CRFM Fishery Report - 2009

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Report of Fifth Annual CRFM Scientific Meeting - Kingstown, St.Vincent and the Grenadines, 9-18 June 2009

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Foreword

The Fifth Annual Scientific Meeting took place during 09-18 June, 2009. During this Meeting, CRFM Resource Working Groups examined data from the following fisheries: the spiny lobster (*Panulirus argus*) fishery of Jamaica; the queen conch (*Strombus gigas*) fishery of St. Lucia; the red hind (*Epinephelus guttatus*) and queen triggerfish (*Balistes vetula*) fisheries of Montserrat; the beach seine fishery of St. Vincent and the Grenadines; the shrimp trawl fishery of Trinidad and Tobago; and the Atlantic Seabob (*Xiphopenaeus kroyeri*) fisheries of Guyana and Suriname. The report of the assessment of Eastern Caribbean fourwing flyingfish (*Hirundichthys affinis*), completed by WECAFC in 2008, was also reviewed and acknowledged.

Additionally, the characteristics of the finfish and conch fisheries of the Turks and Caicos Islands and Nevis (of St. Kitts and Nevis) respectively were examined to make specific recommendations for improving sampling of these fisheries in the future. The LPWG did not undertake any assessments in 2009, but completed several tasks, of which the main ones were: preparation of 3 technical reports for consideration by ICCAT's Standing Committee on Research and Statistics, and development of a monitoring and management plan for the finfish fisheries of the Turks and Caicos Islands.

An informal meeting of the Working Group on Data, Methods and Training was held, during which current issues pertaining to each of the three areas (data, methods, training) were discussed, and key inter-sessional tasks were identified, as well as the need for basic training in R (statistical software) to be pursued at the next meeting of the Working Group. At the request of the Executive Committee of the Caribbean Fisheries Forum, the proposal to establish a CRFM Scientific Committee was also reviewed and finalized by the Meeting.

The Report of the 2009 CRFM 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 2009. Six national reports were submitted for consideration by the 2009 Meeting, and these are published as Supplement 1 to Volume 1. Volume 2 contains part A (Overview), and the fishery management advisory summaries of individual fishery reports comprising part B of each Working Group report, where relevant. 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.

Contents

List of Acronyms and Abbreviations

ACP	-	African, Caribbean and Pacific states
ANOVA	-	Analysis of Variance
CARICOM	-	Caribbean Community
CARIFIS	-	Caribbean Fisheries Information System
CERMES	-	Centre for Resource Management and Environmental Studies
CFF	-	Caribbean Fisheries Forum
CFRAMP	-	CARICOM Fisheries Resource Assessment and Management Programme
CLWG	-	Conch and Lobster Resource Working Group
CPUE	-	Catch Per Unit of Effort
CRFM	-	Caribbean Regional Fisheries Mechanism
CSC	-	CRFM Scientific Committee
DANIDA	-	Danish International Development Agency
DMTWG	-	Data and Methods Working Group
FAD	-	Fish Aggregating Device
FAO	-	Food and Agriculture Organization of the United Nations
GDP	-	Gross Domestic Product
GLM	-	General Linear Model
ICCAT	-	International Commission for the Conservation of Atlantic Tunas
IMA	-	Institute of Marine Affairs
INSOPESCA	-	Instituto Socialista de la Pesca y Acuicultura
IUU	-	Illegal, Unreported and Unregulated fishing
LAPE	-	Lesser Antilles Pelagic Ecosystem Project
LPWG	-	Large Pelagic Fish Resource Working Group
MCMC	-	Monte Carlo Markov Chain Methods
MPA	-	Marine Protected Areas
MS	-	Microsoft
MSC	-	Marine Stewardship Council
MSY	-	Maximum Sustainable Yield
MT	-	Metric Tonne
NMFS-SEFSC	-	National Marine Fisheries Service – South East Fisheries Science Center
NOAA		National Oceanic and Atmospheric Administration
RSF	-	Reef and Slope Fish
RSWG	-	Reef and Slope Fish Resource Working Group
SCPWG	-	Small Coastal Pelagic Fish Resource Working Group
SEDAR	-	Southeast Data, Assessment and Review Process
SGWG	-	Shrimp and Groundfish Resource Working Group
STATIN	-	Statistical Institute of Jamaica
TCI	-	Turks and Caicos Islands
TIP	-	Trip Interview Programme
UNDP	-	United Nations Development Programme
UNU-FTP	-	United Nations University – Fisheries Training Programme
USA	-	United States of America
USVI	-	United States Virgin Islands
UWI	-	University of the West Indies
WECAFC	-	Western Central Atlantic Fishery Commission
YPR	-	Yield Per Recruit

1. Opening of the Meeting

The Opening Ceremony commenced at 9.15 a.m. and was chaired by Mr. Leslie Straker, Senior Fisheries Officer from St. Vincent and the Grenadines.

Mr. Raymond Ryan, Chief Fisheries Officer for St. Vincent and the Grenadines, welcomed participants and addressed them on the issue of the importance of fisheries and its contribution to human and social well-being. Mr. Ryan highlighted the implications for developing states with regard to the emergence of a new legal ocean regime, and the key roles of science, the CRFM and the CRFM annual scientific meetings in helping the region to meet these challenges successfully. He took the opportunity to commend the CRFM's contribution in assisting Member States to achieve good fisheries management practices and in nurturing regional collaboration in this regard. In addition, Mr. Ryan recognized the sustained effort to ensure the continuation of the annual scientific meetings since 2004.

The feature address was delivered by the Minister of Agriculture, Forestry and Fisheries, St. Vincent and the Grenadines, Mr. Montgomery Daniel. Minister Daniel noted that the work of the CRFM Resource Working Groups was critical to ensuring sustainable fisheries development in the region. Minister Daniel further noted that his government was encouraged by the wide range of activities and achievements of the annual scientific meetings, and he acknowledged the recent CRFM-assisted studies completed for the national spiny lobster and beach seine fisheries. The meeting was also apprised of the progress of recent and ongoing fishery projects in St. Vincent and the Grenadines, including several development projects such as the national fleet expansion programme and the completion of the Owia fisheries complex on the north-east coast. Minister Daniel recalled the tasks to be undertaken during the present scientific meeting, and indicated that he was looking forwarded to the availability of the outputs for informing the management process in the near future.

Dr. Susan Singh-Renton addressed the meeting on behalf of the CRFM Secretariat. Dr. Singh-Renton took the opportunity to highlight the continuing commitment of the CRFM in ensuring that the region's scientific methodologies kept pace with evolving fisheries management needs, particularly: the need for regional coordination in the case of shared resources, the need to take into account the ongoing impacts of climate change and to implement the ecosystem approach to fisheries. She pointed out the opportunities afforded by developments within the CRFM that sought to facilitate more detailed consideration and debate of the scientific outputs by the Caribbean Fisheries Forum, and the recent decision by the CRFM Ministerial Council to hold separate meetings for more extensive deliberations on policy and management matters at the regional level. The need for making use of the opportunities available through the mandates and ongoing activities of related agencies and institutions was also emphasized. In closing her address, Dr. Singh-Renton also offered a vote of thanks.

2. Adoption of meeting agenda and meeting arrangements

Mr. Leslie Straker served as the Meeting Chairperson. The representative from FAO requested an opportunity to make a presentation on the Magadalesa (Moored Fish Aggregating Devices in the Lesser Antilles) Project that was being coordinated by the WECAFC Working Group on FADs. It was agreed that this presentation would be accommodated under agenda item 8, and the Meeting agenda was then adopted with this modification (Appendix 1).

3. Introduction of participants

Participants were invited to introduce themselves.

The following Member States were in attendance at this year's meeting: Dominica, Grenada, Guyana, Jamaica, Montserrat, Nevis (of St. Kitts and Nevis), St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, and Turks and Caicos Islands.

Observers in attendance were from: Institute of Marine Affairs (IMA), University of the West Indies (UWI) (Cavehill and St. Augustine Campuses), National Marine Fisheries Service - South East Fisheries Science Center (NMFS SEFSC), International Commission for the Conservation of Atlantic Tunas (ICCAT), Food and Agriculture Organization (FAO).

A list of participants is provided in Appendix 2.

4. Presentation of national (country) reports

National reports were submitted by Grenada, Guyana, Jamaica, St. Lucia, Montserrat, and the Turks and Caicos Islands. These reports are published as Supplement 1 to this report.

5. 2009 Reports of the CRFM Fishery Resource Working Groups

5.1 Conch and Lobster Resource Working Group (CLWG)

Chairperson: Anginette Murray
Kimberlee Cooke and Anginette Murray (Jamaica); Shawn Isles (Nevis); Allena Joseph (St. Lucia)
John Hoenig (Consultant); Paul Medley (Consultant); June Masters (CRFM Secretariat)

A. Overview

Three countries (Jamaica, Saint Lucia and Nevis) attended the meeting. There were no representatives from the other countries that indicated in the 2008-09 work plan that they would participate.

During the inter-sessional period discussions were held with the members of the CLWG to determine the work plan for this year's scientific meeting with the view of conducting regional assessments. The following summarizes the discussions held before and during the meeting.

<u>Regional Assessments</u>
Two approaches were proposed:

1. One approach was to seek to answer a truly region wide question involving the analysis of combined data or
2. More individualized approach geared towards separate analyses answering the same question for each country.

Proposed problems with regional assessment included:

- Previous attempts to do regional assessments such as at the WECAFC level, resulted in more summary type analyses such as summaries of the total landings of the various so called stocks
- Many of the countries that make up the CRFM are believed to be in different lobster stocks. Consequently, in depth scientific analysis of the combined data would therefore not be very meaningful. In addition, data from the non-CRFM countries would be integral as part of such in depth analysis.

The Working Group noted that conch and lobster are not highly migratory species and the different countries appear to have distinct stocks (although recruitment in some areas may be dependent on dynamics in other ("source") areas). Consequently, integrated models of conch or lobster populations over large geographical scales do not appear appropriate.

The Working Group further notes that a wider view of assessment to include approaches used in other countries is helpful. Currently, three approaches seem to be evolving: 1) using abundance surveys as a means for judging stock status and choosing management measures, 2) using a series of catch and effort data to fit biomass-dynamic (surplus production) models, and 3) combining abundance surveys and catch rate data so that a) catch rates can be converted into estimates of abundance, and b) abundance estimates can be incorporated in biomass-dynamic models. For each approach, information from other countries can be useful. Examples are given below.

There are advantages in sharing experiences with, and information on, the design and analysis of abundance surveys using scuba diving. This can make the design and implementation of new surveys easier and improvements in design or methods can be shared. It may also be possible to share personnel for surveys.

It is difficult to establish a reliable biomass-dynamic model when the time series of observations is short, particularly when fishing effort has not varied much over the course of the time series. One way around this is to incorporate prior information into the model. To do this, experiences in other countries are used to formulate likely values for parameters which are then incorporated into the model as prior distributions. Thus, comparative studies of conch and lobster population dynamics in different areas would be useful.

Comparative data from different countries have other important uses. For example, one might ask what levels of biomass density appear sustainable and what levels have led to stock crashes based on the collective experiences of all countries. Similarly, the question of what levels of exploitation are reasonable can be approached through comparative studies of dynamics across countries.

Therefore, the Working Group proposes that a regional approach to assessment should focus on comparative studies of population dynamics and on development of generally applicable methodology.

<u>Work Attempted</u>
Given the constraints that existed, the CLWG was not able to conduct regional assessments as envisaged. Instead the focus once again was on individual assessments and making plans for the upcoming year. Analyses completed at the current meeting included the establishment of the tail length that corresponds to the legal minimum carapace length incorporated in the legislation for Caribbean spiny lobster for Jamaica. Nevis reviewed existing landings data while designing a sampling plan. Jamaica updated the surplus production model for lobster and Saint Lucia updated the production model for conch.

Recommendations made by the CLWG are as follows:
<u>Research Recommendations</u>

1. Jamaica: Conch
    a. Compile and verify all data on catch, effort, and catch rate, with particular reference to units and conversion factors.
    b. Estimate catchability coefficient from several years of survey and landings data.
    c. Estimate exploitation rate from the survey data and landings
    d. Estimate survival rate from the 2007 survey data and landings
    e. Create a simple model of conch population dynamics based on total catch and two survey estimates (requires access to 2007 survey data)
    f. Explore use of biomass dynamic models. In particular, inquire as to why the original biomass dynamic model was not developed further.

2. Jamaica: Lobster.
    a. 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.
    b. Obtain missing catch and CPUE data for the periods 1982-3, 1990, completing the time series used in the most recent assessment and check the CPUE data for errors.
    c. 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.
    d. Obtain size compositions from tail measurements within the size categories.

3. St. Kitts and Nevis: Conch.
    a. Compile all available fisheries data for conch. Perform quality control checks, and integrate the data from Nevis and St. Kitts. In particular, for the landings data there appear to be problems with year and with units.

    b. Consider the impact of a suite of possible management actions to reduce fishing mortality, with respect to
        - Enforceability
        - Effectiveness
        - Impact on the industry

    c. Monitor the resource through annual abundance surveys based on scuba diving to count conch along transects. These surveys will document distribution and abundance of conch by size class and can be used to track changes in the population over time. Abundance surveys also offer the possibility of estimating
        - Exploitation rate
        - Annual survival rate
        - Recruitment to the fishery (and thus a forecast for the next year)

    d. Monitor catch and effort for at least a portion of the fishery as a means of monitoring relative abundance.

    e. Determine the value of the catchability coefficient, so that commercial catch rates can be converted into estimates of stock abundance. This requires surveys be conducted to estimate abundance.

