hutchinson *et al*., 2007).

Earlier assessments have been conducted for the croaker fishery in 1999 and 2000. Yield per recruit analyses of the state of the fishery in Trinidad and Tobago (Manickchand-Heileman and Kenny, 1990; Soomai *et al*., 1999) concluded that *M. furnieri* was fully exploited. A depletion model (Soomai *et al*., 1999), a biodynamic model of the shared fishery between Trinidad and Tobago and Venezuela (Alio *et al*., 2000) and a bio-economic analysis (Soomai and Seijo, 2000) all indicated that *M. furnieri* was being fully to over-exploited.

The 1999 and 2000 assessments for croaker caught by local fleets were however based on catch and effort data from artisanal fleets only and did not include data from the industrial trawl fleet. In addition length data for croaker landed by local fleets were not available. Subsequent to this, in 2003 an ongoing biological sampling programme was established for the croaker to collect length information and species composition of *M. furnieri* in landed market categories of trawl bycatch at the main trawl landing sites.

3.8.2 Overall Assessment Objectives

The main objectives of the assessment were to analyse the available data on the whitemouth croaker fishery and to build a stock assessment approach to give management advice for this fishery. Monthly catch and effort data for gillnets, trawl and line gear were available. Monthly length data for the species were obtained from a biological sampling programme conducted during the period of 2005 -2006. Length data for the species were also collected in May 2007 from an at-sea trawl survey that measured both discards and retained fish. The stock status was determined by evaluating changes in the total mortality (Z) based on changes in mean length through the Beverton and Holt method. Length-converted catch curves were also fitted to the data. An abundance index was developed from the commercial landings database to evaluate the relative abundance of the stock by incorporating monthly catch per unit of effort (CPUE) data by gear and fishing area into a standardized index of abundance model for unbalanced data using the general linear model (GLM).

3.8.3 Data Used

Table 1. Input parameters for the mean size model, length converted catch curves, and linear model of relative abundance.

Data Type	Fleets	Period	Source
Catch and Effort	Artisanal gillnets –monofilament, multifilament Artisanal handline – banking Artisanal bottom longline – palangue Artisanal live bait line - a-la-vive Trawl - artisanal and semi-industrial	1995 – 2007, 1975, 1963 (by month)	Fisheries Division: Beach landing statistics collected at all major landing sites around Trinidad.
	Industrial trawl	2000 - 2006 (by month)	
Length Frequencies	Trawl – artisanal, semi-industrial, industrial	2005 – 2006 (by month)	Fisheries Division: Samples collected at major trawl landing sites
	Trawl - industrial	May 2007	

			At-sea sampling on gear surveys

3.8.4 Assessment

3.8.4.1 Objective

The main objective of the assessment was to evaluate changes in total mortality (Z) based on changes in mean length and size frequency composition through the Beverton and Holt (1956, 1957) mean size estimator and a length-converted linearized catch curve. Estimates of total mortality were then used to derive fishing mortality using previous estimates of natural mortality. A secondary objective was to assess changes in relative abundance by developing an index of abundance from catch per unit effort series for various gear types.

3.8.4.2 Method/Models

(a) Beverton-Holt mean size mortality estimator

Size frequency data from the trawl fishery comprising three fleets (artisanal, semi-industrial, industrial) over the period 2005 to 2007 were evaluated to determine the most appropriate data set to be used in a mean length analysis. Mean lengths were calculated for each fleet and year and total mortality was estimated for each fleet and year combination through the Beverton-Holt estimator (Beverton and Holt, 1956 & 1957). The derivation of the Beverton-Holt estimator begins by assuming deterministic asymptotic growth as described by the von Bertalanffy equation

$$L_t = L_\infty (1 - \exp(-K(t - t_o))) \quad (1)$$

where L_t is the length at age t, and L_∞, K and t_o are the parameters. The instantaneous total mortality rate, Z yr^{-1}, is assumed to be constant over time and over age for all ages $t > t_c$, where t_c is the age at which animals are fully vulnerable to the fishery and to the sampling gear. It is also assumed that recruitment is continuous over time at constant rate R. The mean length of those animals above the length L_c corresponding to the age t_c is

$$\bar{L} = \frac{\int_{t_c}^{\infty} N_t L_t \, dt}{\int_{t_c}^{\infty} N_t \, dt} \quad (2)$$

where L_t is given by (1) and $N_t = R \exp(-Z(t-t_c))$. Performing the integrations in (2) and simplifying yields

$$\bar{L} = L_\infty (1 - \frac{Z}{Z+K} \exp(-K(t_c - t_o))) \ . \quad (3)$$

Equation (3) is easily solved for the mortality rate and, through algebraic manipulation, the parameter t_o can be eliminated and replace with L_c. Thus,

$$Z = \frac{K(L_\infty - \bar{L})}{\bar{L} - L_c} \quad (4)$$

There are six assumptions behind this method.

1. Asymptotic growth with known parameters K and L_∞ which are constant over time.
2. No individual variability in growth.
3. Constant and continuous recruitment over time.

4. Mortality rate is constant with age for all ages $t > t_c$.
5. Mortality rate is constant over time.
6. Population is in equilibrium (i.e., enough time has passed following any change in mortality that mean length now reflects the new mortality level).

K and L_∞ for the whitemouth croaker (Table 2) were derived from a previous study conducted in Trinidad and Tobago (Manickchand-Heileman and Kenny, 1990).

Table 2. Parameters for the von Bertalanffy growth model, length weight conversion and natural mortality used in the assessment estimated from Manickchand-Heileman and Kenny 1990.

Growth Model		
L_∞ (cm)	K (year^{-1})	M
74.1	0.145	0.36
Length-Weight Conversion		
A	b	t_0
4.8 x 10^{-5}	3.0375	-0.145

(b) Length converted Catch Curves

The length-converted linearized catch curve model described in Hilborn and Walters (1992) was used in the assessment. The method consists of plotting the natural logarithm of the number in a length category versus the relative age at the midpoint of the length category. Relative age (*t*) is derived form the von Bertalanffy growth equation and defined as:

$t = -(ln(1-L_t/L_\infty))$ (1)

where L_t is the length at age *t*, and L_∞ are the parameters. Total mortality is estimated from the slope of the descending limb of the curve (the right side of the curve) as

$slope = 1 - Z/K$ (2)

where *Z* is the total mortality and *K* is the von Bertalanffy growth coefficient. Length conversion to age requires a growth model. Parameters for the growth model were provided from a previous study on the croaker (Manickchand-Heileman and Kenny 1990). This was the best available information for the fishery in Trinidad and Tobago.

(c) Standardized CPUE

An abundance index was developed to evaluate stock relative abundance. The catch per unit of effort (CPUE) data from the commercial landings database were incorporated into a standardized index of abundance model for unbalanced data using the general linear model (GLM). Observations from 1995 through 2007 were included in the analysis. The commercial landings database contained records for the main gears landing croaker over the period 1995 to 2007 (banking, palangue, a-la-vive, artisanal, semi-industrial and industrial trawl, multifilament and monofilament gillnet), as well as other nets and lines that landed small quantities of croaker on a more infrequent basis. In developing the abundance index, data from the industrial trawl fishery were not included since records were available only from 2000 - 2006 and not for the entire time series as for the other gears. Observations from fisheries with similar operating characteristics were combined into a single fishery gear for the model. The final CPUE model included variables for 13 years (1995-2007), 12 months (January-December), 6 gears and 9 fishing areas representing each coast of Trinidad and the Orinoco Delta areas (Venezuela). Table 3 lists the parameters.

Table 3. Variables used in the general linear model (GLM) analysis.

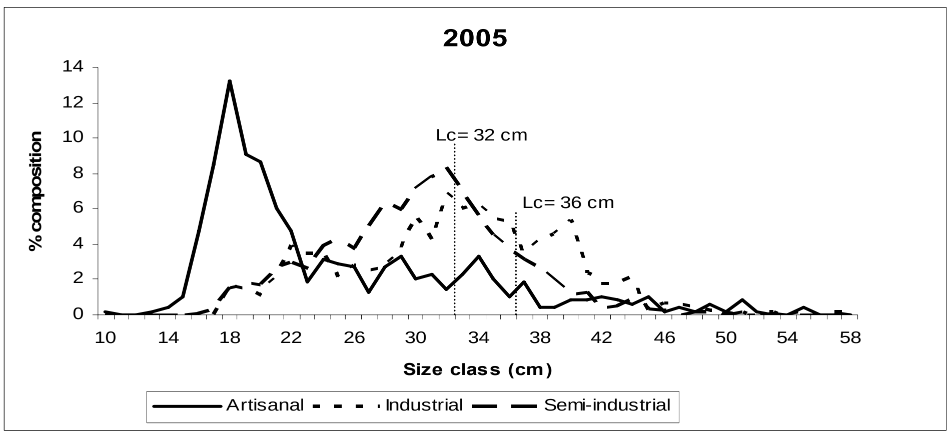
Class Level Information		
Class	Levels	Values
YEAR	13	1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
MONTH	12	1 2 3 4 5 6 7 8 9 10 11 12

Class Level Information		
Class	Levels	Values
AREA	9	North North-East East South-East South South-West West North-West Venezuela
GEAR	6	Banking Bottom_longlines Lines Monofilament Multifilament Trawl

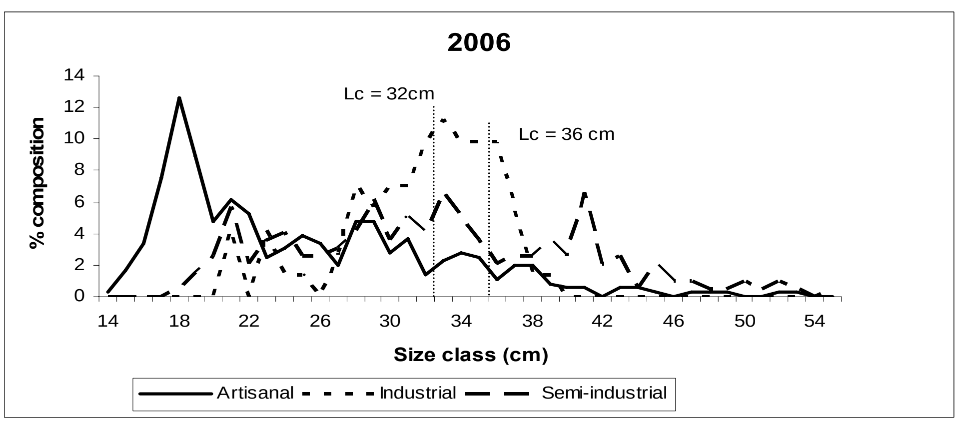
3.8.4.3 Results

Length data collected over the period 2005-2007 from the trawl fishery were used to obtain length frequencies and are plotted in Figure 2. From the plots, two size limits were selected representing the length at which the fish are selected into the fishery. The trawl fishery appears to have close to a knife edge selection with full vulnerability (L_c), selected by eye, at around 32 cm and at 36 cm and then a gradual decline in the abundance of larger individuals.

(a)



(b)



(c)

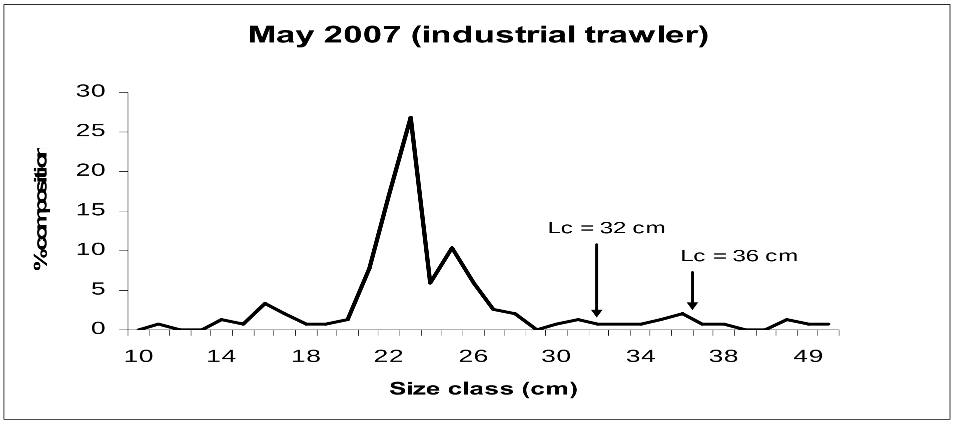


Figure 2. Percent composition of length frequencies from sampled croaker landings from artisanal, semi-industrial and industrial trawl fleets Cumulative catch of all individuals measured in the trawl catches were used to determine the length at full vulnerability (L_c) to the gear (indicated by a dashed line/arrow). (a) Percent composition plot for samples collected from the three trawl fleets in 2005 (b) Percent composition plot for samples collected from the three trawl fleets in 2006 (c) Percent composition plot for samples collected from the industrial fleet in 2007.

Total mortality (Z) calculated for each fleet at Lc values of 32 cm and 36 cm was always high and showed a wide range of values with no apparent trends by fleet or year. Values of fishing mortality (F) were estimated by subtracting the 1990 estimate of natural mortality (M= 0.36) from the estimated Z. Values of Z and F are given in Table 4.

Table 4. Z estimates calculated from Beverton and Holt method and F values calculated for trawl gear types (using M=0.36).