4. Saint Lucia: Conch.
    a. Conduct a visual survey to fine tune the conch assessment study previously done.
    b. Map habitat for both fished and non fished areas.
    c. The collection of catch and effort data on the conch fishery should be continued and should include depth estimates.

<u>Other recommendations</u>

1. Further training on basic analytic and data handling skills is needed, in particular the use of pivot tables in Excel and the R statistical language. 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

2. 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.

3. 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.

4. 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.

5. 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.

6. 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.

7. 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 the requirements prescribed by such organizations should first be addressed by the Caribbean Fisheries Forum.

8. 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.

Proposed workplan for Sixth CRFM Scientific Meeting

Due to the limited countries represented at this year's meeting the Working Group proposes to do some work in the inter-session, as follows.

- Correspond with member states to develop workplan
- Prepare for training in R at the next Scientific Meeting by having participants download R and Tinn-R prior to the meeting. Consultant will prepare detailed instructions and assist scientific officers in the member states.
- Examine the socio-economic data from Saint Lucia
- Develop specific plans for a transect survey of conch abundance in St. Kitts and Nevis and in Saint Lucia.

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 Sixth CRFM Scientific Meeting are noted below.

- Analyze conch survey data from St. Kitts and Nevis if survey has been completed
- Analyze conch survey data from Saint Lucia if survey has been completed
- Analyze Jamaica conch survey data from 2007, as well as biological data, if prepared and available.

Other topics may be identified during the inter-session.

B. Fishery Reports

5.1.1 Spiny Lobster (*Panulirus argus*) fishery of Jamaica

5.1.1.1 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"

5.1.1.2 Status of Stock

An update of the previous year's assessment was carried out on the industrial lobster fishery of the Pedro Bank. The results, due to limitations of the available data, were still not conclusive, but provided some indications of the status of the fishery. The model suggested the stock is not overfished and current catches are not resulting in overfishing.

With the inclusion of an additional three years data there is still no evidence that the stock is overfished. Both the previous and updated assessment revealed that the recommended MSY from the Pedro Bank was at a median of 200mt. Data from the industrial fishery revealed that since 2004 the catch has been decreasing from 450 mt to 111.5 mt as seen in 2007. With lower catches, the model now predicts that the stock is not being overfished ($F < F_{MSY}$) and is not overfished ($B > B_{MSY}$).

It should be noted that the production model does not fit the data well. This is because the catch rate series does not appear to be informative. Consequently, the model outputs are highly dependent on what is being assumed for the priors. Nonetheless, the model is the only one currently available and provides some guidance on appropriate levels of harvest.

5.1.1.3 Management Advice

Current management measures include a Close Season for the months of April to June for all lobster fishers; there is also the recent implementation of a current legislation that prohibits persons from having lobsters during the Close Season. 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 number of industrial vessels.

As a cautionary approach Jamaica may consider implementing a total allowable catch of 200t 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 Government should also consider establishing minimum tail weight and length regulation, so that these size regulations can still be enforced after processing. A minimum tail size, consistent with the minimum legal carapace length, was determined at this meeting.

5.1.1.4 Statistics and Research Recommendations

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. For the purposes of this assessment it is assumed that the industrial fleet catch is a constant proportion of the total catch. This assumption needs to be further verified. Export data were available from 1979 – 2007 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:

- 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.
- Obtain missing catch and CPUE data for the periods 1982-3, 1990, 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.

<u>Research</u>

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. 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.

It was recommended in the plenary session that patterns in recruitment and in landings be compared across wide geographical areas to look for regional patterns. This would be a major research undertaking and would require a commitment from member states.

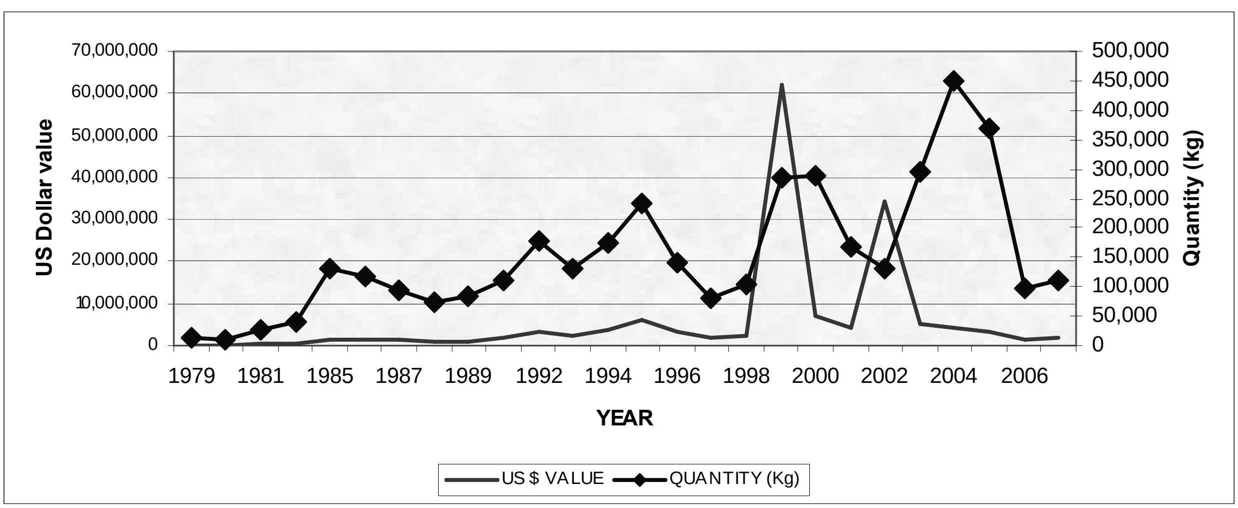

Fig. 1: Export quantities and US$ value of the spiny lobster for Jamaica period 1979 – 2007 (Data Source: Statistical Institute of Jamaica)

5.1.1.5 Stock Assessment Summary

The most important 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.

Attempts were made to assess the status of the lobster stock using a surplus production model 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 (median B/B_{MSY} = 1.25), and overfishing is not occurring (median F/F_{MSY} = 0.49, and most recent catch (111 tonnes) < replacement catch (179 tonnes)).

It should be noted that the production model does not fit the data well. This is because the catch rate series does not appear to be informative. Consequently, the model outputs are highly dependent on what is being assumed for the priors. Nonetheless, the model is the only one currently available and provides some guidance on appropriate levels of harvest.

Table 1: Comparison of new and previous 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.

	2008 Assessments			2009 Assessments		
90% Confidence Intervals (percentiles)	**5%**	**Median (50%)**	**95%**	**5%**	**Median (50%)**	**95%**
R	0.06	0.21	0.71	0.05	0.20	0.65
B_∞ (t)	2280	4415	10734	2293	4271	9515
$B_{current}$ / B_∞	0.34	0.66	0.92	0.37	0.62	0.90
MSY (t)	78	207	1098	75	195	878
Observed Yield (kg)	450, 807 (2004)			111,500 (2007)		
Replacement Yield (t)	73	187	352	71.00	179.00	335.00
B/BMSY	0.69	1.31	1.84	0.74	1.25	1.80
F/FMSY	0.25	1.63	6.64	0.08	0.49	1.80

Minimum tail length

Fig. 2 shows the plot of carapace length versus tail length for male and female lobsters combined. A linear regression described the relationship by:

carapace length = -1.63 + 0.58 * tail length, with R^2 = 0.78.

Thus, it is estimated that lobsters with a tail length of 134.2 mm have on average a carapace length of 76.2 mm. Also computed were 95% prediction intervals, such that 95% of future observations should fall in the interval. The prediction intervals show that a lobster with a tail length greater than or equal to 153 mm has at least a 95% chance of being legal sized.

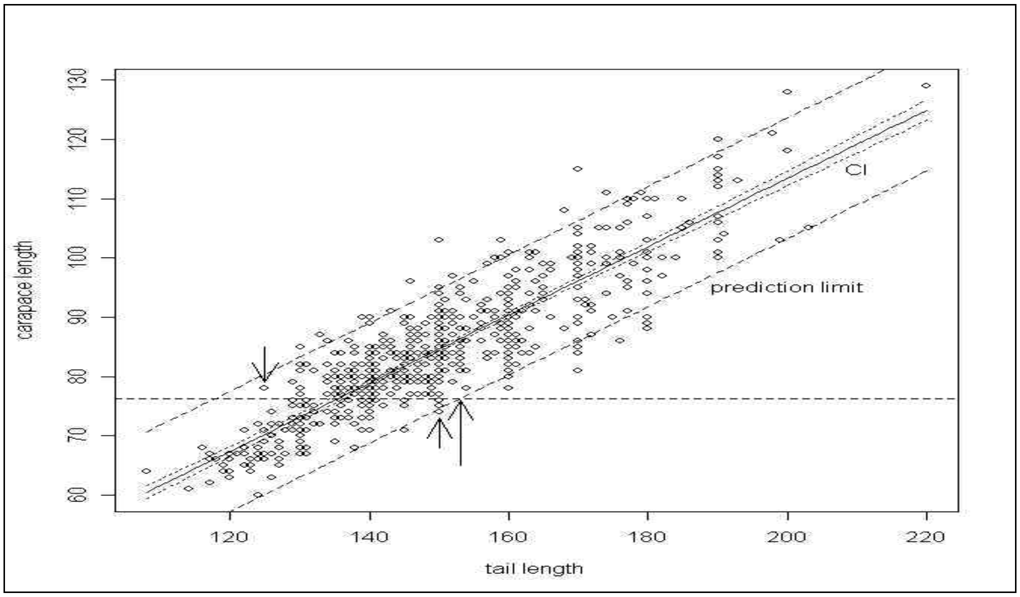

Fig. 2: Plot of carapace length versus tail length for male and female lobsters combined

A conversion factor of 0.565 was established in order to convert tail length to carapace length (mm). This factor will become useful for inspectors in determining whether the tails measured do in fact correspond to the minimum legal tail-length.

5.1.1.6 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.

5.1.1.7 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, the prohibition of the possession and landing of lobsters during the closed season of lobsters. However, monitoring data suggest that these regulations are not being strictly respected.

5.1.1.8 Scientific Assessments

<u>Background/ Description of Fishery</u>

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). During the 1980s, about 60 percent of total lobster landings came from the Pedro Bank but declined to 20 percent during 1996 -1997 (Fig. 3). The contributions of lobsters landed in Jamaica that comes from the island shelf and the banks have not been recently quantified. Fig. 4 reflects the total production for a nine year period, based on the available export data.

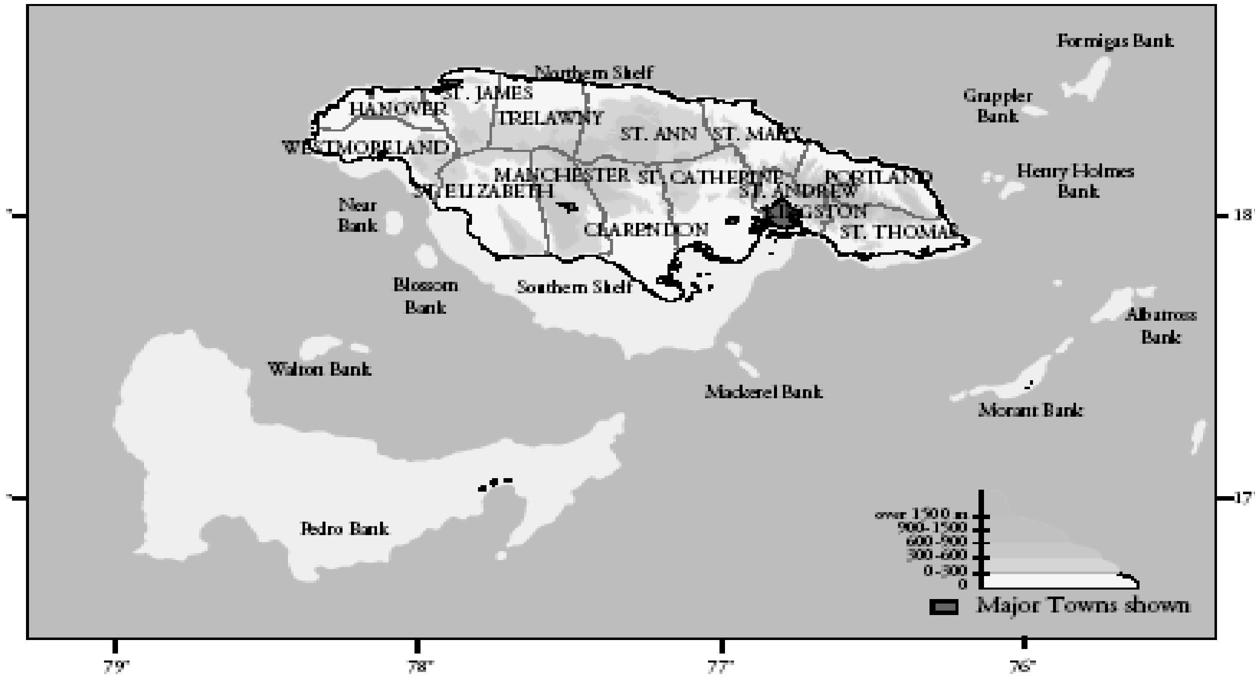

Fig. 3: Jamaica's Fishing Grounds (Offshore and Inshore Banks)

According to Munro (1983) the lobster populations in Jamaica have changed considerably. 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.