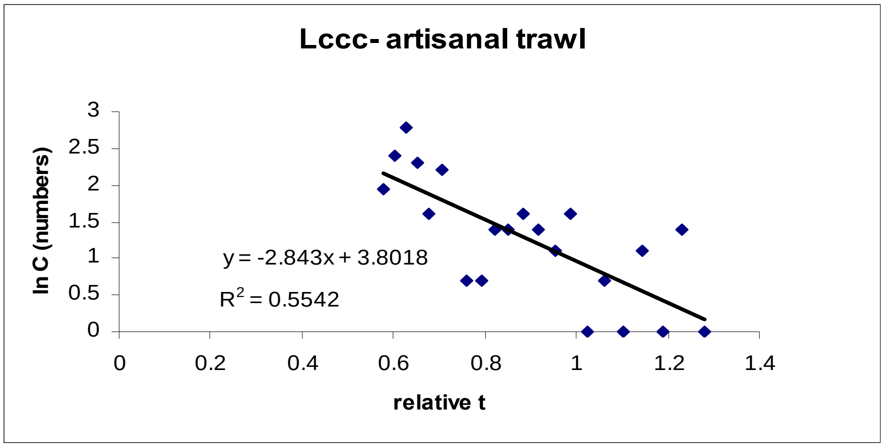
Beverton and Holt	2005		2006		2007	
Lc	32	36	32	36	32	36
Z (artisanal)	0.69	0.61	0.92	0.97		
Z (semi-industrial)	1.35	1.39	0.68	0.69		
Z (industrial)	0.93	1.10	1.91	4.49		
Z (industrial) trawl study					0.87	0.75
average Z	0.99	1.03	0.80	2.05		
F	0.63	0.67	0.44	1.69	0.51	0.39

The downward trend on the right of each frequency was used to fit the catch curve. It was assumed that the downward trends to the right of the mode are due to mortality and growth alone and the fish are fully selected by the fishery in the area to the right of the mode.

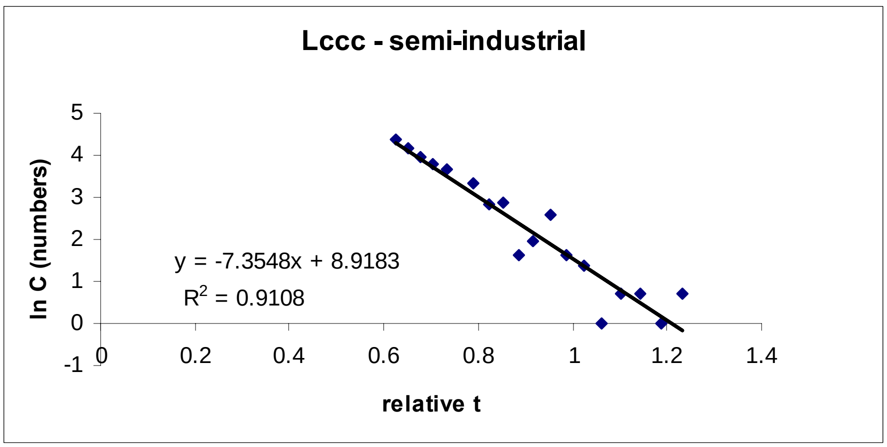
Figure 3 shows the log-abundance plotted against the relative age as calculated from length for 2005 for the artisanal, semi-industrial and industrial fleets. The values for the slope of the regression lines and the R^2 goodness-of-fit statistic are given in the plots. Table 5 gives the Z and F values estimated from the length converted catch curves.

An overall average Z was calculated from the individual Z values derived for each year and trawl fleet. The fishing mortality, F, was calculated as the difference between the Z and M values. Total mortality estimates from all years range from 0.56 to 1.30 yr^{-1}.

(a)



(b)



(c)

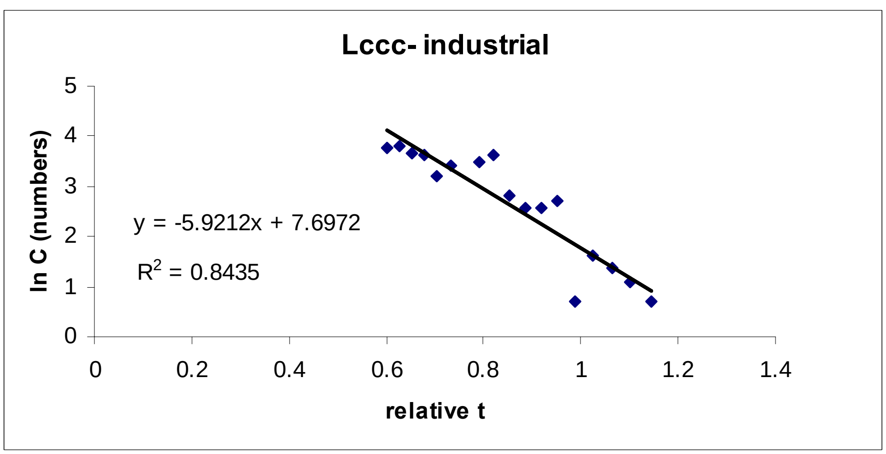


Figure 3. Length converted catch curves (Lccc) derived from sampled croaker landings from the three trawl fleets (artisanal, semi-industrial and industrial trawlers) for 2005. (a) Lccc for the artisanal fleet (b) Lccc for the semi-industrial fleet (c) Lccc for the industrial fleet.

Table 5. Estimated total mortality (Z) and fishing mortality (F) estimated from length converted catch curves for croaker for 2005-2007.

	2005	2006	2007
Z (artisanal)	0.56	0.72	
Z (semi-industrial)	1.21	0.64	
Z (industrial)	1.00	-0.25	1.30
Average Z	0.92	0.37	
F	0.56	0.01	0.94

The observed CPUE trend from the raw data, as seen in Figure 4, does not reveal changes in CPUE over the time series, however the raw data reveals an outlier in 2003, by about 50%. Preliminary inspection of the data did not reveal an obvious reason for the outlier. It is recommended that additional review of the basic raw CPUE data takes place inter-sessionally to investigate this disparity in the observed trend more fully.

The standardized annual CPUE trend did not suggest significant changes in the CPUE over the total time series of 1995 through 2007. However the analysis suggests the need for additional review of the raw data to investigate the 2003 predicted point. In addition, the confidence intervals are large suggesting large uncertainty associated with the point estimates.

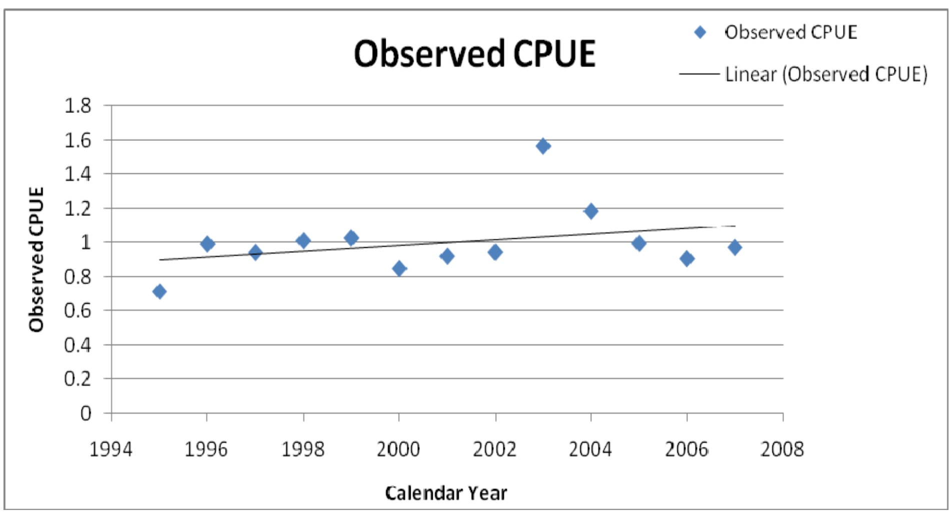


Figure 4. Observed catch per unit effort (CPUE) from total landings and effort data for the period 1995-2006.

<u>3.8.4.4 Discussion</u>

The estimates of total mortality were high but quite variable. This suggests that the recent fishing mortality for croaker is above natural mortality. This implies that the stock is being fished at or above the maximum sustainable yield (MSY). The results of this analysis however, are based on 1990 estimated growth parameters and estimates of the von Bertalanffy growth parameters. To improve the reliability of the results, future studies should be focused on updating these parameters and developing an empirical age-growth relationship. Otolith and scale samples should be taken for this purpose and samples should be taken from trawls and gillnet fisheries representing the entire age range of the population.

Croakers are considered as bycatch for gillnet, trawl and line gears, and only make up a relatively small proportion of the catch in these fisheries. An attempt was made to include the discards in this study by including the length data collected from a 2007 trawl study that measured total catch of the species. The data available from this 2007 study was collected at sea and was a better estimate of the catch of croaker per trip compared with land-based sampling where croakers are mixed with other groundfish and landed in broad market categories. Data should continue to be collected on these discards at sea.

The length frequency data by themselves cannot be the basis of a full assessment and should be supported by age data. Also, assessments using catch and effort data generally require a long time series and are only useful if there are significant changes in catch and effort over time. This assessment used catch and effort data from 1995 – 2007; however, catch and effort data were collected prior to 1996. The incorporation of historical data into a standardized CPUE series will improve results by providing a longer time series to give a more informative assessment.

Earlier yield per recruit analyses of the species suggested growth over-fishing which means that reductions in fishing effort would result in little long term change in yield. An assessment of spawning biomass per recruit is recommended to determine the risk associated with the current open access fishing regime.

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Appendix 6

REPORT ON THE PROCEEDINGS OF THE SMALL COASTAL PELAGIC FISH RESOURCE WORKING GROUP (SCPWG)

(Crafton Isaac, Kris Isaacs, John Jeffers, Maren Headley, Susan Singh-Renton)

1. Introduction

1.1 Review of Fisheries

Small coastal pelagic (SCP[6]) fish resources constitute a significant portion of fish landed in the CRFM region. In some instances these resources make up between 30% and 55% of total fishery landings (Jardine and Straker, 2003; Jeffers, pers. comm.). Small coastal pelagic fish resources supply an important source of affordable, high quality proteins for many individuals throughout the region. In the northern Leeward Islands, the high prevalence of ciguatera poisoning, associated with the consumption of reef-associated predator species, has increased dependence on small coastal pelagic fish species as a food source. The population of Montserrat is also heavily dependent on small coastal pelagic fish resources as a food source since many reef fishing sites have been lost due to volcanic activity (Jeffers, pers. comm.).

In recent years, the demand for small coastal pelagic fish species as bait particularly in the longline fishery has increased dramatically. This has drastically decreased the amount of these catches available to the local markets as both food and bait, as higher prices for these species are obtained from the foreign longline vessels. During early 2008, apparent dramatic declines in the availability of small coastal pelagic fish to the local consumption market was believed to be directly linked to the diversion of fish supplies to foreign longline vessels. In a move to alleviate public concerns, fisheries managers in St. Vincent and the Grenadines took a decision to impose a 1-year ban on the sale of these fish as bait to the foreign longline vessels.

Flyingfish resources are included in the scope of this Working Group. A stock assessment of the four-winged flyingfish will be conducted by the WECAFC Ad Hoc Flyingfish Working Group in July 2008. The report of the WECAFC assessment will be reviewed during the next on-site meeting of the Working Group in 2009.

Small coastal pelagic fisheries in the CRFM region have certain characteristics which make collecting data and management a challenge. These characteristics include:

- The widespread subsistence nature of the fisheries which militates against a structured data collection programme;
- The remoteness of some landing sites, with difficult access for data collection;
- The temporal dispersal of fishing operations which makes them difficult to predict;
- The lack of exact knowledge of the marketing and disposition of catches;
- The inability of data collectors to segregate catch by species in some instances.

1.2 Working Objectives

Acknowledging the contribution of small coastal pelagic fisheries to social and economic stability and food security, especially of rural communities in Eastern Caribbean islands, and recognizing the growing demands for such resources both as food and bait, together with recent concerns about their state of health and the potential imbalance between demand and supply, the Working Group agreed to develop a plan of action for strengthening the information base used to inform the development of management and

[6] In this context, small coastal pelagic (SCP) fish resources refer to small schooling pelagic fish found in sheltered bays and targeted by coastal gears.

conservation measures for small coastal pelagic fisheries. The development of the overall action plan was based on addressing the following specific objectives.

- To review trends in the fisheries.
- To review the status of data collection and management activities within CRFM Member States.
- To develop a plan of action to improve data and information systems and management of the fisheries concerned.

In view of the recent one year ban imposed in St. Vincent and the Grenadines in respect of the sale of small coastal pelagic fish as bait to foreign vessels, the Working Group was also asked to make recommendations for a 6-9 month study of the local fishery. The results of this study were required to assist stakeholders and managers to gain a better appreciation of the continued need for/relevance of the ban.

2.0 Data Collection and Management Activities

To inform a preliminary review of data collection and management activities for small coastal pelagic fisheries within the CRFM region, a questionnaire was prepared and circulated to national representatives to the 2008 CRFM scientific meeting. A summary of the responses received is provided in Tables 1-3. The information gathered was considered in the development of the action plan to improve data and information systems and management discussed in section 4.0 of this report.

3.0 Fisheries Trends

Data on the annual landings of small coastal pelagic fish resources were obtained from the FAO database (FAO, 2008). These data were plotted to examine trends in landings over time, as well as the relative importance of landings of each species by country (Figures 1-19). Data for CRFM countries were only available in the database for the following species: Atlantic bonito, Atlantic thread herring, big eye scad, Brazilian sardinella, broad striped anchovy, Carangids, Clupeoids, Crevalle jacks, halfbeaks, Atlantic black skipjacks, needlefishes, rainbow runner, scads, scaled sardines and snook (*Robalo*). In several instances, the catch data showed marked fluctuations from year to year, e.g. figs 3, 7, 8, 12, and 14, which may likely have been mainly due to inconsistencies in accuracy and levels of reporting, not only at the individual species level (e.g. fig. 7), but also instances where more than one species were lumped together for reporting purposes (e.g. figs. 10 and 12). Nonetheless, the catch data were useful in providing an indication of existing fisheries for the various species, and afforded a preliminary appreciation of the relative importance of targeted species to the various reporting countries.

4.0 Action Plan to Improve Data and Information Systems and Management

In order to ensure sustainability of these fisheries, given their increasing importance both as a source of food and bait, it is necessary to improve overall understanding of this fishery. The following individuals were invited to join in the discussions for developing the action plan: Elizabeth Mohammed (Trinidad & Tobago); Christopher Parker (Barbados); Nancie Cummings (NMFS, SEFSC); Todd Gedamke (NMFS, SEFSC); Bruce Lauckner (UWI, St. Augustine).

The discussion focused primarily on two major issues:

1. Challenges experienced with data collection/sampling of these fisheries and possible solutions;
2. The need for St. Vincent and the Grenadines to conduct an evaluation of its beach seine fishery before the expiration of the one year national ban on the sale of bait to foreign longliners. This

one year ban was imposed in April 2008. In the absence of a regular and consistent sampling programme, this evaluation was considered necessary to provide updated management advice.

4.1 Data collection – challenges

Certain commonalities among small coastal pelagic fisheries in the CRFM region were identified:

- The complexity of fishing and post-harvest activities, including the extensiveness and difficulty of accessing fishing areas/ landing sites, and the possible time span and unpredictability of fishing and landing operations;
- The informal nature of the fishing practices where fishing opportunity, conduct and marketing are often influenced by traditional and cultural norms.

In addition, in countries such as Trinidad, Guyana, and Suriname, the gears were more diverse, and consequently, accurate determination of total removals by species has proven to be difficult. Depending on the fleet type, gear used and hence target species, the treatment and also recording of removals (catches) at the individual species level were inconsistent over time. There may also be an unknown amount of discards.

Based on the challenges highlighted, several ideas were discussed.

- The need to develop both short and long term plans for improving data collection and management of the fisheries;
- In the short-term, the need to identify and list all the essential components comprising the sampling frame so as to facilitate at least estimation of total removals and short term patterns in these;
- The need to design an appropriate long-term sampling programme.

Arising out of the above, there were some specific suggestions on sampling approaches. Based on the questionnaire responses, the Working Group recognized that there were human resource, as well as financial, constraints, and therefore acknowledged that each country would have to consider what would be feasible at the national level.

4.2 Proposed Action Plan

Based on the review and discussion of present available data and information on the nature and dynamics of these fisheries, the agreed proposed action plan identified the following tasks to be undertaken.

1) In the short-term, and certainly before the next meeting of the Working Group, countries should develop complete lists of the fishers, fishing units (including vessels and vessel owners), landing sites, fishing areas, gears and gear owners, species harvested, and market routes. These data would facilitate the establishment of a sampling frame. The sampling should be accomplished through the use of a simple data/interview form. A suggested data/ interview form is provided as Addendum 1 to this report.
2) In the long-term, fishing activity data should be gathered using weekly or fortnightly on-site interviews. During on-site interviews, data collectors should take the opportunity to collect samples for biological analysis. All data collected should be quantifiable to some extent, even if not directly measurable, e.g. low, medium, high. In instances of interval data, actual measurements of a few samples should be taken from time to time, to provide a guide for interpretation.
3) Where fishing units combine gears to facilitate capture of large fish schools, this would need to be recorded as a different type of fishing effort.
4) Given the important contribution of these fisheries to overall landings and food security in several countries, countries should ensure that appropriate human and financial resources are

made available to implement the proposed sampling programmes. It should be noted that key informants and fishers in the respective communities could be utilized to assist with sampling of the fisheries.

5) Countries should engage fishers in consultations prior to commencing the proposed sampling programmes, to inform them of the intentions of the national fisheries authority. This should be conducted as a goodwill gesture and to nurture co-operation from fishers during data collection activities.
6) Countries should undertake a survey to quantify the social and economic importance of these fisheries. Such a survey should be designed to provide information on the contribution of these fisheries to food security on local and national scales, employment, and the relationship of the supply of fresh fish with the consumption of other non-local sources of animal protein, e.g. chicken.
7) If funds are available, countries should conduct research to improve understanding of the biology and ecology of these resources.

4.3 Proposed action plan –specific recommended tasks for St. Vincent and the Grenadines

In view of the one year ban imposed in St. Vincent and the Grenadines, in April 2008, regarding the sale of small coastal pelagic fish as bait to foreign-owned longline fishing vessels, and

Noting the request to the Working Group to make recommendations for a 6-9 month study of the local fishery that would provide a better appreciation of the continued need for/relevance of the ban,

the Working Group identified the following specific tasks to be undertaken over the next 6-9 months.

1) The sampling frame should be completed as soon as possible, followed by establishment of the long-term sampling programme and completion of the socio-economic survey. The socio-economic survey should also include a survey of the needs of the foreign-owned longline vessels.
2) In conducting its sampling programme, St. Vincent and the Grenadines would need to consider ways of avoiding double counting of the beach seine catch and of sampling effectively those small coastal pelagic catches taken in the Grenadines. With regard to catches taken by fishers in Union Island, Grenada should assist with sampling, since a substantial portion of the catch from Union Island is landed and sold in Grenada.
3) Following completion of tasks (1) and (2) during the inter-sessional period, the available data from sampling and surveys should be analysed to facilitate a review of the need for retaining the ban on the sale of small coastal pelagic fish as bait to foreign-owned longliners.

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Table 1. Questionnaire responses providing information on the management objectives and measures in effect for small coastal pelagic fisheries, as well as the species targeted and gears used.

Country	Management Objectives	Management Measures in Effect	Species Targeted in order of Importance	Gears used in order of Importance
Barbados	o To sustainably utilize and manage the coastal fish resources o To reduce coastal conflicts that impair fisheries management *Fisheries Division, Ministry of Agriculture and Rural Develop (2004)*		i) Jacks and Cavallis (*Caranx spp.*) ii) Pilchards (*Clupeidae, Engraulididae*)	i) Gill nets ii) Seine net iii) Cast net
Grenada	o To ensure the socio-economic viability of the fishery and the maintenance of the habitats. *Anon. (2004)*		i) Big eye scad (*Selar crumenophthalmus*) ii) Round scad (*Decapteurs spp.*) iii) Rainbow runner (*Elagatis bipinnulata*) iv) Crevalle jack (*Caranx sp.*) v) Needlefish (*Belonidae*) vi) Southern sennet (*Sphyraena picudilla*) vii) Ballyhoo (*Hemiramphus sp.*)	i) Beach seines ii) Cast nets
Jamaica	o To ensure the viability of the fishery through maintaining and enhancing habitat, and the protection of nursery areas Murray, pers. comm.	Mesh size restrictions: The mesh size of the bunt should be 3.17 com (1 ¼ inches) or more wide upon the bunt being fully stretched The mesh size of the corners should be 4.43 com (1 ¾ inches) or more wide upon the corners being fully stretched The mesh size of the wings are 5.08 cm (2 inches) wide or more, upon the wings being fully stretched.	i) Atlantic thread Herring (*Opisthonema oglinum)* ii) Yellowfin Mojarra (*Gerres cinereus*) iii) Anchovies iv) Herring, Atlantic thread (*Opisthonema oglinum*) v) Round Sardinella (*Sardinella aurita*) vi) Atlantic Leatherjacket (*Oligoplites saurus*) vii) Atlantic Lookdown (*Selene vomer*) viii) Cutlassfishes ix) Ground Croaker	i) Sprat net ii) Trammel net iii) China net iv) Beach seine

			(*Bairdiella rhonchus*) x) Kingcroakers (*Menticirrhus spp.*)	
Montserrat	o Maintain the socio-economic viability of the fishery o Maintain the integrity of the fish habitat *Anon. (1997)*		i) Needlefish (*Belonidae*) ii) Ballyhoo *(Hemiramphus spp.)* iii) Big Eye Scad (*Selar crumenophthalmus*)	i) Beach net ii) Gill net
St. Kitts & Nevis	o To maintain and improve the net incomes of the fishers and operators in the fishery; o To include as much fishers in the fishery as is possible, given the biological, ecological and economic objectives listed above; o To promote co-management *Anon. (2007)*	Gear restrictions	i) Jacks (*Carangidae*) ii) Big Eye Scad (*Selar crumenophthalmus*) iii) Round Scad (*Decapteurs spp.*) iv) Needlefish (*Belonidae*) v) Ballyhoo (*Hemiramphus sp.*) vi) Gar (needlefish) vii) Ballahoo ix) Jack (big eye scad) x) Fry and sprat xi) Bonito	i) Beach seine ii) Cast net iii) Gill net
St. Lucia	o To ensure sustainable use of the resource; o To maintain and improve the net incomes of operators in the fishery at a level above the current income level. *Anon. (2006)*	Mesh size restrictions Cast nets with a mesh size of less than 25.4 mm may not be used. Beach seines with a mesh size of less than 31.75mm may nnot be used, except when no more than one third of the entire length of seine is of mesh size less than 31.75mm; A trawl net or a bottom gillnet with a mesh size of less than 76.2mm may not be used; Gear restrictions: Restriction on use of traps Trammel nets for fishing purposes may not be used without the written permission of the Chief Fisheries Officer and in accordance with any conditions as the Chief Fisheries Officer may specify. Soak time restrictions: Fishing nets may not remain in place in the sea	i) Big Eye Scads (*Selar crumenophthalmus*) ii) Round Scad (*Decapteurs spp.*) iii) Herrings (*Clupeidae*) iv) Ballyhoo (*Hemiramphus sp.*) v) Crevalle Jack (*Caranx sp.*) vi) Small tunas (*Auxis thazard, Sarda sarda, Thunnus albacares)*	i) Beach seine ii) Fillet nets (nets used as a seine or a floating gill net) iii) Cast nets

		for longer than eight consecutive hours without the written permission of the Chief Fisheries Officer and in accordance with any conditions that the Chief Fisheries Officer may specify; Area Restrictions The use of gill nets is not permitted in the Soufriere Marine Management Area (SMMA).		
St. Vincent & the Grenadines	o To stabilize the net income per fisher at a level above the national minimum desired income; o To maintain the stocks at the MSY level. *Anon. (2005)*	Gear restrictions: Trammels (tangle) nets are prohibited Restriction of ballyhoo nets Size restriction on meshed gear	i) Jacks (Carangidae) ii) Robins (Decapterus spp.) iii) Ballyhoo (Hemiramphus) iv) Small tunas v) Herrings (Clupeidae) vi) Silversides (Atherinidae) vii) Anchovies (Engraulidae)	i) Seines ii) Cast nets iii) Gill nets-fixed or drifting (ballyhoo)
Suriname	o To identify ways to exploit the resource and develop products of commercial value (other than food). *Anon. (2000)*	Gear restrictions Area restrictions	i) Anchovies (*Engraulididae*) ii) Herring*s (Clupeidae)* iii) Jacks *(Carangidae)* iv) Scombridae (mackerel) v) Sphyraenidae (Barracuda)	i) Fish trawlers ii) Pelagic trawlnet
Trinidad & Tobago	There are no specific management objectives. The general objective for all fisheries are: o To ensure that the exploitation of the fisheries resources and the conduct of related activities, are consistent with ecological sustainability (e.g. for target species, non-target species, and marine environments) and that proper conservation and management measures are implemented so that the fisheries resources are not endangered by over-fishing. Mohammed, pers. comm.	Sale restrictions Sale of sardines as bait other than to bona fide fishers is prohibited. Gear restrictions Seines for catching bait o Length not to exceed 120 feet; o Width not to exceed 900 feet. o Mesh not to be less than half an inch square. Cast nets for catching bait: o Length not to exceed 6 feet. o Mesh not to be less than half an inch square. Gar seines for catching fish other than Cavalli or Jack: o Length not to exceed 500 feet at centre. o Mesh not to be less than half and inch square. Seines known as Italian Seines: o Length not to exceed 900 feet. o Mesh to be not less than half an inch	i) Herrings (*Clupeidae*) ii) Robins (*Decapterus sp.*) iii) Anchovies (*Engraulididae, Sardinella sp.*) iv) Needlefishes (*Belonidae*)	i) Tuck seine ii) Fillet (Multifilament gillnet) iii) Trawl net iv) Italian seine v) Monofilament gillnet vi) Beach/Land seine

		square. A minimum mesh size (diagonal stretched mesh) of approximately 11 cm (4.75 inches) except where mullet is targeted. Monofilament nets with a diagonal stretched mesh less than approximately 11 cm (4.75 inches) may not be carried on board a vessel together with nets of another mesh size. Area restrictions No fish, shell-fish, crabs or shrimps shall be taken within the area lying between a line drawn from the mouth of the Caroni River to a buoy fixed one thousand feet seaward from the sewerage outfall and then to the mouth of the Diego Martin River, and the shore. No fish or shell-fish (including oysters, crabs and shrimps) shall be taken anywhere between Claxton's Bay and the mouth of the Cipero River or from the sea between the said places for a distance of one half of a mile seawards from low water-mark. 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 the cover of night. Trawling is also permitted on the south coast of Trinidad, outside of 2 nautical miles. Trawling is subject to a zoning regime in the Gulf of Paria, where artisanal trawlers are permitted to operate outside of one nautical mile from the coast; semi-industrial trawlers are permitted in depths of 6 fathoms or more and 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 inches) when trawling for fish. Fleet Restrictions		

		A restriction has been placed on any further increase in numbers of artisanal, semi-industrial and industrial trawlers.		