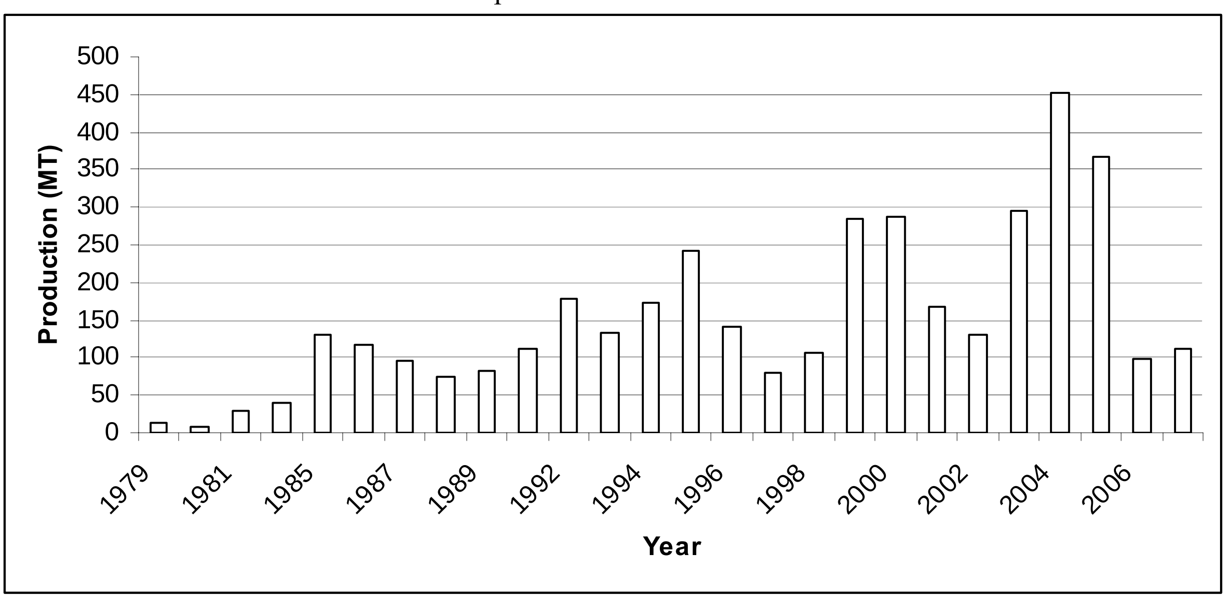

Fig. 4: Export of spiny lobster for the period 1979 -2007.

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.

The artisanal fishery
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. Fig. 5 shows the weight of spiny lobsters caught by artisanal fishers using various gear types for 2005.

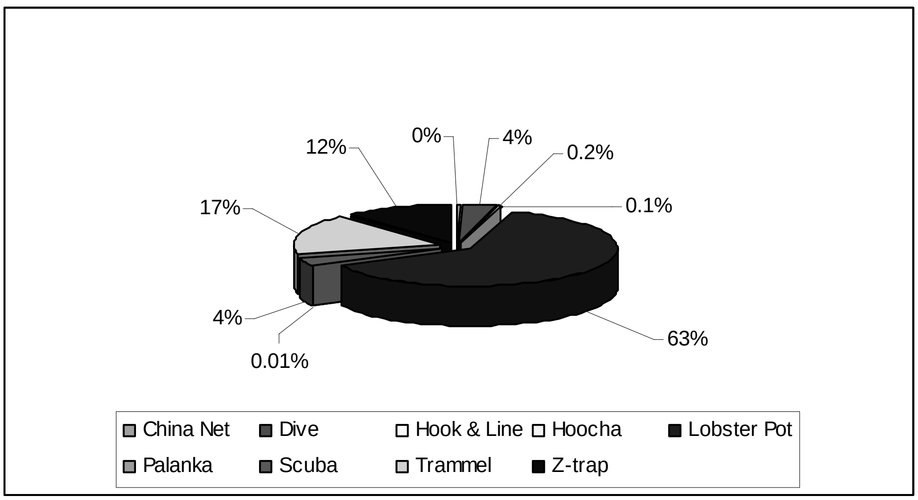

Fig. 5: Percent distribution of weight of spiny lobster landed by artisanal fishers using various gears on the South Shelf of Jamaica in 2005.

The industrial fishery
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 licenses were issued to fish lobsters on the Pedro Bank using Florida traps in 2006. These vessels are operated by 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.

Biology/Research
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.

<u>Management Regulations</u>
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. Effective from the 2009 close season, is a new legislation that prohibits persons from having lobsters during this Close Season. No entity or individual shall have in their possession any lobster or parts thereof after 21 days of the commencement of the annual close season. Lobsters found after this period are subject to seizure and prosecution in a Court of Law. In addition, no lobsters must be kept alive in any holding device during the Close Season. Enforcement activities include end-of-season declarations of lobster by the processors and inspections of fish processing plants, hotels, beaches, and restaurants. Further restrictions were placed on the industrial vessels: limited entry and gear restriction (Florida traps only).

Licenses 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 license.
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.

<u>Monitoring, Control and Surveillance</u>

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 of the year are used to undertake enforcement through the deployment of teams from the various supporting entities along with the Fisheries Division.

<u>Available data</u>

a) *<u>Fishery-dependent</u>*

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) *<u>Socio-economic</u>*

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 Fig. 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

Overall Assessment Objectives

The overall objectives were to establish a minimum tail length that co-relates to the minimum legal carapace length; establish a conversion factor from tail length to 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.

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).

Assessment 1: Conversion factor

Objective

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

Method/Models/Data

During the third CRFM Scientific Meeting it was noted that in order to provide advice to management a method was needed to convert between tail length and carapace length. Over the past year, additional data were collected so that there are now 625 pairs of observations. A linear regression of carapace length on tail length was computed and was used to compute the tail length at which the average carapace length is 76.2 mm (i.e., minimum legal carapace size). Prediction intervals were also computed to determine the tail length above which there is a greater than 95%

chance of the carapace being legal size (> 76.2 mm). Although the linear regression formula can be used to convert between tail and carapace length, it was thought that a simpler procedure might be useful. Consequently, a linear regression through the origin was computed so the slope can be used as a conversion factor (multiplier) to obtain carapace lengths.

Results/Discussion

Fig. 6a shows the plot of carapace length versus tail length for male and female lobsters combined. A linear regression described the relationship by carapace length = -1.63 + 0.58 * tail length, with R^2 = 0.78. Thus, it is estimated that lobsters with a tail length of 134.2 mm have on average a carapace length of 76.2 mm. Also computed were 95% prediction intervals, such that 95% of future observations should fall in the interval. The prediction intervals show that a lobster with a tail length greater than or equal to 153 mm has at least a 95% chance of being legal sized.

A simpler conversion procedure is to develop a constant multiplier relating carapace length to tail length. This was obtained by computing a regression through the origin. The results were similar to those obtained from the regression not forced through the origin (Fig. 6b). Consequently, carapace length can be estimated by the equation: Carapace length, mm = 0.565 x tail length, mm.

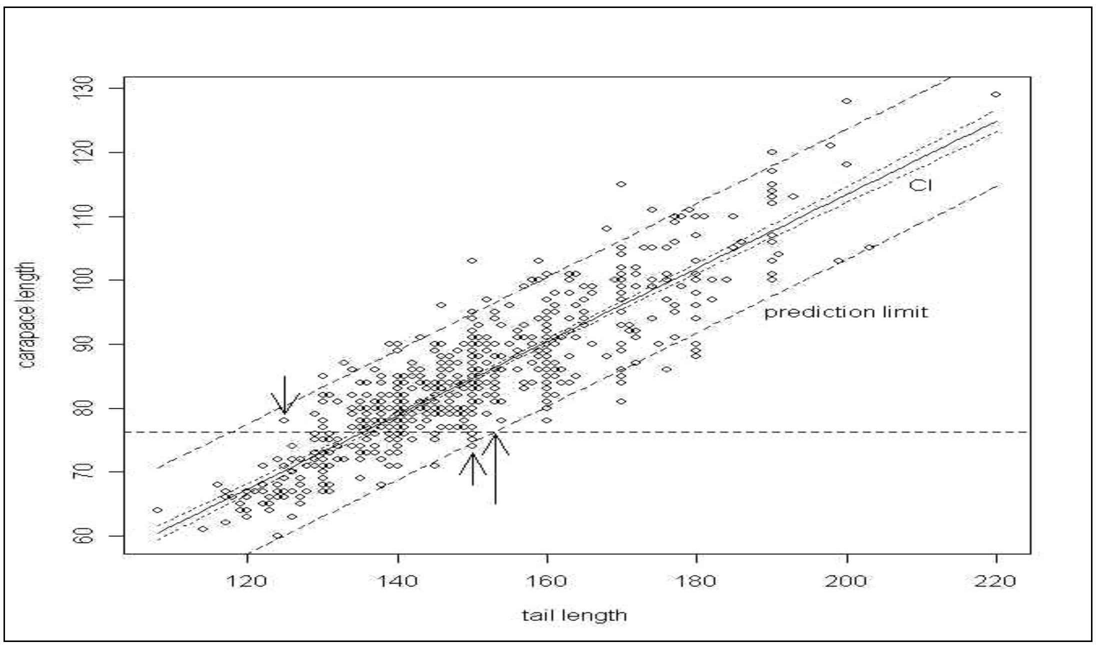

Fig: 6a Plot of carapace length versus tail length for male and female lobsters combined. The solid line is the linear regression described by carapace length = -1.63 + 0.58 * tail length. R2 = 0.78. The dashed lines are 95% prediction intervals. The short arrow on the left indicates that no lobsters with a tail length less than 125 mm were legal size. Similarly, the short arrow on the right indicates that all lobsters with a tail length greater than 150 mm were legal sized. The long arrow on the right is the fitted prediction limit that indicates that a lobster with a tail length greater than or equal to 153 mm has at least a 95% chance of being legal sized. Also shown are 95% confidence intervals for the position of the regression line (dotted lines).

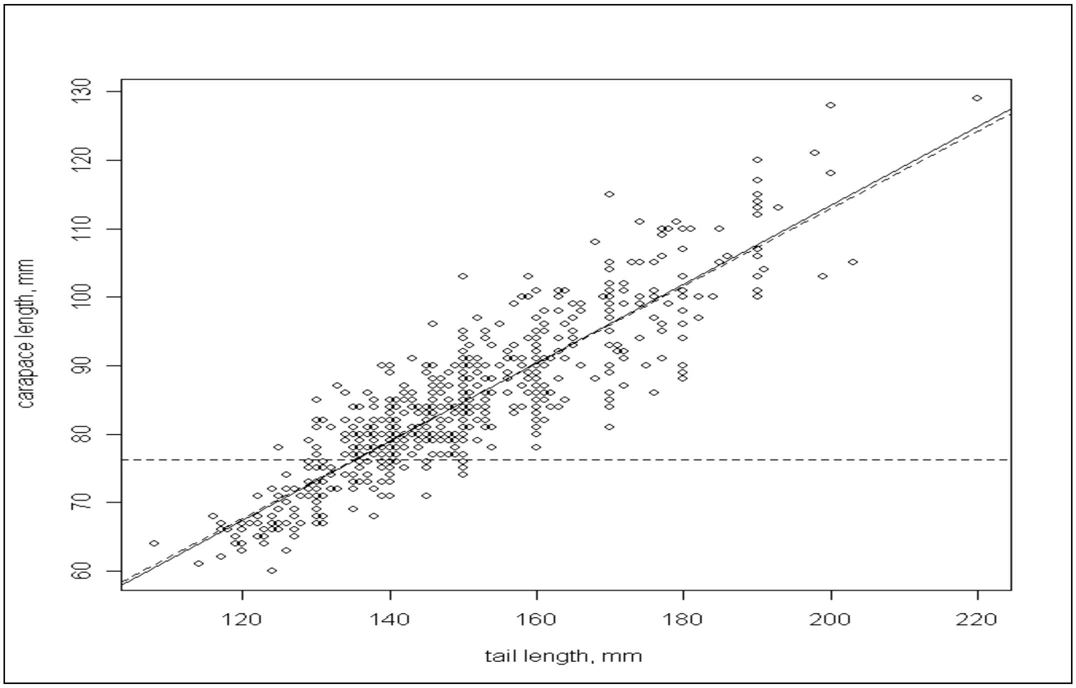

Fig. 6b: Comparison of linear regressions forced (dashed line) and not forced (solid line) through the origin. Over a wide range of tail lengths the lines are very close.

Assessment 2: Stock Assessment

Objective

The aim was to update the Bayesian assessment using three additional years of data from 2005 through 2007.

Method/Models/Data

Overview

The method applied is the same as that used at the Fourth CRFM Scientific Meeting; it used the method applied in the 2008 assessment of Saint Lucia's conch fishery. The detailed fitting methodology is not reproduced here. This document repeats only the specific aspects described in the 2008 assessment.

This is still 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 (Fig. 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.