Table 2. Questionnaire responses, providing information on the statistical monitoring and assessment activities for small coastal pelagic fisheries.

Country	**Ongoing Data Collection**	**Data Collection Location and Method**	**Types of Data Collected**	**Unit of Effort**	**Years for which Catch and Effort Exist**	**Constraints to Data Collection**	**Data Deficiencies**	**Assessments Conducted**
Barbados	Y	Landings at all primary and tertiary sites	Landing site, aggregate catch	fishing trip	Late 1950s		No coverage of tertiary sites at which a large number of jacks and cavallis are landed	
Grenada	N	St. Johns Parish One data collector	Landing site, gear, catch weight by species, Lunar information	Number of casts		Inadequate human resource, Budgetary, Remoteness of landing sites, SCP not considered a priority.	Lack of qualitative and quantitative data No data quality checks	Limited
Jamaica	Y	Where: landing sites How: designated data collectors Type: sample (catch and effort, biological)	Landing site, gear, effort, sample weight (by species), length, weight (indiv), maturity	Hours fished	1996	Inadequate human resources, budgetary	Various types of nets are used hence the various weights need to be determined in order to standardize for all net types. - though site information is collected it is still uncertain as to the exact location of this fishing grounds	
Montserrat	Y	Little Bay, Daily, Census	Landing site, gear,	No. of sets per	2002-2007	Budgetary	Getting samples for measurements	

			catch weight by species	day			especially in the case of the big eye scad	
St. Kitts & Nevis	Y	Landing site on a trip interview basis. The data are collected at least 2 times per week as we have 2 data collectors and five landing sites.	Landing site, gear, catch weight by species, aggregate catch, effort	Days	2000-2007			
St. Lucia	Y	Interviews conducted at landing sites Observations of catch. Data Collectors assigned to collect data at major landing sites. Data collected from every other boat that comes in for each day over 15 days each month.	Landing site, gear, catch weight by species, effort, sample weight (by species), weight (indiv)	Using fish days, total boats out and sampled days. Formula: fish days *total boats /sampled days.	Data is lumped under "other species" and would have to be extracted.	Lack of biological data, & not all landing sites are sampled. Fishers continue to be reluctant in giving accurate information on their fishing activities.	Inadequate human resources and budgetary	None
St. Vincent & the Grenadines	Y	Landing site Use of designated Fisheries data collectors Sample and estimation	Landing site, gear, catch weight by species, sample weight by species	Gear and hours	1993-1994	Inadequate human resources and Remoteness of landing sites	Insufficient data collected Not enough sites visited	None
Suriname	N	At the landing sites by observers or the company reports the department	Landing site, catch weight by species	Catch in tons of fish	1995-2007	SCP not considered a priority		None
Trinidad & Tobago	Y	Artisanal multi-gear fleet is sampled at 18 landing sites	Landing site, gear, aggregate	Boat trip, Hours fishing.	1995-2004	Inadequate human resource, Budgetary, Remoteness of	Data not recorded to species level. Landings data may	None Limited

		around Trinidad.	catch, effort	Beach seine-one haul		landing sites,	reflect only a portion of the catch or catches from more than one trip. Records of landings from a-la-vive and fishpots are more likely associated with the capture of the species as bait using a net/seine rather than their capture by the respective gears.	

Table 3. Questionnaire responses, indicating options for improving statistical monitoring and for conducting focused studies aimed at enhancing knowledge and understanding of the nature and dynamics of small coastal pelagic fisheries.

Country	**Types of Data which can be collected given the available resources**	**Types of Data which could be realistically captured in the short to medium term**	**Suitability of a Focused Short Study of SCP**	**Realistic Opportunity to obtain funding for such a study**
Barbados	Catch and effort	Catch effort	Y	Y
Grenada	Catch and effort, catch by weight by species, length frequencies, maturity	Catch and effort, catch by weight by species, length frequencies	Y	Y
Jamaica	Catch and effort, catch by weight by species, length frequencies, maturity, stomach contents	Catch and effort, length frequencies, maturity	Y	N
Montserrat	Catch and effort, catch by weight by species, length frequencies	Catch and effort, catch by weight by species, length frequencies	Y	Y
St. Kitts and Nevis	Catch and effort, catch by weight by species, length frequencies, maturity	Catch and effort, catch by weight by species, length frequencies, maturity	Y	Y
St. Lucia	Catch and effort, catch by weight by species, length frequencies	Length frequencies	Y	Y
St. Vincent & the Grenadines	Catch and effort, Catch by weight by species, length frequencies	Catch and effort, Catch by weight by species, length frequencies	Y	
Suriname	Catch and effort, catch by weight by species, length frequencies, maturity	Catch and effort, catch by weight by species, length frequencies, maturity	Y	Y
Trinidad & Tobago	Catch and effort, Catch by weight by species	Catch and effort, Catch by weight by species	Y	N

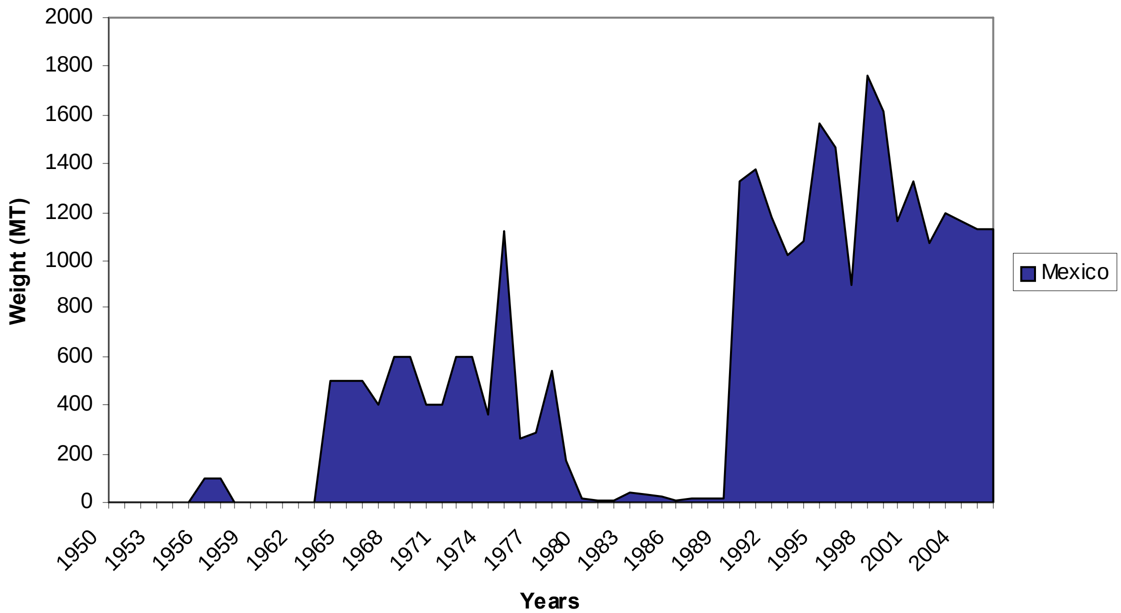

Figure 1. Annual catches of anchovies, by country (Source: FAO 2008).

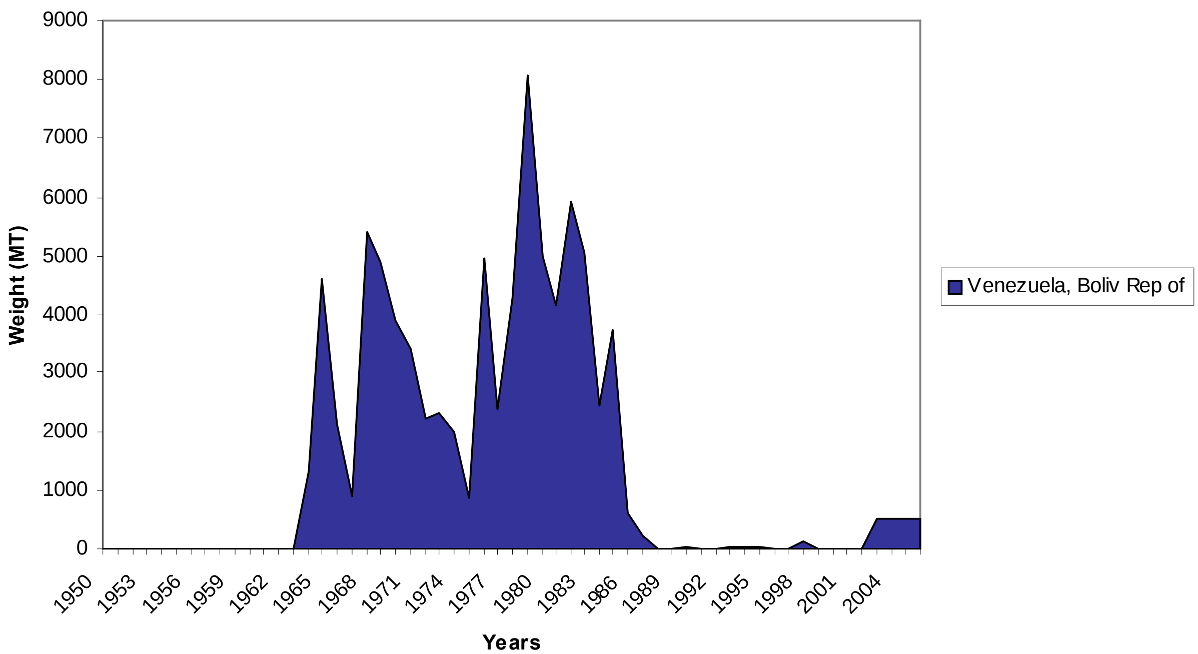

Figure 2. Annual catches of Atlantic Anchoveta, by country (Source: FAO 2008).

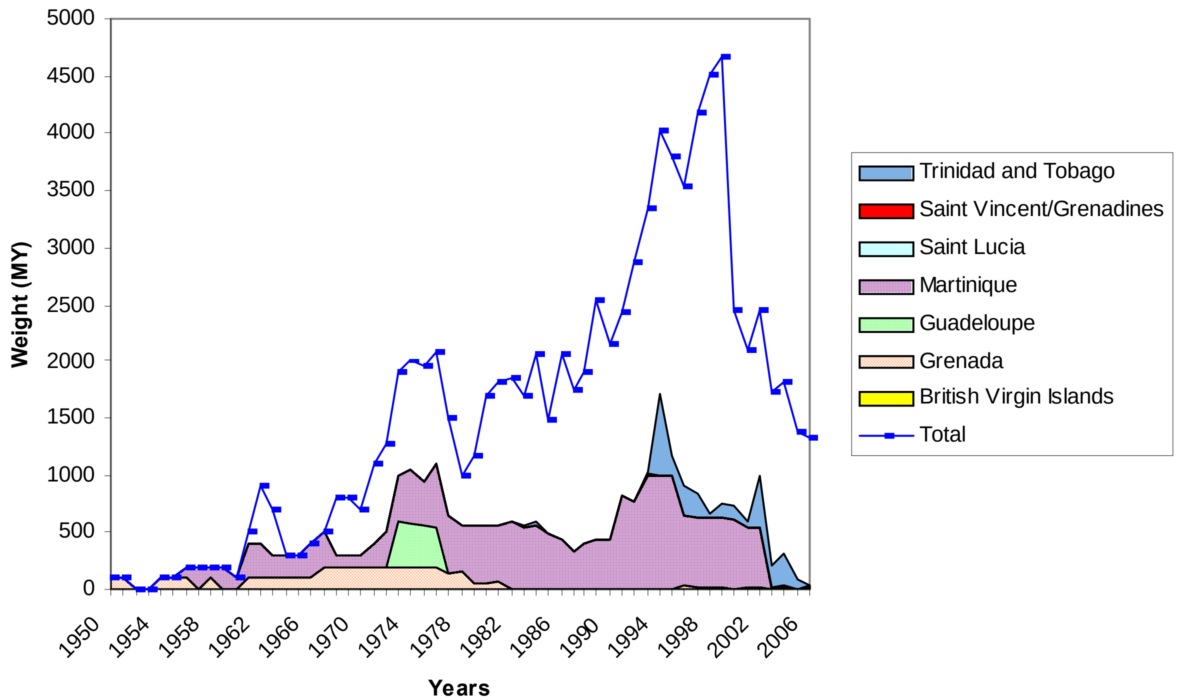

Figure 3. Annual catches of Atlantic Bonito, by country (Source: FAO 2008).

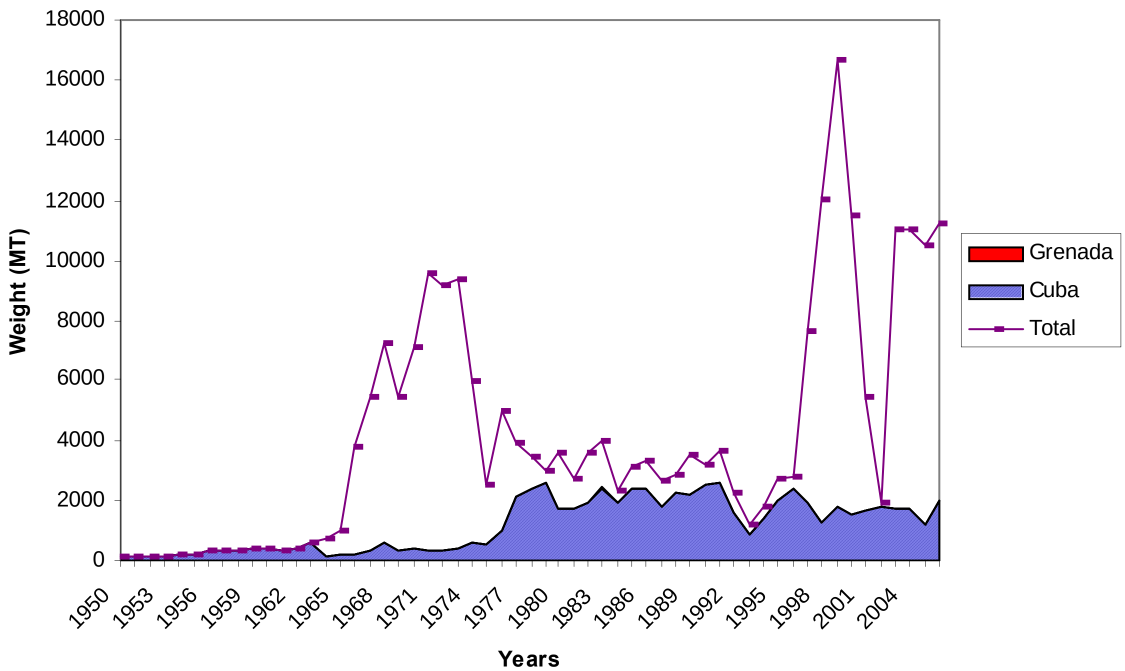

Figure 4. Annual catches of Atlantic thread herring, by country (Source: FAO 2008).

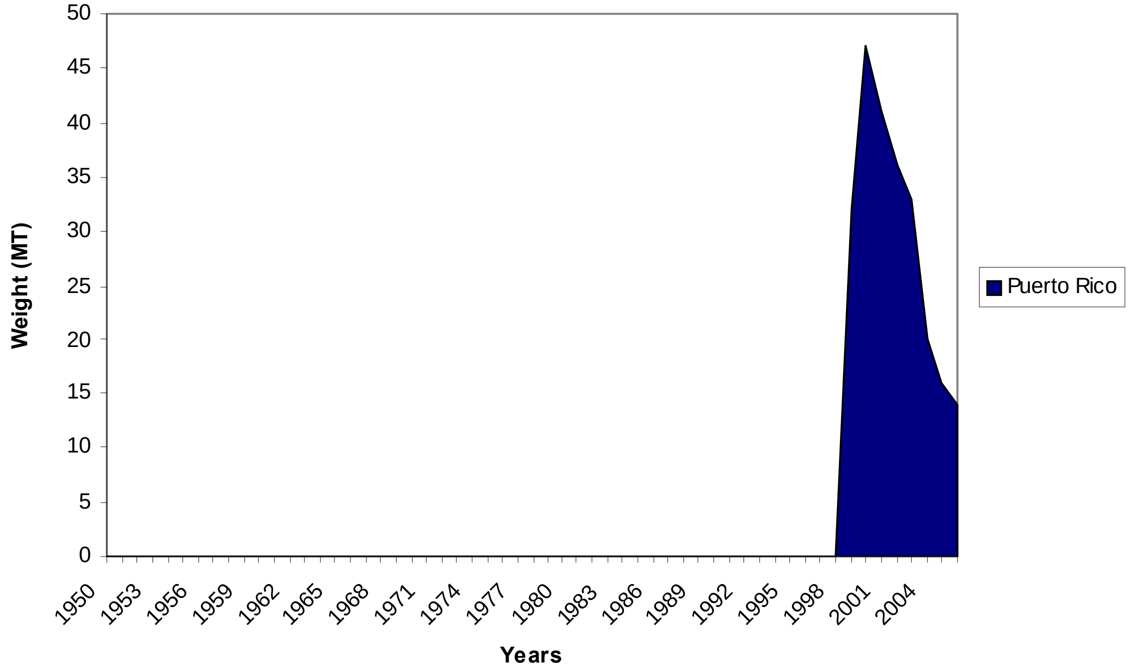

Figure 5. Annual catches of Ballyhoo halfbeak, by country (Source: FAO 2008).

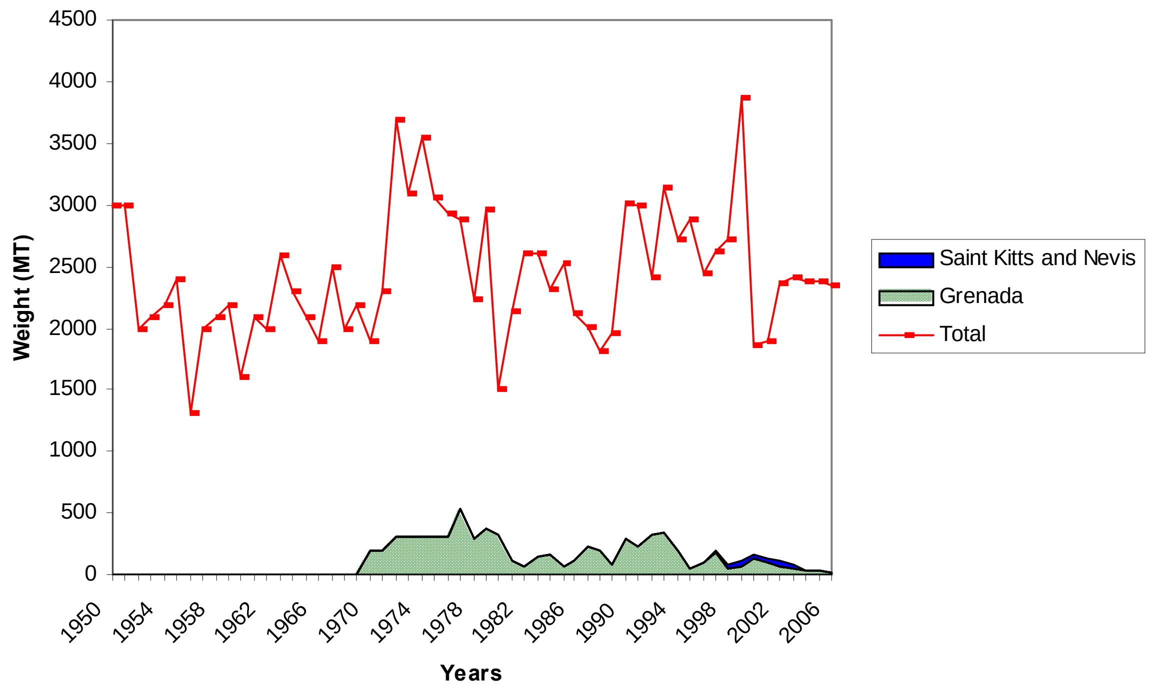

Figure 6. Annual catches of the big eye scad, by country (Source: FAO 2008).

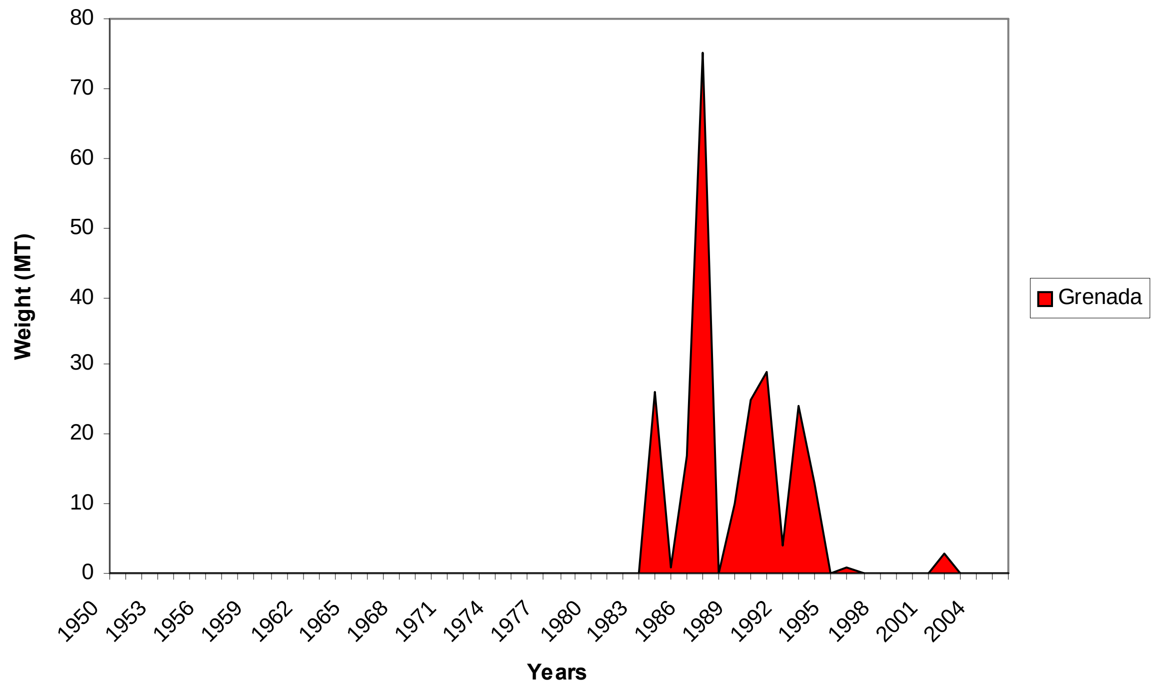

Figure 7. Annual catches of Brazilian sardinella, by country (Source: FAO 2008).

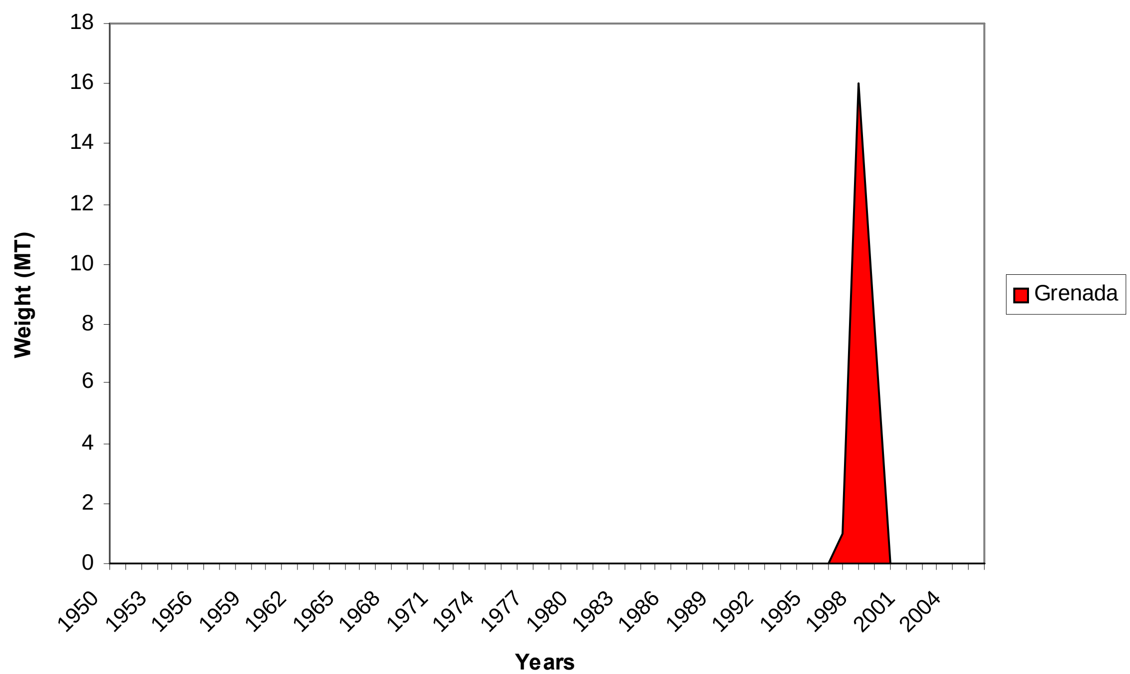

Figure 8. Annual catches of broad striped anchovy, by country (Source: FAO 2008).