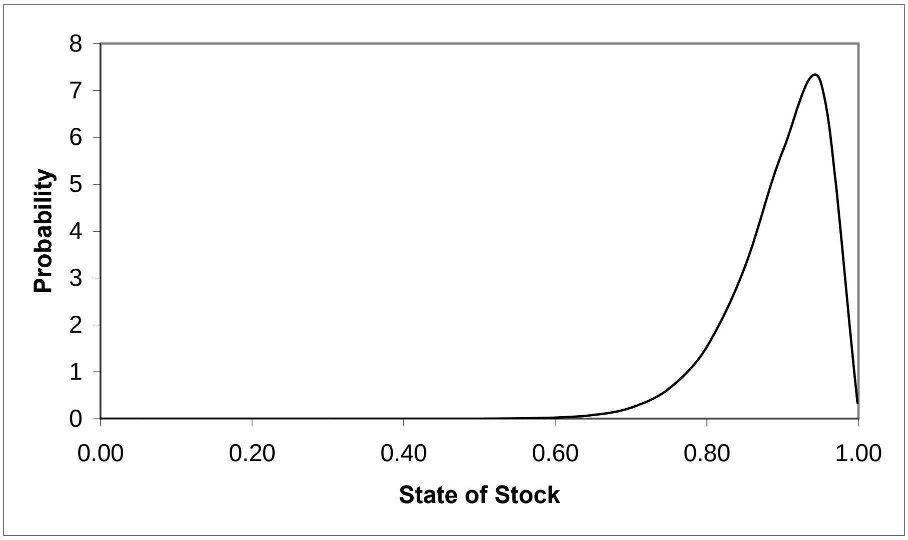

Fig. 7: The beta distribution for the prior of the initial stock state (α=18, β=2, μ=0.9). The initial state probability was subjective, but based on the assumption that the stock was likely to be close to unexploited in 1979, so that almost all the probability mass was between 0.7 and 1.0.

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 (Fig. 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 (Fig. 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

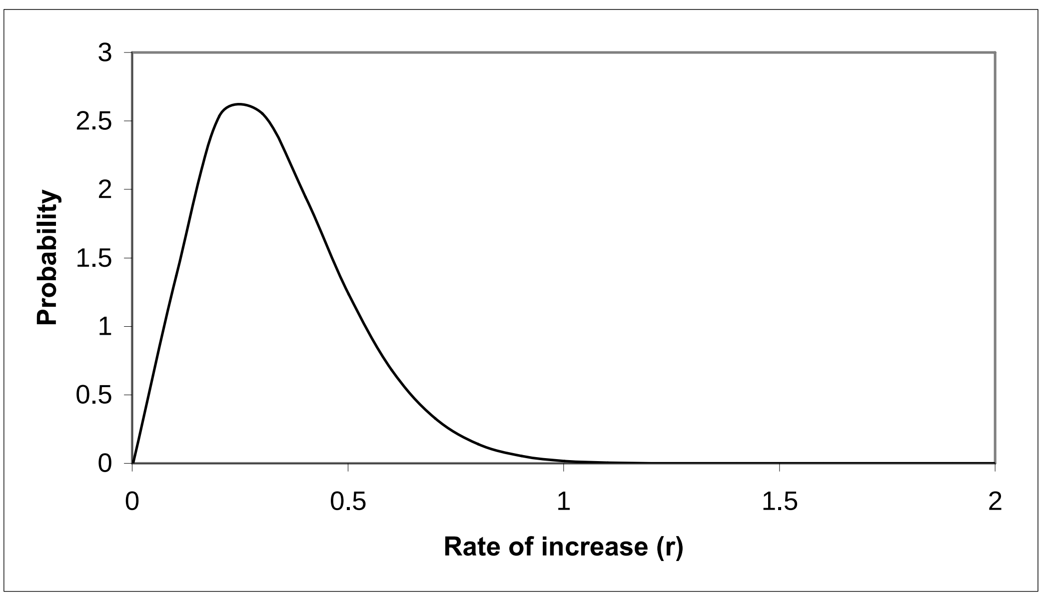

Fig. 8: Beta distribution for the rate of increase (*r*) prior based on the 2003 Turks and Caicos Islands assessment (α=3, β=14.91, μ=0.168; x values are multiplied by 2.0 to get the *r* parameter) and preserving 98% of the probability mass for r values between 0 and 1.0. The value is limited to exist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

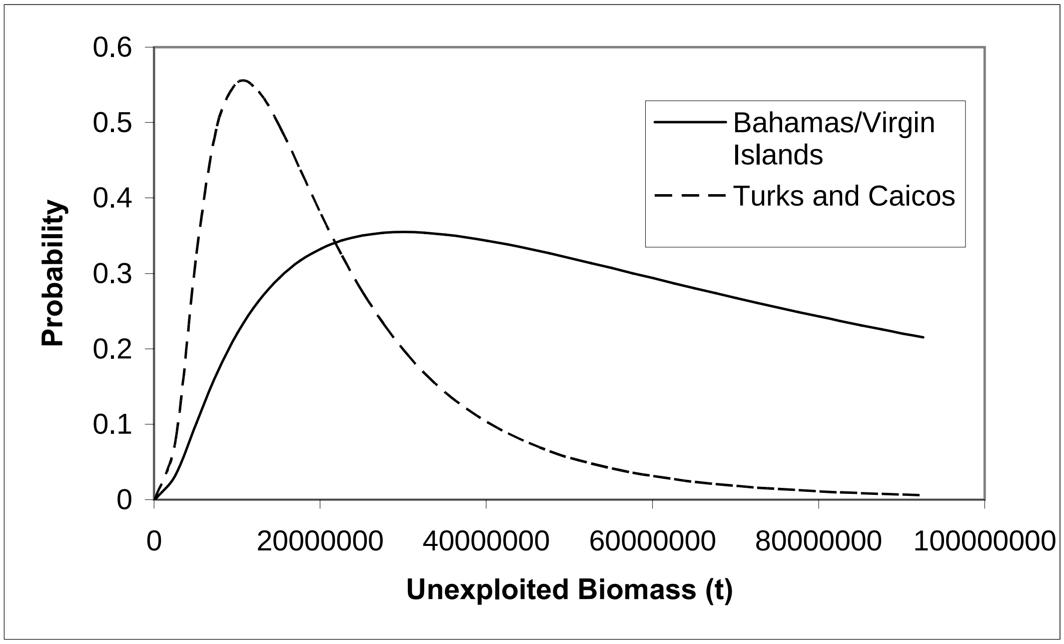

Fig. 9: Log-normal probability density for the unexploited stock size. The prior was designed so that 90% of the probability mass was between the minimum and maximum values derived from the Turks and Caicos Islands and Jamaica assessments scaled for the range of Pedro Bank habitat areas (37000-201000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

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 (Figs. 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.

The previous results were that it was likely that the stock was not overfished, but that overfishing occurred in 2004.

The model was updated with three (3) more years of data 2005, 2006 and 2007. Due to the fact that the catches in 2005-2007 were considerably less than in 2004 (for which the previous model was run); the fishing mortality is now estimated with high probability to be less than that producing MSY. Thus, the model predicts that the stock is not overfished (Fig. 12) and overfishing is not occurring (Figs. 13, 14).

However, the production model is not believed to be reliable because the CPUE time series does not appear to be informative (Fig. 10) as it is highly variable and does not appear related to landings. The model does not fit well as evidenced by the residuals (Fig. 11). Thus the model is highly sensitive for what is assumed for the priors. Thus, the model gives a rough picture of stock condition and suggests the stock is not overfished and that overfishing is not occurring. The simplest measure of stock status may be the catch rate in the fishery, and the most recent catch rates do not indicate major stock decline.

The best advice is to keep to a policy of prudence in keeping the landing to 200 mt (Fig. 15).

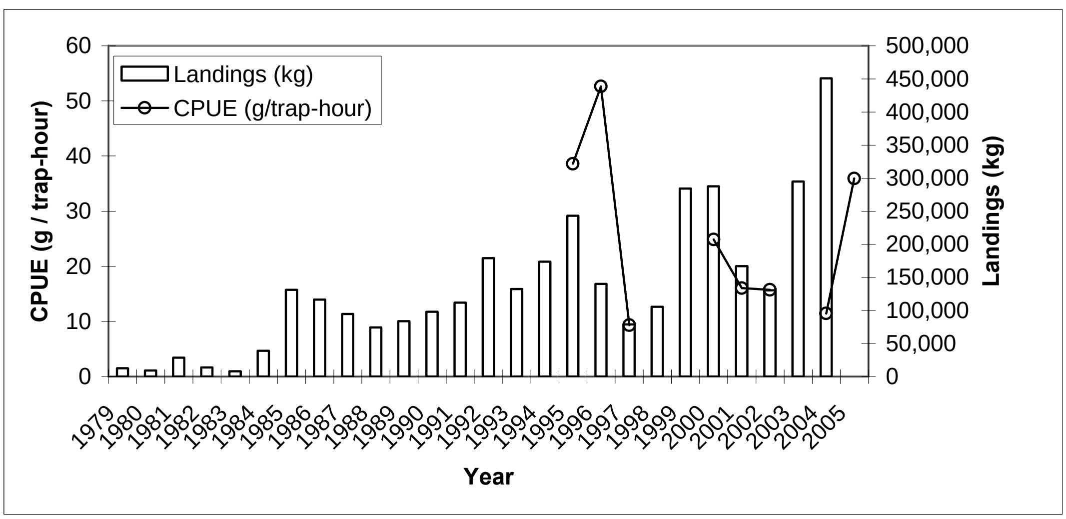

Fig. 10: Exports and CPUE data for the Pedro Bank spiny lobster fishery. Artisanal catches are not covered, but thought to be an insignificant proportion of the catch.

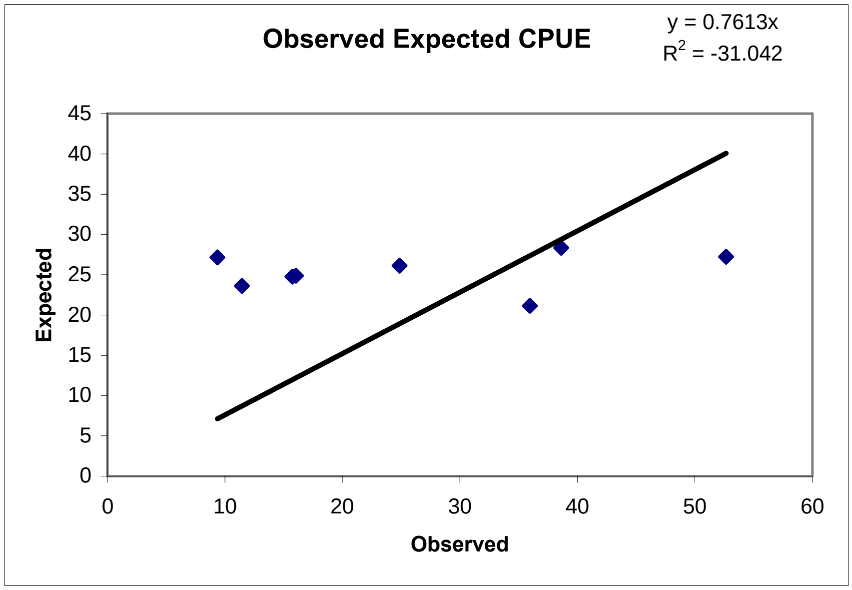

Fig. 11: Observed and expected CPUE from the fitted model. There is no trend in the observed CPUE, and the CPUE are not informative on the abundance for this model.

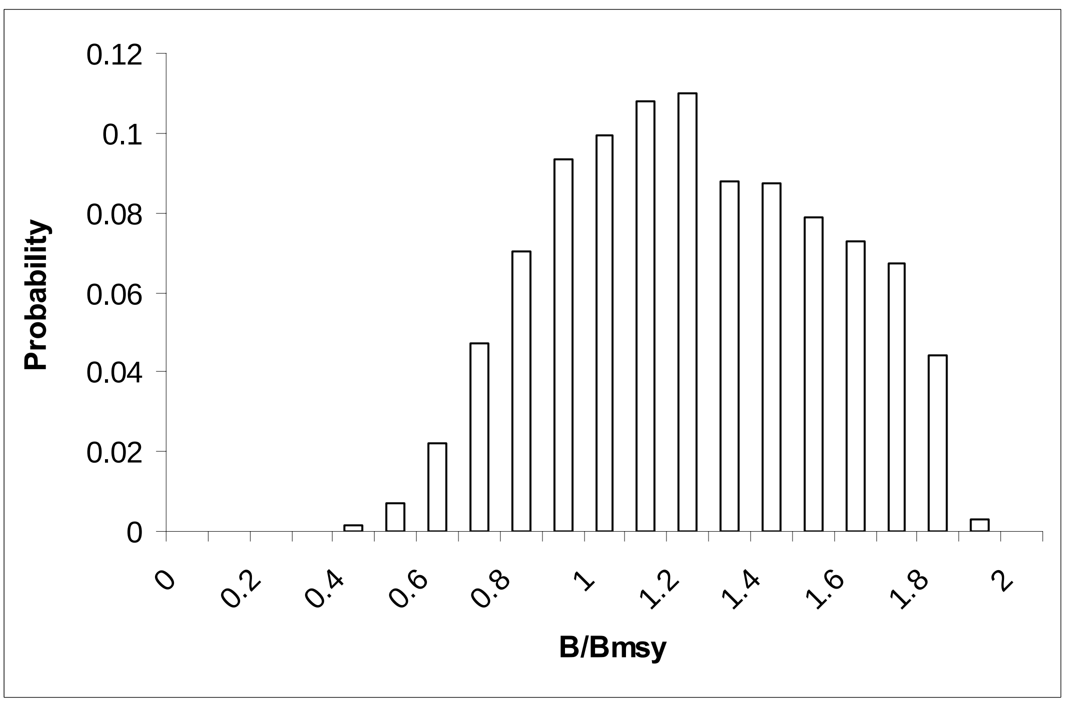

Fig. 12: Stock status (Biomass / Biomass at MSY) as a probability function based on the prior information on likely stock size and productivity, and the available catch-effort data. The results indicate that it is likely that the current biomass is above the MSY reference point ($B/B_{MSY} > 1$).