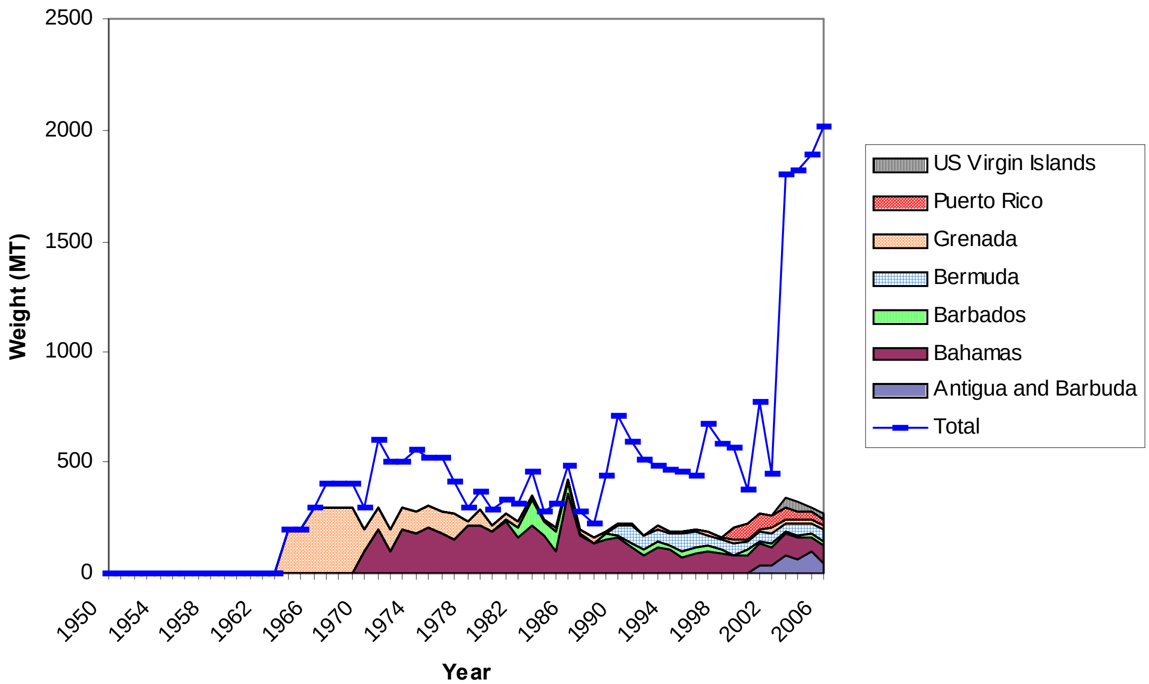

Figure 9. Annual catches of Carangids, by country (Source: FAO 2008).

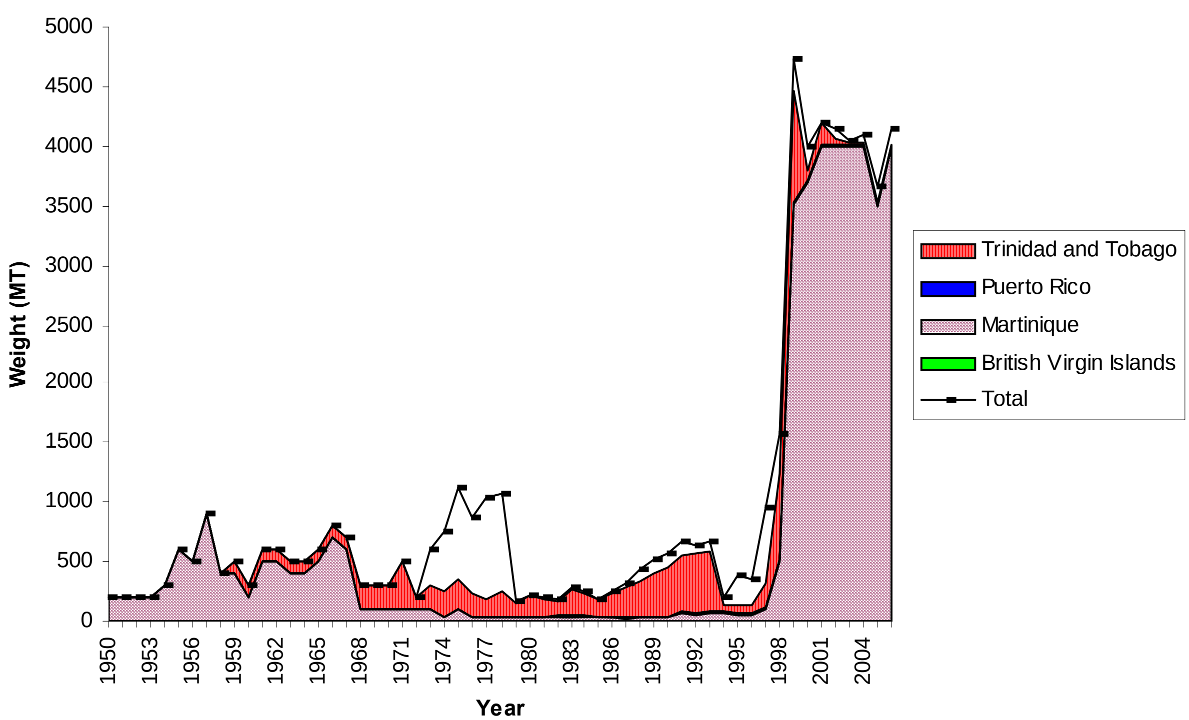

Figure 10. Annual catches of Clupeoids, by country (Source: FAO 2008).

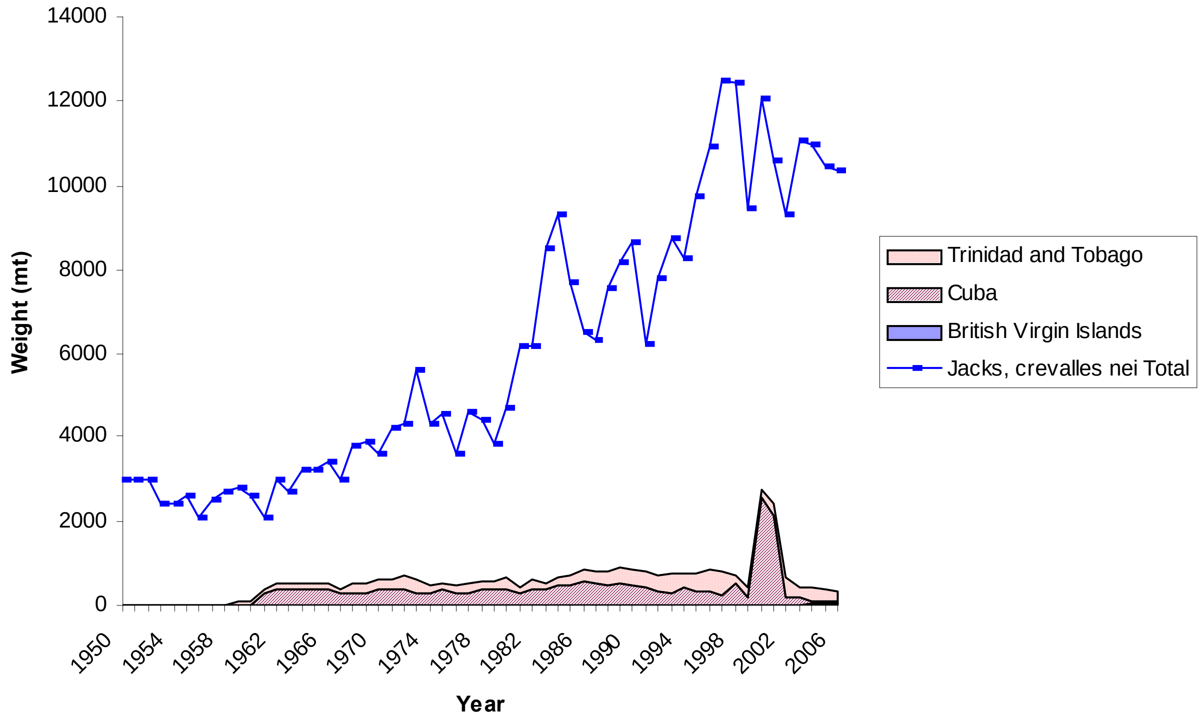

Figure 11. Annual catches of crevalle jack, by country (Source: FAO 2008).

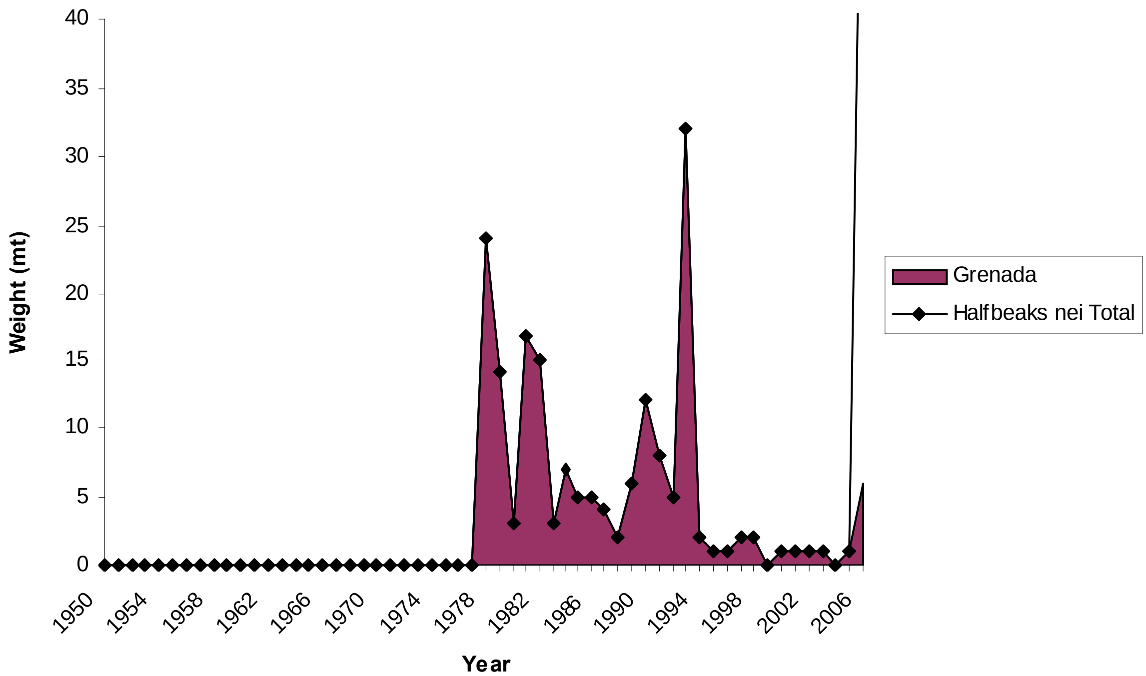

Figure 12. Annual catches of Halfbeaks, by country (Source: FAO 2008).

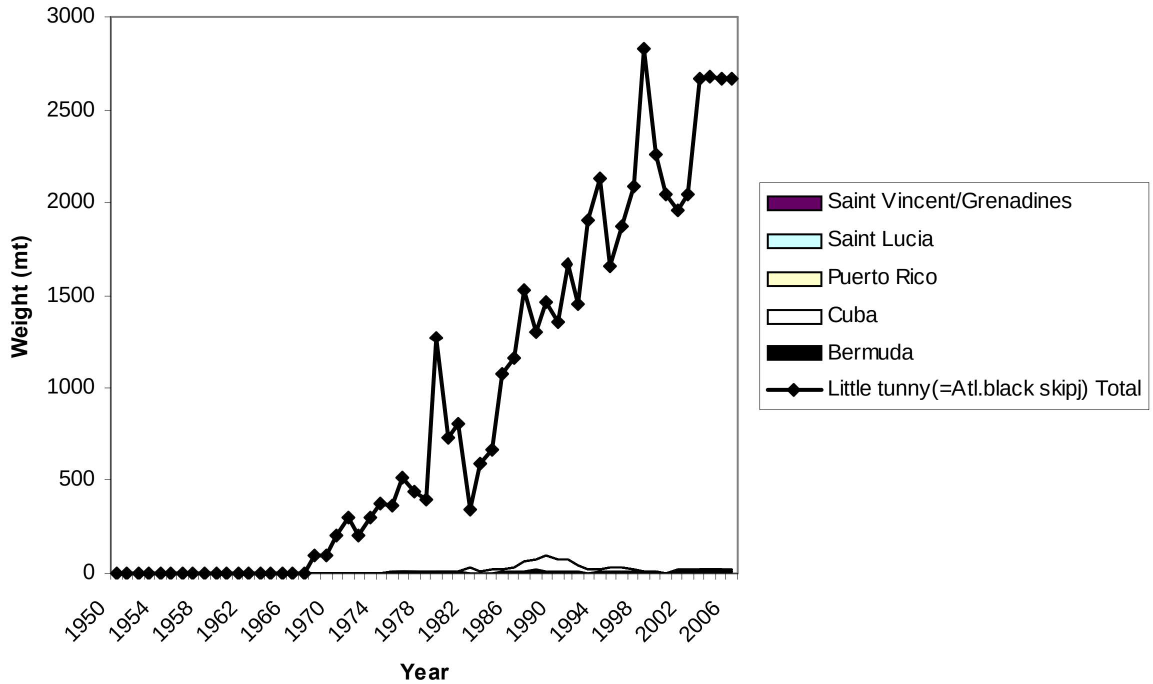

Figure 13. Annual catches of Atlantic black skipjack, by country (Source: FAO 2008).

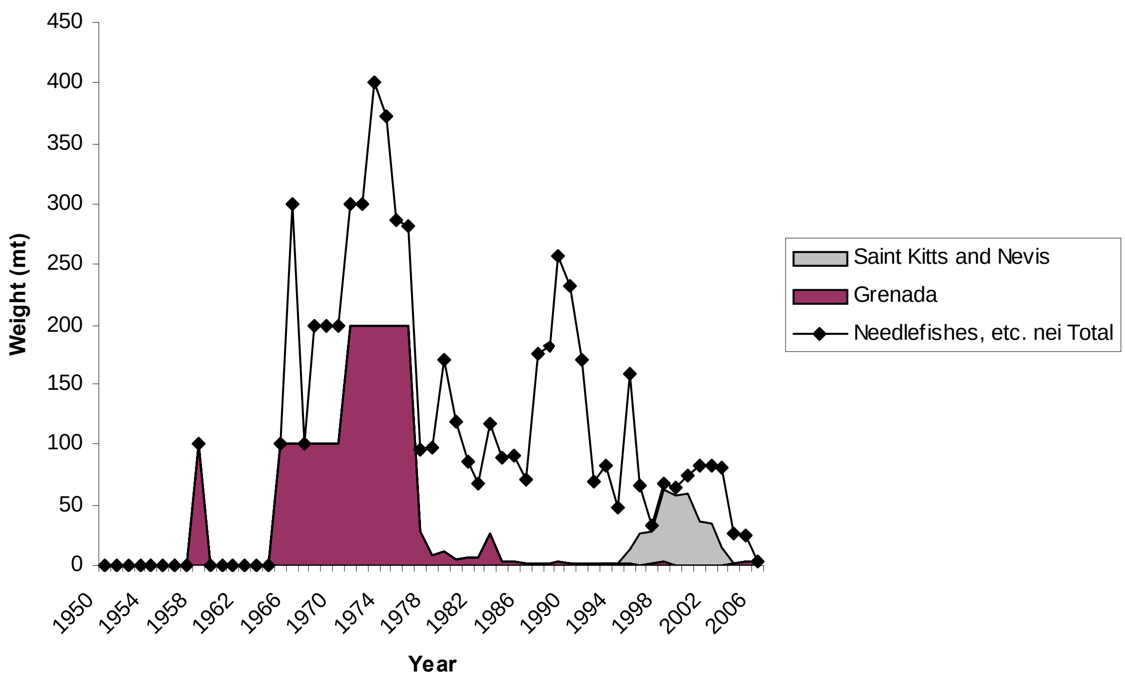

Figure 14. Annual catches of needlefishes, by country (Source: FAO 2008).

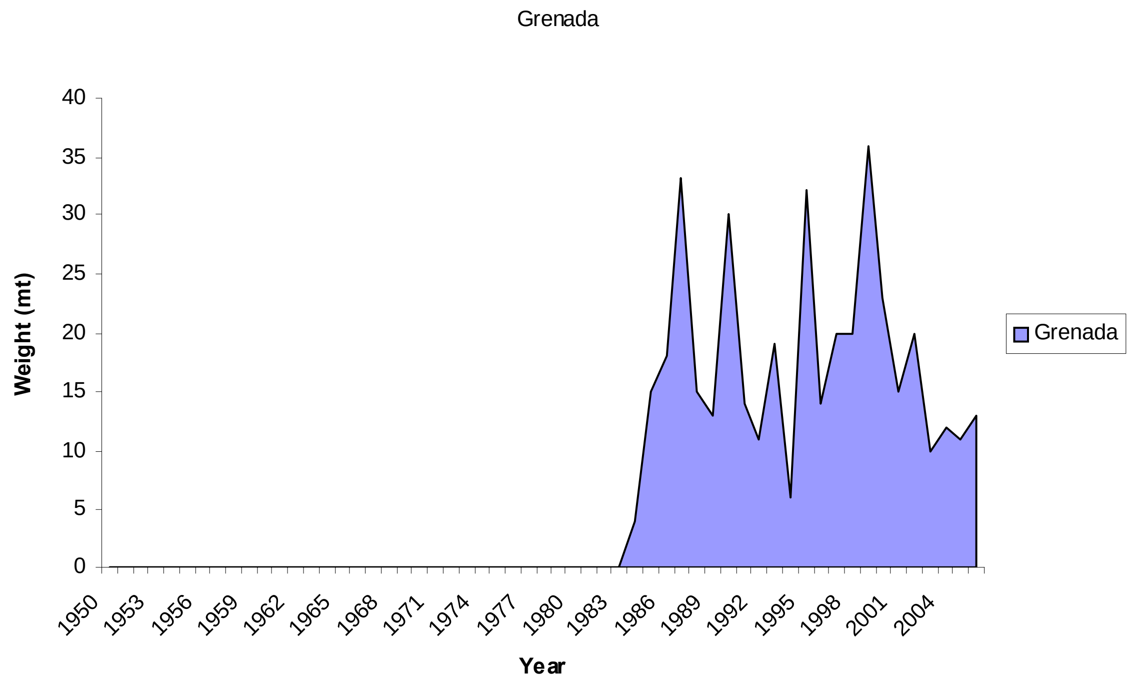

Figure 15. Annual catches of rainbow runner, by country (Source: FAO 2008).

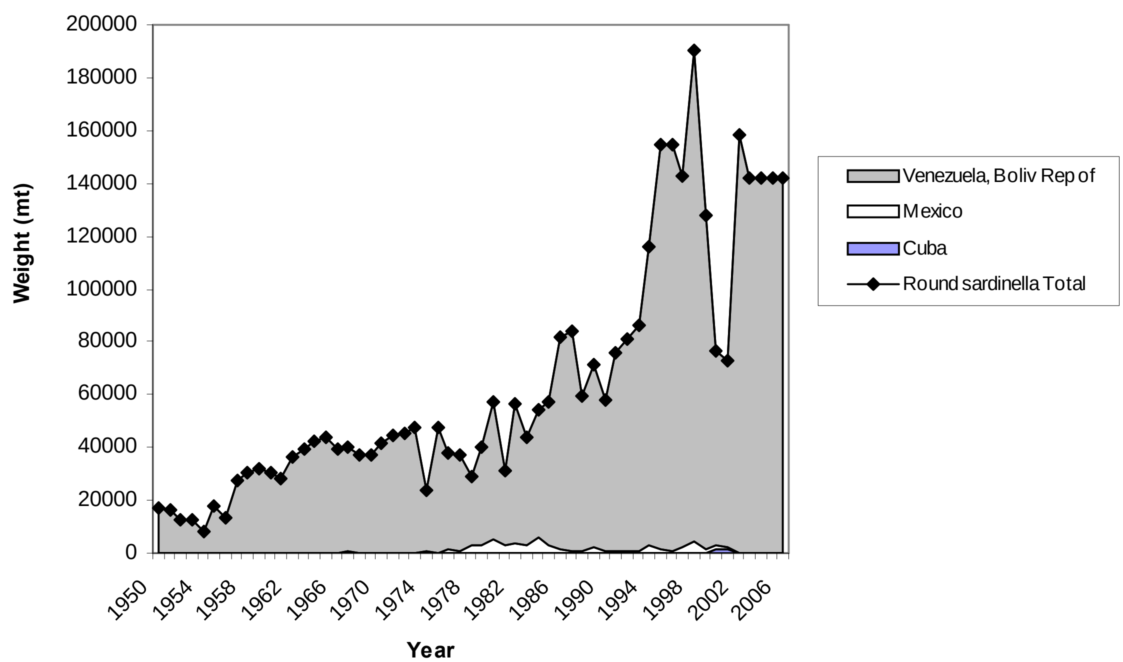

Figure 16. Annual catches of round sardinella, by country (Source: FAO 2008).

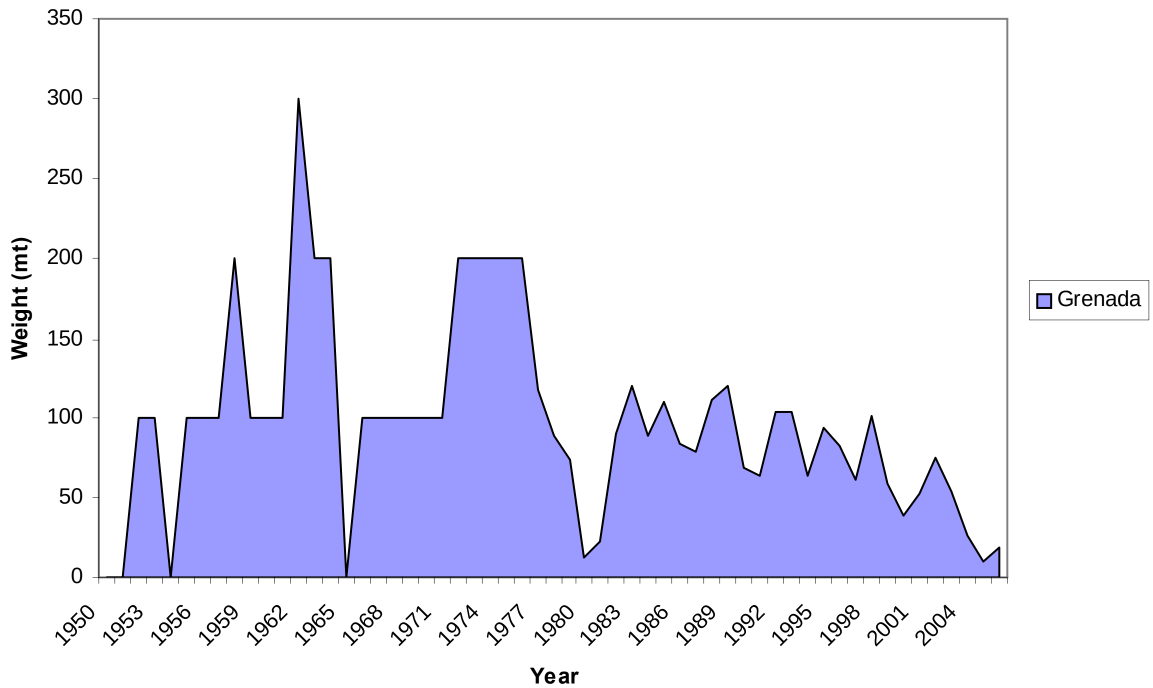

Figure 17. Annual catches of scads, by country (Source: FAO 2008).

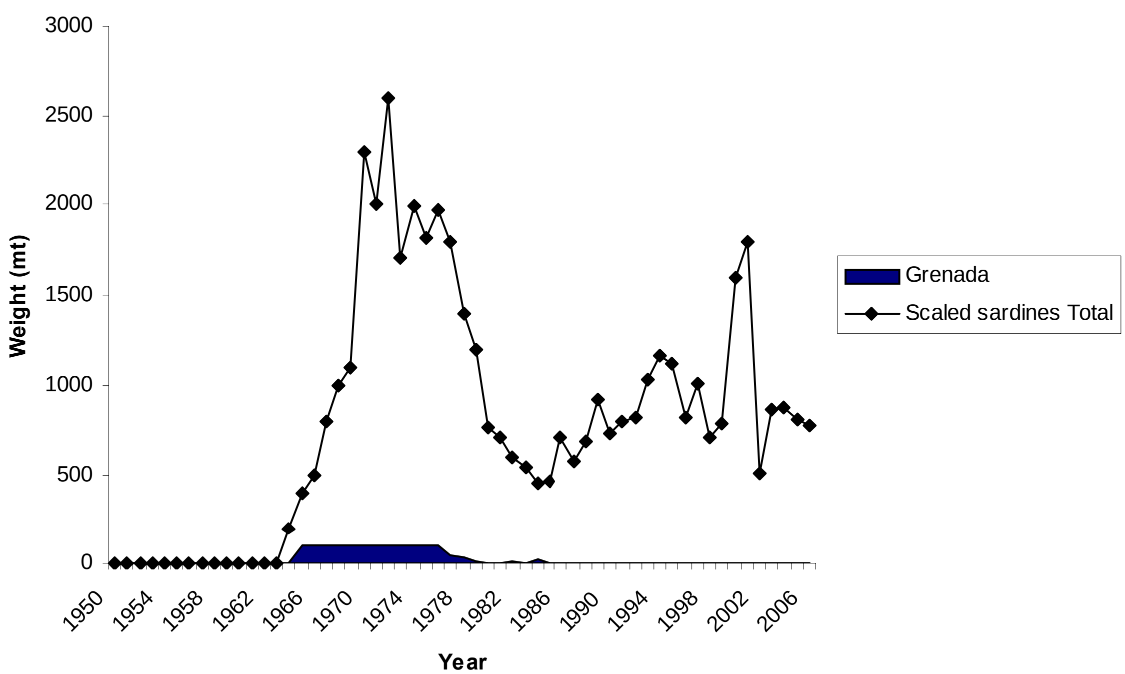

Figure 18. Annual catches of scaled sardines, by country (Source: FAO 2008).