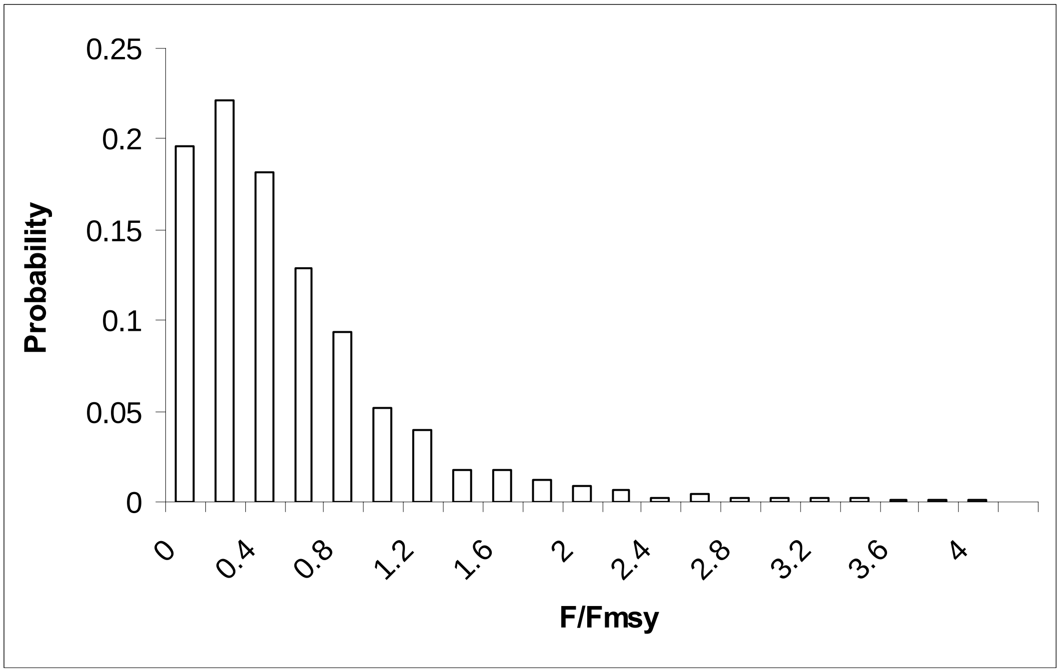

Fig. 13: Relative fishing mortality (fishing mortality / fishing mortality at MSY) as a probability function based on the prior information and the available catch-effort data. The results indicate that overfishing ($F/F_{MSY} > 1$) is highly unlikely. However, there is a very high level of uncertainty exhibited by the long tail of the density, and the model does not fit the data well. Based on the available information high levels of overfishing are possible.

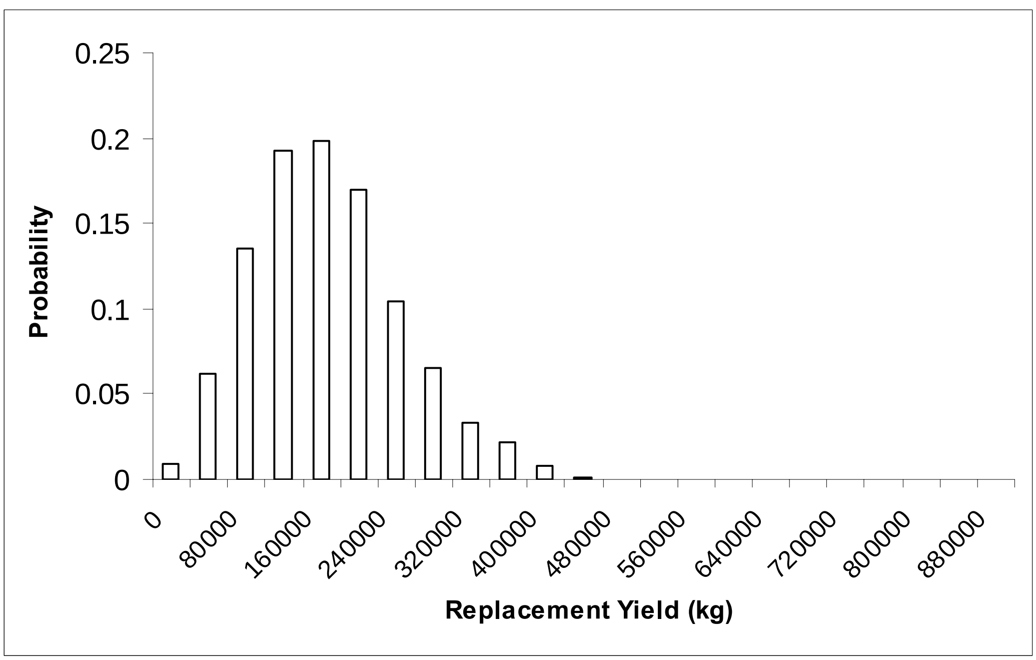

Fig. 14: The replacement yield as a probability function based on the prior information on likely stock size and productivity. The replacement yield is the current production from the stock, so that exceeding this yield will result in the stock biomass falling. The median estimate is 179 tonnes indicating a 50% chance of the stock increasing – or decreasing – if the harvest is at this level.

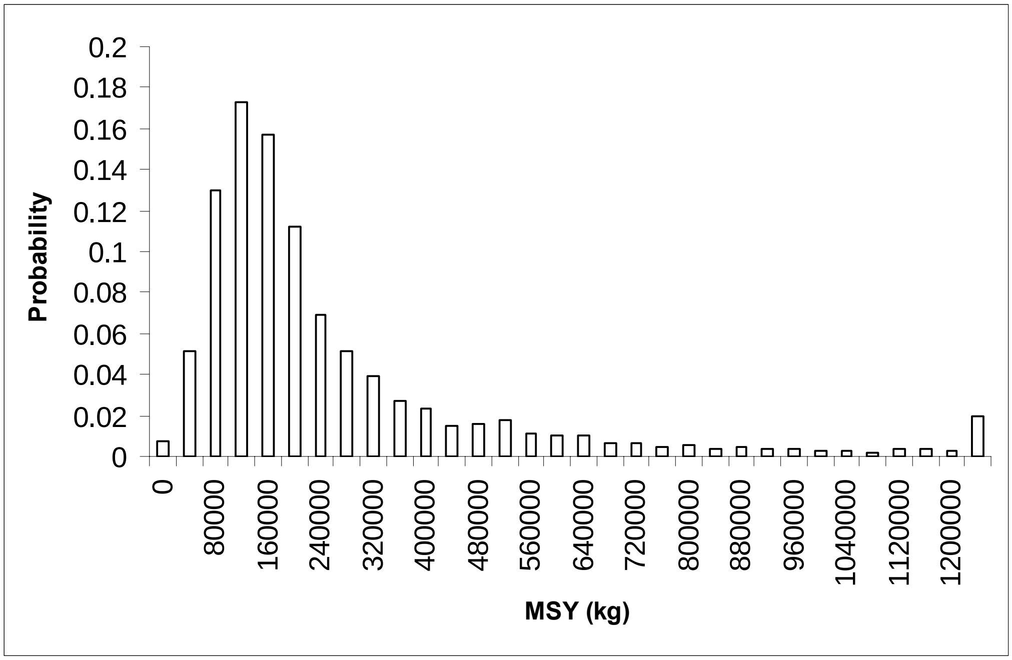

Fig. 15: The estimated maximum sustainable yield suggests that yields above median 200t are unlikely to be sustainable even if the stock were at optimum size, and catches in general should be kept below this level. If the stock were thought to be at optimum size, catches lower than 200 tones would be more precautionary, and catches below 100t per year would be unlikely to cause overfishing.

Discussion

The updated models have shown minimal changes from last year's figures of potential productivity. It can still be said that 200 mt is the best estimate for long term yield as it pertains to the stock.

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 (Fig. 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:

- The CPUE index is proportional to abundance.
- The biomass dynamics model is appropriate for describing the dynamics of the species.
- Total catches are well estimated.
- 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.

<u>Research Recommendations</u>

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.

Management

The stock assessment model does not indicate a problem with overfishing at the present. However, two considerations are relevant to management. The first is that the model does not fit the data well and may not be reliable. The second is that catches have declined in the last three years but it is not clear why and there is little reason to believe the decline is due to management actions. Therefore, the reduced catches may not persist and some prudence in management is in order. It would be worthwhile to investigate possible causes for the recent decline in catches and also to investigate why there does not appear a tight relationship between exports and prices.

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 include:

- Ensure that current closed season is enforced as there is evidence of continuous landings
- Conduct data collection training exercises with data collectors
- Collect fishery-independent research data (catch and effort and biological) during the closed season
- Collect catch and effort and biological and socio-economic data from the processing plants and at a minimum of at least two main landing sites in an intensive sampling program for one year
- Plan for the establishment of no take zones to protect recruited stock
- Increase the minimum carapace length with increased enforcement
- Monitor fishing effort and begin to formulate plans to change the open access regime should this become necessary
- 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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5.1.2 Conch Fishery of Jamaica

5.1.2.1 Research Recommendations for the Jamaica conch Fishery

There are two approaches to assessing the status of conch on Pedro Bank. The first is to look at catch rates in the commercial fishery along with associated fishery data such as the spatial distribution of fishing effort. The second is to monitor biomass through periodic surveys (generally every 3 years). These two approaches are not incompatible and the results from the two methods should be integrated to obtain improved assessment of the resource. The calculations proposed here were not attempted at the meeting because of uncertainties about the data. The following recommendations were developed by the Working Group.

1) Compile and verify all data on catch, effort, and catch rate, with particular reference to units and conversion factors.

5.1.2.2 Commercial catch and effort statistics

Monitoring catch rates provides a method for tracking changes in the population over time. However, this provides qualitative indications on what changes in quota might be appropriate.

2) Estimate catchability coefficient from several years of data.

The catch rate index of abundance can be converted into an estimate of absolute population abundance if information is available on the catchability coefficient. The catchability coefficient, q, is the constant of proportionality that relates catch rate, c/e, to average biomass, $\overline{B}$. Thus,

$$c/e = q\overline{B}.$$

The absolute biomass can be estimated from transect surveys. The average biomass over the course of the year can be estimated as the average of the estimates obtained from the survey at the start of the year and the end of the year (or start of the next year). (If the biomass does not change much from the start of the year to the end then a single survey might suffice).

Estimates of q should be made for several years in order to obtain a precise result.

3) Explore use of biomass dynamic models.

Given a sufficient number of years of data on catch and effort in the conch fishery, it should be possible to develop a biomass dynamic (or surplus production) model. Furthermore, estimates of absolute abundance or catchability coefficient from transect surveys can be incorporated in the model and used to “anchor” the fitted trajectory of biomass over time to observed values.

A surplus production model was developed prior to the initiation of the transect surveys but was abandoned. It was not clear to the Working Group why this was so and it is recommended that the surplus production model be revisited to see what it might contribute to towards the development of a surplus production model in the future.

Commercial catch data can also be used in conjunction with a survey estimate of abundance to compute an estimate of the exploitation rate (see below).

5.1.2.3 Diver transect surveys of abundance

Additional analyses of the survey data should be considered. In particular, in addition to the estimation of catchability coefficient described above, it is worth trying to estimate exploitation rate and annual survival rate from the survey data from 2007.

4) Estimate exploitation rate. The exploitation rate, u, is the fraction of the population present at the start of the year that is harvested during the year. It can be estimated from the landings and survey data as follows:

$$u = \frac{landings}{\hat{N}_{adults} + \hat{N}_{large\ juveniles}}$$

where $\hat{N}_{adults}$ is the survey estimate of adult conch at the start of the year and similarly $\hat{N}_{l\,\mathrm{arg}\,e\ juveniles}$ is the estimate for large juveniles. We include the large juveniles in the denominator because these animals become adults during the year and contribute to the landings.

5) Survival rate. The annual survival rate, S, is the fraction of the population present at the start of the year that is alive at the end of the year. If there are surveys at the start of year 1 and 2 that produce estimates of the number of adults and large juveniles, then survival rate can be estimated by

$$S = \frac{N_{adult,2}}{N_{adult,1} + N_{large\ juvenile,1}}.$$

Here, the subscripts refer to the component of the population (adult vs. large juvenile) and the survey (1 or 2). The number of adults at time 2 represents the surviving number of adults from time 1 plus the surviving number of large juveniles from time 1 (which have now become adults at time 2). Hence, it is necessary to include the large juveniles in the denominator.