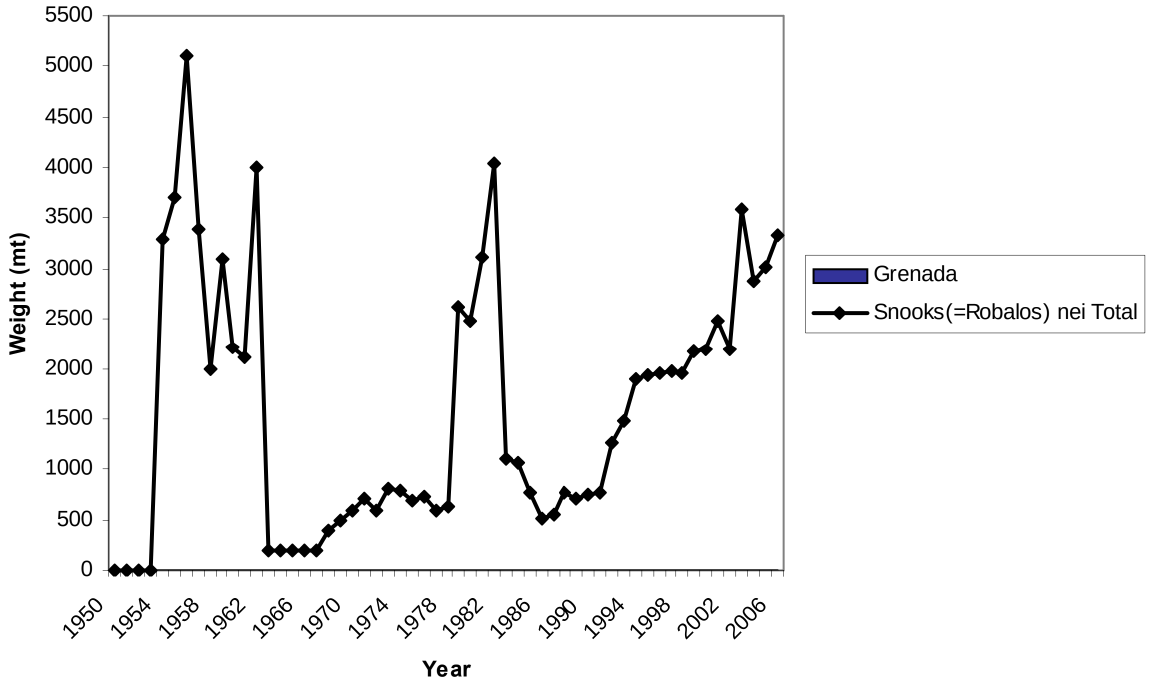

Figure 19. Annual catches of snook (Robalo), by country (Source: FAO 2008).

Addendum

DRAFT DATA/INTERIEW FORM FOR SCP FRAME SURVEY FOR RAPID ASSESSMENT OF THE FISHERY.

[This is a rough draft prepared for discussion among scientists. The aim of the survey is to quickly establish the universe of SCP fisheries in member states. This survey should be followed by another to determine socioeconomic dimensions of SCP fisheries. However, SVG may choose to include a socioeconomic component in this rapid assessment]

NAME OF INTERVIEWER………………………………………………

DATE………………………………….

LOCATION OF INTERVIEW………………………………………………

1. Name of interviewee …………………………………. Age [ ] 20 – 30 yrs [ ] 30 – 40 yrs [ ] 40-50 yrs [ ] over 50yrs
2. Name of vessel……………………………………………. Reg. #................................
3. Status in the fishery? [ ] Owner of gear [ ] owner of boat [ ] Captain [ ] Crew
4. [ ] Full time? [ ] Part time?
5. Base of operations?..
6. Area(s) of operations?...

FISHING UNIT

7. Type(s) of gear used? [ ] Beach seine [ ] Cast net [ ] Trawl [ ] Gill net [ ] Tuck seine [ ] Italian seine [ ]Fillet net [ ] Trammel net [ ] China net [ ] Other (please specify)

8. Boat type? [ ] Double ender? [ ] Pirouge? [ ] Trawler [ ] Launch

9. Power source? [ ]Outboard HP……….. [ ] Inboard HP…………..
[ ] Sail [ ]Oars

10. Persons involved? [ ] Captain Number of crew (core)? ……………..

FISHING EFFORT

11. Number of sets or trips per day? …………………
12. Number of days per week fished? ……………….

SEASONALITY

13. Months fished? ………………………………………………………….

14. Time of month for fishing?.......................................

15. Is fishing influenced by phases of the moon? [ ] Yes [ ]No

16. **Earliest** time of day for fishing? ……………AM. **Latest** time? ..…………….PM

DISPOSITION OF THE CATCH

17. What portion of the catch is sold locally ……….% , sent to the market ……….%, sold to
The wider community……….%, retained as crew share ……….%, retained as helpers'
Share …………%?

NOTES

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Appendix 7

Proposal for Establishment of a CRFM Working Group on Data, Methods and Training (Revised 20 June 2008)

Background and Rationale

The CRFM Ad Hoc Working Group on Methods was established in 2005 to devote specific attention to developing and testing assessment methods that could be applied to data-poor situations and that could make better use of the types and quality of data collected by CRFM countries. An on-site meeting of the Ad Hoc Working Group was convened once a year during the period 2005-2007. During its third and final meeting held in November 2007, the Ad Hoc Working Group reviewed its progress and recommended the establishment of a CRFM Working Group on Data and Methods, based on the following justification.

The Ad Hoc Working Group acknowledged the need to keep under continual review the assessment methodologies adopted and currently being applied, as well as the need to investigate new methodologies. Additionally, the advantage of examining data management issues and conducting assessment preparatory tasks was recognized. The Ad Hoc Working Group further noted the importance of ensuring opportunities for continued training, both formally and "hands-on ", and also for facilitating networking with other agencies, institutions, projects, etc., which are involved in addressing issues of interest to the Working Group.

Terms of Reference

The following are the terms of reference for the CRFM Working Group on Data and Methods.

- Keep under review recommendations to improve data collection required to facilitate assessments during the Annual Scientific Meetings.
- Keep under review data management and fishery assessment methodologies, with emphasis on those that are suitable for application to Caribbean fisheries.
- Keep under review agreed criteria for evaluating the performance and suitability of data management and fishery assessment methodologies proposed and utilized.
- Keep under review recommendations on data management and assessment methodologies.
- Facilitate data preparatory tasks requested during the Annual Scientific Meetings.
- Facilitate training opportunities to improve understanding and application of the methodologies proposed.
- Consider and pursue additional tasks pertaining to the development and application of data management and fishery assessment methodologies, including establishment and execution of a communications plan.
- Document findings in meeting reports, and present findings to the Annual Scientific Meetings.
- Collaborate with other agencies and institutions with similar and related interests.

Mode of Operation

The CRFM Secretariat will be responsible for coordinating the activities of the Working Group. The Working Group is expected to carry out tasks inter-sessionally, so as to ensure timely delivery of outputs, as well as their quality.

The Working Group, through the CRFM, will work closely with staff of national and regional institutions, and also regional organizations such as OECS and FAO (WECAFC), in order to make full use of available technical expertise. In addition, the CRFM will promote collaboration with scientists from non-CRFM countries to secure the inclusion of their inputs.

Membership of the Working Group & Participation

CRFM Member States will be members of the Working Group. Countries and organizations that have observer status with the CRFM will be invited to participate in the meetings.
Scientific representatives, from research institutions and organizations and who are working on issues of interest to the Working Group, will be invited to participate in the activities of the Working Group.

Working Group Meetings

An on-site meeting of the Working Group will be convened as required by the annual scientific meetings. The annual scientific meetings will identify the specific tasks to be addressed, in accordance with the Terms of Reference noted above.

The Working Group will also utilize available internet services to facilitate discussions and other activities, as deemed appropriate.

Appendix 8

Summary of: The FAO Lesser Antilles Pelagic Ecosystem Project

The FAO project: "Scientific basis for ecosystem-based management in the lesser Antilles including interactions with marine mammals and other top predators" (GCP/RlA/140/JPN) ended in 2007. It was more commonly referred to as the Lesser Antilles Pelagic Ecosystem project, or LAPE project; it developed the scientific basis (data, models and recommendations) for future management plans for an ecosystem approach to sustainable and responsible utilization of these pelagic resources. The project also assisted the participating countries develop research and management capacity with the skills to use ecosystem assessment for responsible management beyond the life of this project. In this way the scientific understanding developed within the LAPE project can be brought to bear on emerging global and regional issues that will have ecosystem effects. Examples could include issues such as the ecosystem effects of climate change or the impacts of population recovery of top predators such as cetaceans. This report reviews the main activities, results and conclusions of the LAPE project.

Appendix 9

The ECOST methodology: an integrated approach of social, economic and ecological systems

The ECOST project[7] aims to develop a methodology to assess the societal costs and benefits of fishing activity at metier level. The societal costs and benefits are defined to consist of social, economic and ecological costs and benefits. The economic costs and benefits of fishing activity are traced along the production chain of fisheries that is from fish harvesting to processing and to marketing. The economic costs and benefits are not calculated in isolation of social and ecological systems. Rather, this research develops an integrated framework in which the three systems are interactively related each other. The linkage between social and economic systems is made through income distribution. The linkage between economic and ecological systems is made through changes in biomass stock. And, the linkage between social and ecological systems is considered to be made through environmental problems and protections.

Fishing activity means a cost to the ecological system if it removes biomass stock at a scale beyond nature's ability to recover. As biomass stock declines, catching as same amount of fish as before will require more fishing effort. In this sense, the ecological system in turn induces additional cost to the fishing activity. Both of the two types of costs are related to the ecological system, but they are different by nature. The former measuring the damage to the natural system can be regarded as the ecological cost, while the latter should be taken as the indirect economic cost caused by ecological system. However, if fishing activity does not affect the natural state of biomass stock, the ecological system will offer a net benefit to the activity.

The impact of fishing activity on social system involves much complexity, but can in principle be analyzed through employment, income generation and distribution, and spending. On one hand, fishing activity creates fisheries jobs for households and provides fish products for consumption; on the other hand, fisheries incomes are relatively low on average particularly in the developing economy and unevenly distributed among earners, causing a number of social problems such as poverty, food insecurity, poor health care, less education, and others. Some social issues such as social relations, personal security, freedom and choice, etc are related to fisheries as well but not based on income or cannot be measured directly in economic value. In this research we focus on the income-based social problems and assess social costs and benefits through the changes in income level and distribution induced by fishing activity.

The costs and benefits of the social, economic and ecological systems are conceptually different, some can be directly measured in value, some not. Conventionally, economic costs and benefits are measured in monetary term, social costs and benefits in various types of relative indicators, and ecological costs and benefits in quantitative changes of species. However, from policymaker's point of view, it is often convenient and desirable to have a tool to compare all fishery-related costs and benefits in a common unit. Recently, a goods & services approach emerges to describe inter flows among ecosystem, economy and society (Millennium Ecosystem Assessment, 2003). According to the approach, ecosystem, economy and society each produces its goods and services and provides them for other two's use, which has value and can be measured with a number of valuation methods. The present research adopts the approach to measure the societal costs and benefits of fishing activity in value, which involve the measurement or conversion of social and ecological costs and benefits in monetary term.

[7] Funded by the EU.

Appendix 10

Stock Assessment Course by the University of the United Nations - Fisheries Training Programme (UNU-FTP)

The UNU-FTP is part of the UNU network of academic training and research institutions engaged in research, postgraduate training and disseminations of knowledge in furtherance of the purposes and principles of the Charter of the United Nations. The UNU-FTP has capacity in areas of interest that coincide with those of the CRFM which can provide synergy with, and add value to the work of both CRFM and UNU-FTP.

The UNU-FTP has identified the Caribbean as a suitable region to offer its assistance in fisheries and to promote cooperation between Iceland and the CARICOM Member States. Several training opportunities targeting various areas of fisheries are being explored at present, including the development of a course in fisheries statistics/ stock assessment for the CRFM countries (1 or 2 courses) to be held in the region.

The UNU-FTP expects to commence work on development of the proposed stock assessment course later in 2008, with inputs from CRFM and UWI/CERMES.

Appendix 11

A Proposal
For a Training Workshop on Data Collection for Large Pelagic Fishes in the Caribbean Region

Background

The International Commission for the Conservation of Atlantic Tunas (ICCAT) is responsible for data compilation, assessment and management of tuna and tuna-like species in the Atlantic Ocean. In recent years, ICCAT has conducted regional training workshops in South America and western Africa aimed at capacity-building for collection of fisheries data, as well as improved awareness of the reporting requirements by ICCAT. This proposal is for an additional training workshop in the Caribbean region. ICCAT would cover the travel and subsistence costs for participants and instructors.

Items to be covered

1. Major ICCAT species:
    - Historical catches and distribution;
    - Status;
    - Identification
2. Sampling for fisheries data
    - Port sampling
    - At sea sampling with observers
    - Logbook systems
    - Other approaches
3. Characterization of large pelagic fisheries in Caribbean countries
4. ICCAT requirements on data reporting
5. Filling out ICCAT forms for data submission

Time and Venue

The Workshop would last five full days and would be held sometime between December 2008 and April 2009. A possible venue is Guyana

Target participants

The workshop should be limited to 10 participants from ICCAT Contracting Parties or Cooperating Parties. Participation by scientists from other countries may be considered if space is available, but their costs would not be covered by ICCAT. The Workshop will be conducted in English.

Appendix 12

FLR – a flexible open source modeling framework for management strategy evaluation

The FLR framework is a flexible open-source modeling framework that allows the development and implementation of a variety of fishery, biological and economic models. A main objective is to allow the evaluation of alternative management strategies and procedures for their robustness to uncertainty, prior to implementation. FLR can also be used to perform exploratory data analysis and develop population parameter estimates as well as perform stock assessments. All of this can be done in either a frequent or Bayesian framework. In addition, FLR is currently being extended to incorporate mixed fisheries, multispecies and ecosystem and economic models.

The seminar aims to provide participants with an understanding of the FLR framework, its uses in fisheries research, stock assessment and management, and examples of its application around the world. At the end of the seminar, attendees with a background in modeling will be able to use the FLR training programme to develop their own applications for fisheries.