5.1.2.4 Integrated model of fishery and survey data.

6.) Create a simple model of conch population dynamics based on total catch and two survey estimates. In addition to using fishery and survey data to estimate the catchability coefficient in the fishery and the exploitation rate, it is possible to put together a simple model of the population dynamics of conch and use it to either estimate unreported catch (if this is large) or to check on the reliability of the available data (if unreported catch is small). The model looks like a simplified version of the Collie-Sissenwine model (Collie and Sissenwine 1983).

The basic idea is to predict the abundance of adult conch in a second survey from the abundance of adults and large juveniles in the previous survey (i.e., one year earlier) and the known catch. The model can be written as;

Predicted adults at time 2 = number of adults and large juveniles at time 1 – catch – natural mortality.

An assumption has to be made about the value of natural mortality. Several trial values should be tried. If illegal fishing is minimal then the predicted abundance of adults should match the observed abundance if the surveys and catch data are reliable. This can provide an important check on the reliability of the available data. If, on the other hand, there is substantial unreported catch, then the difference between predicted and observed number of adults at time 2 can provide an estimate of the unreported catch.

If annual surveys are available for several years then a multi-year model can be constructed which can be used to smooth the estimates of abundance to reduce measurement error, as in the Collie-Sissenwine method.

5.1.3 The Nevis Conch Fishery

Trends in landings are not currently available. Examination of various reports with landings data revealed problems with incorrect units and confusion about years. Consequently, there is a need to examine the historical landings data. Anecdotal information suggests conch may have been depleted from inshore areas and fishers are now fishing in deeper water.

5.1.3.1 Management Objectives

Currently, the fishing regulations pertaining to conch are as follows:

(1) In this Regulation, "immature conch" means:

- (i) a conch, the shell of which is smaller that 18 cm in length; or
- (ii) a conch, the shell of which does not have a flared lip; or
- (iii) a conch with a total meat weight of less than 225 grams (0.5 lbs) after removal of the digestive gland.

(2) No person shall take, sell or purchase or have in his possession any "immature conch".

(3) The Minister may by notice published in the *Gazette* declare any period or area or both as closed for conch fishing.

(4) No person shall fish for conch during the period of a closed season for conch.

(5) This Regulation relates to the Queen Conch (*Strombus gigas)*.

5.1.3.2 Status of the Stocks

The status of the stock is uncertain because no assessment has been made.

5.1.3.3 Management Advice

No advice can be provided at this time. There is a need to compile information on landings and other statistics pertaining to the fishery, regulations in effect, and on potential regulations and their probable impacts. Data must be integrated with data from St. Kitts because fishers from the two islands fish the same grounds.

5.1.3.4 Statistics and Research Recommendations

<u>Data Quality</u>

There is a need for the landings data from Nevis and St. Kitts to be compiled, checked and combined. Other sources of data should be sought, if possible.

<u>Research recommendations</u>

- Inventory and compile all available data for Nevis and St. Kitts; put them in a comparable format and perform quality control checks. In particular, landings need to be examined because the available reports are contradictory with respect to years and units of measurement.

- Effort should be made to collect information on total fishing effort during the year. One way to do this would be to get plant operators to provide information on the number of tanks of air supplied to fishers.

- Determine the depths at which most of the fishing is taking place and try to determine the distribution of fishing effort over the banks. This will help in designing an abundance survey and will also be useful for determining if there is localized depletion of the resource causing shifts in fishing locations over time.

- When landings data have been checked, they should be examined for trends over time.

- Consider a suite of possible management actions to reduce fishing mortality, with respect to
    - Enforceability
    - Effectiveness
    - Impact on the industry

- Monitor the resource through annual abundance surveys based on scuba diving to count conch along transects. These surveys will document distribution and abundance of conch by size class and can be used to track changes in the population over time. Abundance surveys also offer the possibility of estimating
    - Exploitation rate, or the fraction of the population present at the start of a year that is harvested during the year
    - Annual survival rate, or the fraction of the population present at the start of a year that survives to the end of the year.
    - Recruitment to the fishery (and thus a forecast for the next year)

  Transect surveys of conch resources are used in Florida (USA) and Jamaica and have been used in the Turks and Caicos Islands.

- Monitor catch and effort for at least a portion of the fishery. Catch rate (catch/effort) provides a way to monitor relative abundance of the stock. It is not redundant with survey abundance estimates because each source of information provides highly variable (i.e., uncertain) estimates. Thus, it is important to determine the reliability of information on abundance by comparing two or more independent sources of information.

- Determine the value of the catchability coefficient, q, which is the constant of proportionality relating catch rate (cpue) to absolute abundance. That is,

  $$\text{cpue}/q = \text{abundance}.$$

  Catchability, q, can be estimated by dividing cpue in the fishery by the abundance estimated from the transect survey. The precision of the estimated q can be enhanced by using several years of survey and cpue data to do the computation. An estimate of the catchability coefficient is important because it can be used to convert an estimate of cpue in the fishery into an estimate of stock abundance.

  A suggested survey design and sampling procedure is described in Addendum 1.

Addendum 1 to the Nevis Conch Fishery Report - Suggested survey design and sampling procedure

It is recommended that a stratified random sampling scheme be used to estimate conch abundance by size class. The sampling unit is a rectangle of bottom area that is observed by scuba divers. The attributes observed for each sampling unit are the number of adult conch, large juvenile conch, small juveniles, and possibly recently dead adult conch.

Stratification is based on two considerations: defining areas that are as homogeneous as possible in terms of conch abundance, and defining areas of inherent interest. Thus, based on habitat maps, information on the distribution of fishing effort over area and traditional ecological knowledge of conch distribution, it is possible to define areas that are of high, medium and low abundance. The less the conch abundance varies within these strata the more precise the estimates will be. Some areas may be of inherent interest and warrant separate study. For example, it may be important to have estimates of abundance for nearshore areas to determine if these areas are being depleted.

The steps in setting up a stratified random sampling scheme are as follows.

1) Determine the area for which an estimate of conch abundance is desired. There is a trade-off: if the distribution of conch is not known well, then it is prudent to define a large study area to insure that conch are not excluded from the survey. On the other hand, defining a study area that contains a great deal of habitat unsuitable for conch causes inefficiency (poor precision in the estimates).
2) Divide the study area into strata based on areas of inherent interest and areas of homogeneous abundance. Generally, just a few strata are defined.
3) Determine the area of each stratum.
4) Determine how many observations (transects) will be made in each stratum. Generally, the larger the stratum and the higher the abundance in the stratum, the more observations should be made.
5) Randomly select the sample sites for each stratum
6) Define the size categories of conch as follows:
    a. Adults – animals with a thickened lip or a minimum length
    b. Large juveniles – those juvenile conch that will become adults during the year, defined as animals with a thickening lip
    c. Small juveniles – animals above a minimum length but without a thickening lip
7) Perform the counts as follows:
    a. Lay out a transect line of fixed length, e.g., 100 m.
    b. Swim along the transect line holding a measuring stick of a width somewhere between 6 feet and 10 feet.
    c. Count all conch in the path of the diver between the ends of the measuring stick and identify the conch to class.

<u>Estimating abundance</u>. The procedure for estimating abundance of a category of conch (e.g., live adults) in a stratum is as follows:

1) Compute the average count of conch per transect. If there were n transects, and the count in the i<u>th</u> transect was c_i, the average count $\overline{c}$ is

$$\overline{c} = \frac{\sum_{i=1}^{n} c_i}{n} .$$

2) Compute the density of conch, per unit area .If the area observed in one transect is a, then the average density $\bar{d}$ is

$$\bar{d} = \frac{\bar{c}}{a}$$

3) Compute the total abundance of conch in the stratum. If the area of the stratum is A, then the estimated total number of conch $\hat{N}$ in the stratum is

$$\hat{N} = \bar{d}A$$

4) If a sample of conch was weighed and the mean weight was $\bar{w}$ then the estimated biomass $\hat{B}$ of conch in the stratum is

$$\hat{B} = \hat{N}\bar{w}$$

An estimate of the total abundance of conch in the category is obtained by adding together the estimates from all of the strata.

To obtain an estimate of the variance of the estimated number of conch in the stratum, the following steps are performed.

1) Compute the sample variance of the mean count $S_{\bar{c}}^2$ by

$$S_{\bar{c}}^2 = \frac{\sum_{i=1}^{n} (C_i - \bar{c})^2}{n(n-1)}$$

2) The estimated variance of the estimated mean density is

$$S_{\bar{d}}^2 = \frac{S_{\bar{c}}^2}{a^2}$$

3) The variance of the estimated stratum total $\hat{N}$ is

$$S_N^2 = A^2 S_{\bar{d}}^2$$

4) The estimated standard error of the estimated total abundance in the stratum is

$$S_N = \sqrt{S_N^2}$$

To obtain an estimate of the variance of the estimated total abundance over all strata we simply add the estimated variances for all of the strata. The estimated standard error of the total abundance over all strata is the square root of the variance of the estimated total over all strata.

Estimating exploitation rate

The exploitation rate, *u*, is defined as the fraction of the population present at the start of the year that is harvested during the year. It can be estimated from the landings and survey data as follows:

$$\hat{u} = \frac{landings}{\widehat{N}_{adults} + \widehat{N}_{large\ juveniles}}$$

We include the large juveniles in the denominator because these animals become adults during the year and contribute to the landings. Note that it is assumed that the large juvenile category is defined to be those juvenile conch that will become legal during the year.

Estimating catchability coefficiently

The catchability coefficient, *q*, is the constant of proportionality relating catch rate (*c/e*) to abundance *N* or biomass *B*. Thus,

$c/e = q\ N$ or $c/e = q\ B$.

Given observed catch rate in the commercial fishery and survey abundance the catchability coefficient can be estimated by $\widehat{q}$ = (c/e) / B if the catch per effort is in terms of weight. (If the catch rate is in terms of numbers then the catchability coefficient can be estimated by $\widehat{q}$ = (c/e) / N.)

The above relationships hold if biomass (or abundance) is constant .Otherwise catch rate is proportional to average biomass (or number). Catchability coefficient might still be estimated if there are surveys at the start of two years so that the average biomass can be estimated as the average of the two survey estimates. Thus *q* is estimated by

$$\widehat{q} = \frac{c / e\ during\ the\ year}{\hat{B}_{adults,1} + \hat{B}_{adults,2}}$$

where $\hat{B}_{adults,1}$ and $\hat{B}_{adults,2}$ are the biomasses of adults estimated in surveys at the start of the years 1 and 2, respectively.

Estimating survival rate

The annual survival rate, S, is the fraction of the population present at the start of the year that is alive at the end of the year. If there are surveys at the start of the year 1and 2 that produce estimates of the number of adults and large juveniles, then the survival rate can be estimated by

$$\widehat{S} = \frac{\widehat{N}_{adults,2}}{\widehat{N}_{adults,1} + \hat{N}_{large\ juveniles,1}}.$$

The number of adults at time 2 represents the surveying number of adults from time 1 plus the surviving number of large juveniles from time 1 (which have now become adults at time 2). Hence it is necessary to include the large juveniles in the denominator. Note that it is assumed that the large juvenile category is defined to be those juvenile conch that will become legal during the year.

5.1.4 Queen Conch Fishery in Saint Lucia

5.1.4.1 Management Objectives

The management objectives for the conch fishery in Saint Lucia are to:

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

5.1.4.2 Status of the Stock

The abundance of the stock continues to decline. The 2008 landings were beyond the thirty (30) tonnes recommended by the Fourth Annual CRFM Scientific Meeting. The assessment again indicates that the stock is likely to be over finished. The status of the stock appears to have worsened slightly compared to the assessment conducted in 2007.

5.1.4.3 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:

-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.)

- 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.

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

5.1.4.4 Statistics and Research Recommendations

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 Islands was used to estimate key values used in the assessment for Saint Lucia. However, results from Saint Lucia's Conch Resource Study Assessment transect survey were incorporated into the production model for the first time.

- There is a need for an island-wide transect data survey data on the abundance and habitat of conch in Saint Lucia to improve estimates of stock status.

Research

As suggested by the Third Annual CRFM Scientific Meeting, the inclusion of the following data may improve the reliability of the assessment:

- Abundance /Density survey
- Habitat mapping (both fished and non fished areas)

[1] IUU- illegal, unreported and unregulated fishing

- With funding from the European Union Special Framework of Assistance (2003), a conch assessment project has been completed and included 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 and should include depth estimates.

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

- In the long term, it is recommended that data on the density and abundance of conch in Saint Lucia be surveyed regularly 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.

5.1.4.5 Stock Assessment Summary

- Catch per unit effort (CPUE)[2] was used as an index of stock abundance. The measure of effort was the *number of tanks used*. This measure was chosen based on the analysis done at the Fourth Annual CRFM Scientific meeting (CRFM 2008).

- The CPUE index appears to be declining each year (Fig. 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. For 2008, the CPUE index was 10.77.

- 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 2008. The surplus production model was a Bayesian model and provided estimates of Maximum Sustainable Yield (MSY[3]).

- The results indicate that the current biomass of the stock is below the biomass of the stock at MSY (Fig. 2) and the current catch of 37.8 tons is likely to result in over fishing.

[2] CPUE is the quantity of fish caught (in number or in weight) with on 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 above MSY is thought to be unsustainable.

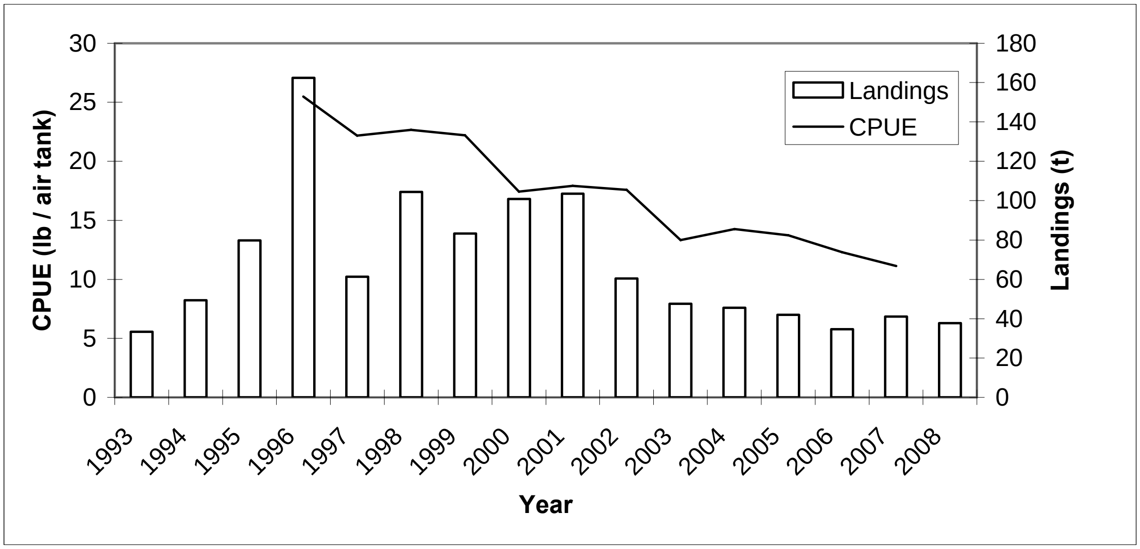

Fig. 1: The CPUE abundance index shows a continuous decline since 1996, suggesting that the stock abundance has declined over this period. The catch time series 1993-2001 has some uncertainty as to the recorded data (see Section 1.4.1).

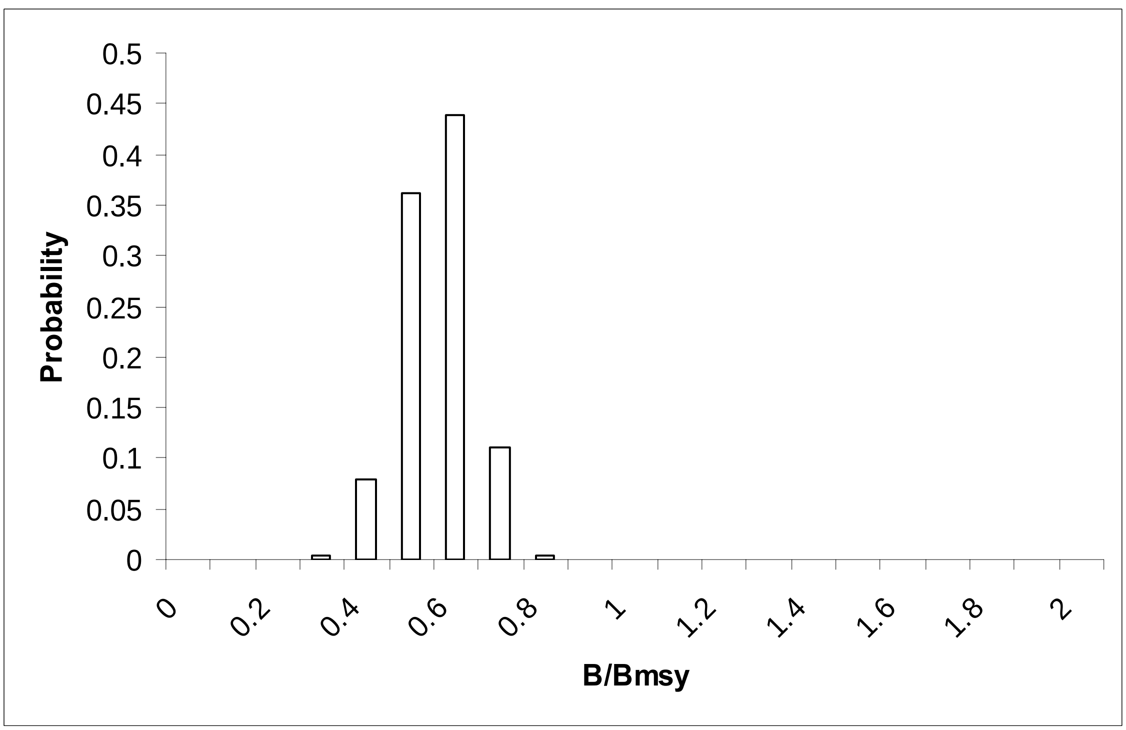

Fig. 2: There is a high probability that the current biomass of the stock is below the MSY target of 1 (B/BMSY < 1).

5.1.4.6 Special Comments

- The Bayesian priors[4] 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.

- Last year it was recommended that improved prior information, based on actual conch habitat areas in St. Lucia, compared with use of data from TCI and Jamaica might increase the accuracy of the assessment. Accordingly, this year a model was fitted in which the prior distribution for virgin biomass was based on observed densities in Saint Lucia taken from the Conch Resource Assessment. The overall results did not differ much from last year's results.

- 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.

5.1.4.7 Policy Summary

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.

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.

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

5.1.4.8 Scientific Assessments

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.

Overall Assessment Objectives

The main objective of this assessment was to update the status of the stock from 2008 and to derive a MSY based reference point for the stock.

Data Used

Name	Description
Catch and effort data	Observed conch landings using trip interview during 1996- 2008
Total conch landings	Annual landings from 1993- 2008 raised from the trip interview data
Observed densities	Derived from Saint Lucia Conch Resource Assessment Study Report

Assessment 1

Objective

The aim was to update the previous assessment with three additional years of data and try a new prior for virgin abundance based on Saint Lucia data.

Method/Models/Data

- The structure of the Surplus Production model remained the same as that used in the report of the Fourth Annual CRFM Scientific Meeting.
- Following the recommendations from last year's report, the measure of fishing effort was the number of air tanks used.
- The new prior distribution for the virgin biomass was obtained as follows:
  - It was assumed that the average biomass density observed in the conch resource assessment study represented an overfished population. Consequently, that density was multiplied by three as an approximation of the virgin biomass density.
  - The resulting density was multiplied by 7900 hectares which is the combined area of the northern and southern fishing area.
  - A log normal distribution for virgin biomass was then specified with the log normal mean equal to 7.97 and equal to 27%.
  -Models were fitted with both the now prior and the prior used last year.

Results and Discussion

The stock assessment carried out in 2008 was repeated in 2009 using the 'number of air tanks' in calculating the observed CPUE and using data through 2008. Estimates are presented in Table 1.

Table 1: Estimates from surplus production model. Estimates are medians of the posterior distributions. Original refers to the prior distribution of virgin biomass based on information from Jamaica and the Turks and Caicos Islands. New refers to the prior for virgin biomass derived from catch rates in Saint Lucia.

Year	r	MSY	Replacement Catch	B/BMSY	F/FMSY
2008(original)	0.115	36.772	31.378	0.625	1.770
2008(new)	0.100	34.544	29.042	0.610	1.919
2007	0.140	41.644	36.853	0.672	1.459

The models using the original and the new prior for virgin biomass produced similar results, with the new prior producing somewhat more pessimistic results. Because the results are similar, we present only the results for the new prior.

The estimate of MSY is highly uncertain (Fig. 3) as are the estimates of replacement catch (Fig. 4). To have a high probability of not reducing the stock further, the landings should be less than the median estimate of replacement catch (29mt).

The distribution of estimates of the ratio of current fishing mortality to fishing mortality producing MSY is entirely to the right of 1.0. Thus the model indicates that overfishing is occurring (Fig. 5). The distribution of estimates of the ratio of current biomass to the biomass producing MSY is entirely to the left of 1.0 (Fig. 6). Thus, the model indicates that the stock is overfished.

The conclusions to be drawn are that the model indicated the stock is overfished and overfishing is occurring. A harvest of 29mt should stabilize the population. Expressed another way, a harvest of 29 mt gives a 50/50 chance of the stock increasing or decreasing further. To have a high probability of rebuilding the stock, the harvest should be restricted to less than 29 mt. Any reduction in quota would contribute directly to stock rebuilding.

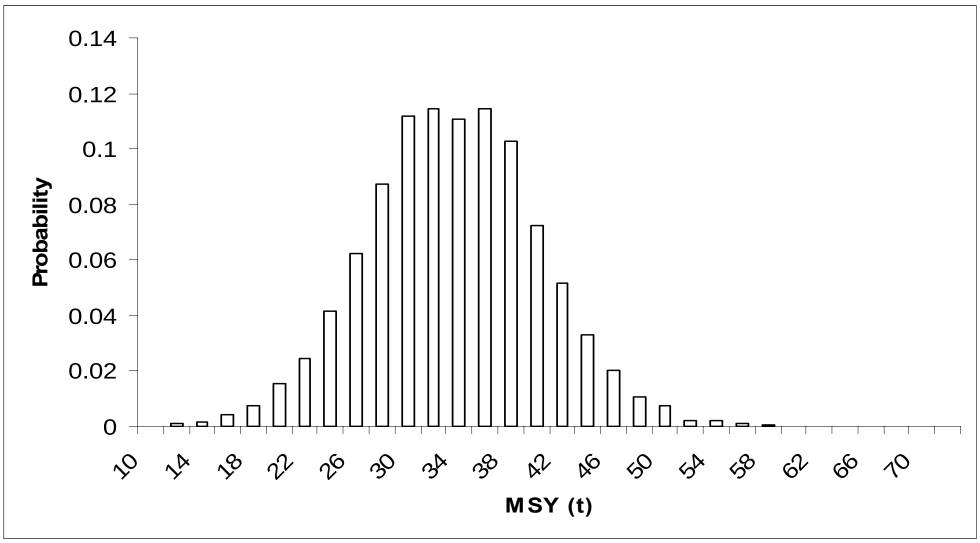

Fig. 3: Distribution of estimates of maximum sustainable yield from the surplus production model.

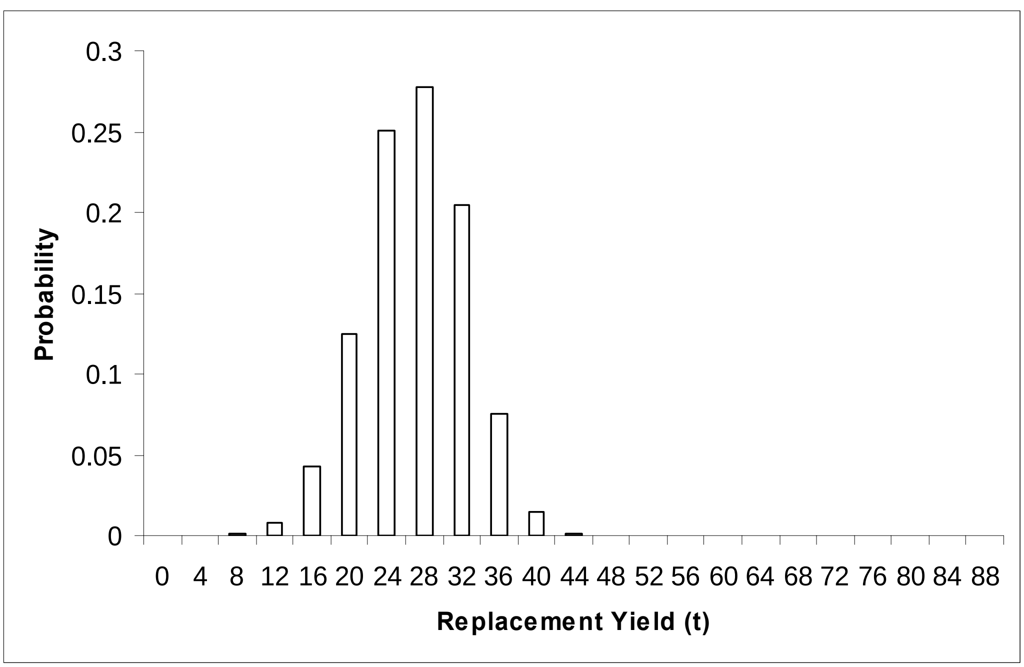

Fig. 4: Posterior distribution of replacement yield using data through 2008 and the new prior for virgin biomass. Most likely value is around 29 tonnes.

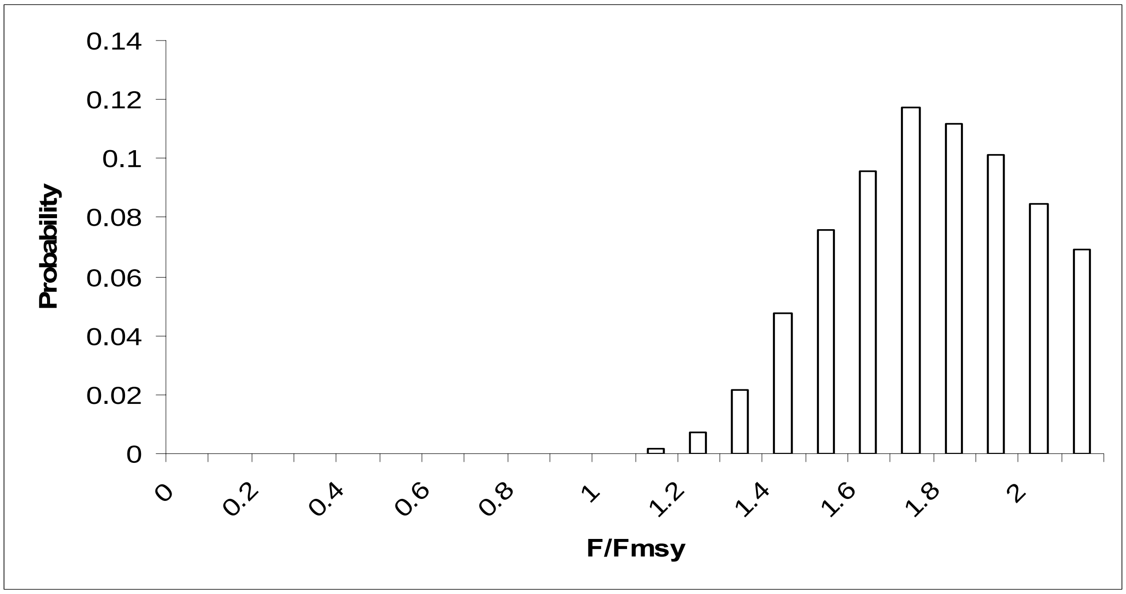

Fig. 5: Distribution of the estimates of the ratio of current fishing mortality, F, to the F resulting in maximum sustainable yield, F_{msy}. Values above 1.0 are considered overfishing.

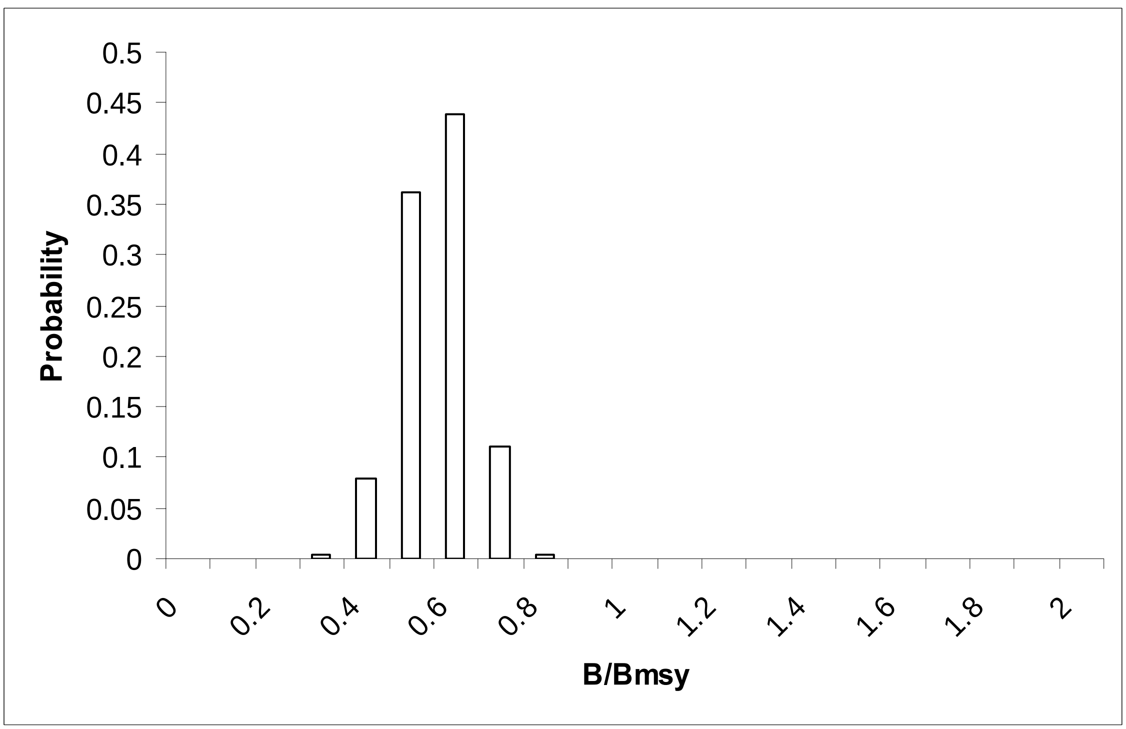

Fig. 6: Distribution of the estimates of current biomass, B, to the biomass capable of producing maximum sustainable yield, B_{msy}. Values less than 1.0 indicate the stock is overfished.

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5.2 Large Pelagic Fish Resource Working Group (LPWG)

Chairman: Leslie E. Straker
Derrick Theophille (Dominica); Paul Phillip (Grenada); Leslie Straker (St. Vincent and the Grenadines) Garth Ottley and Louanna Martin (Trinidad and Tobago); Kathy Lockhart (Turks and Caicos Islands); David Die (Consultant/ ICCAT)

A. Overview

At the Fourth Annual CRFM Scientific Meeting held in 2008 Mr. Christopher Parker, Barbados, was selected as Chairman of the Large Pelagics Working Group (LPWG) for the Fifth Annual Scientific Meeting. However, Mr. Parker was unable to attend this meeting. As a result a new chairperson was nominated, Mr. Leslie Straker. Dr. David Die was the consultant assigned to work with the LPWG. The group approved the following set of tasks on which it would focus its attention during the working group session:

1. Review of inter-sessional activities

    a. Review of the ICCAT Data Training Workshop held in Guyana, plus its recommendations to be considered by the LPWG:

        i. Preparation of an ICCAT SCRS paper providing feedback on the data queries raised by ICCAT during the Feb 09 Guyana workshop - countries concerned would have to provide their explanations and perhaps data as well to justify the explanations.

        ii. Preparation of an ICCAT SCRS paper by Trinidad and Tobago (T&T) to document and justify revision of the T&T billfish catch-series held in the ICCAT database.

        iii. Finalization of port sampling proposal

    b. Review of the ICCAT SCRS 2008 report, including relevant recommendations to be considered by the LPWG.

    c. Review and possible finalization of proposal being prepared by the Turks and Caicos Islands to improve monitoring and management of its finfish fishery.

2. Review and conduct assessments of selected species

3. Discuss training of workshop participants in fisheries statistical analyses

Review of Inter-sessional Activities

Review of outcomes of ICCAT Data Training Workshop
ICCAT, with the support of CRFM, organized a data training workshop in Georgetown, Guyana, February 16-20, 2009. During the workshop participants agreed to revise, after the workshop, some specific issues pertaining the national data provided to ICCAT. The LPWG reviewed the progress made on these issues. The following sections summarize such progress.

Review of billfish catches of Trinidad &Tobago

Prior to 2001, reports of longline billfish landings provided by Trinidad and Tobago (T&T) to the ICCAT Secretariat contained "billfish unclassified." Since 2001 these landings are reported by species. An ICCAT SCRS paper was prepared to review the longline landings for T&T, including the disaggregation of the "billfish unclassified" reports. As a result T&T billfish landings are now reported by species from 1983 onwards. The draft paper is included in Addendum 1.

SCRS paper summarizing responses to data query issues

Several country specific data query issues were raised pertaining to Task 1 at the Guyana workshop. Participants from the relevant countries at the CRFM workshop provided answers to these questions and prepared a draft ICCAT SCRS paper. The draft paper is included in Addendum 2.

During the plenary session of the present meeting, it was suggested that a short introduction and rational section be included in this proposed paper. It was also suggested that in the case of Grenada, a short description of the longline fishery should be included. This will ensure that there are no further misinterpretations by ICCAT with respect to the size of the operations in this country. A query was raised with respect to the verification of the St. Vincent and the Grenadines NEI data from 1990-1999. It was suggested that some information should still be available at ICCAT at least in hardcopy. However, the ICCAT representative indicated that this might not be so and that instead, St. Vincent and the Grenadines should approach the vessel companies and possibly the port in Trinidad and Tobago to look into the possibility of reconstructing some of this data from records that might be available on file. St. Vincent and the Grenadines re-iterated its commitment to resolving this issue and indicated that if portions of the NEI catch were to be officially allocated to St. Vincent and the Grenadines this must be done with some proven justification.

Development of a proposal for port sampling and at sea-observer data collection

The LPWG completed the development of a proposal for ICCAT funding that will support the establishment of port sampling at the transshipment ports of Trinidad where vessels from Belize, St. Vincent & Grenadines and Trinidad & Tobago land tuna and tuna-like species. Additionally, the proposal aims at collecting data in Tobago and Barbados, from port sampling in the former and at-sea observer on the later. Data collected will be landings by species and size data on all ICCAT species. The proposal requests two years of funding from ICCAT and is part of an initiative of CRFM and ICCAT to help contracting parties to fulfil their obligations for data collection. The draft proposal is included in Addendum 3.

During the plenary session of the present meeting, it was indicated that it might be useful to obtain some additional information from the vessels in this proposed sampling program. Some efforts could be focused on collecting some ex-vessel prices and other socio-economic data which could be more beneficial to the countries. However, it was indicated that although this could be useful data, at the moment, it was not a priority for ICCAT. While it is understood that the general focus of the proposed project will be on collecting information on catch, effort and landings, some of these socio-economic type data could also be collected. This could be decided upon by the Parties involved.

There were also some discussions about making the use of logbooks by these target longliners in the proposed program, mandatory. It was indicated that for some of these vessels, in particular, the St. Vincent and the Grenadines registered high-seas vessels, this was already mandatory. However, it is the companies who send the information to the fisheries authority from these logbooks. No fisheries official ever inspects these logbooks. With the proposed sampling program this could be one of the duties of the samplers at the ports – to verify what is reported to the officials from the logbooks.

The question was raised as to whether Grenada, a non-contracting party to ICCAT, could be included in this proposal to at least benefit from the training element. However, it was indicated that because Grenada was a non-contracting party it was uncertain as to how ICCAT will treat this request. The ICCAT representatives indicated that from time to time, ICCAT organizes training workshops by regional blocks on various technical topics from which all countries could benefit. The 2008 Guyana training workshop was given as an example of such a training workshop.

Review of 2008 ICCAT SCRS report

The ICCAT SCRS considered in its meeting of 2008 the proposal by CRFM to hold an ICCAT-CRFM join assessments of Spanish mackerel and blackfin tuna. ICCAT SCRS identified two impediments with respect to moving forward with this proposal: financial resources to support the meeting and the lack of an established agreement between CRFM and ICCAT. There is a need for such agreement to clearly define the output of such a meeting. The LPWG agreed to attempt in the late part of 2009 some form of web-based collaboration between CRFM and selected ICCAT scientists to initiate the activities required to support such a joint assessment.

Turks and Caicos Island Concept Note for Finfish Fishery

Turks and Caicos Islands (TCI) expressed the desire to have the LPWG to comment on a document aimed at guiding the research and monitoring efforts of TCI regarding the finfish fishery of the archipelago. The document proposes a definition of the “universe” represented by the Fin-fish fishery in TCI during 2009. TCI requested the LPWG to examine this document to determine if some of the ideas presented in the document should be applicable to recreational fishery monitoring in other CRFM countries.

The Concept Note was divided into two documents. One is a Concept Note inclusive of policy, goals and objectives. It would be a briefing to show managers that intention of the research priorities for the fin-fish fishery. A second document would be a research strategy to develop a research-monitoring program of the Fin-fish fishery. The current draft of the concept note is provided in Addendum 4.

Essential data to be collected include a list of all landing sites (number and locations), gear types used, and number of fishers involved in the fishery. Additionally a list of priority species (perhaps the top 10-20) needs to be developed. These species should be those of high importance in the fishery because of their quantity and/or value but also may include some of high importance because of their critical conservation status. TCI may consider the process being used in Puerto Rico to develop a similar list for the fisheries of the island[5]. Information on the timing and seasonality of activities as well as historical information on its evolution, even if it includes anecdotal references, needs to be collated as well. Finally the paper proposes to make costs estimates of the monitoring requirements.

All information should be summarized in a briefing document that can help the planning of the overall strategy for data collection. Because TCI proposes to aim at no more than 20% maximum error in sampling it is imperative that the TCI prioritize the value of different data sets. Once the sampling strategy is determined, then forms can be easily created and implemented. Guidance on survey design can be obtained from FAO publications on the matter provided to the LPWG by the consultant.

It was discussed that the collection of information from the sport/recreational fishery may prove rather problematic. It was suggested to collect information by a visiting card supplied when purchasing a fishing license. Alternatively, fishers purchasing a license could be asked to provide an

[5] Todd Kellison, NOAA SEFSC personal communication

email address so that TCI could send them a message directing them to a website where they could enter information on their recreational catch. Regardless of the method used for data collection it was agreed that some form of incentive would have to be provided to encourage recreational fishers to report landing information.

Assessments
In 2008 the LPWG agreed to conduct an assessment of dolphinfish during the 2009 CRFM scientific meeting. Unfortunately no new information on dolphinfish was brought to the 2009 meeting by participants. Therefore it was agreed that this species would not be reassessed this year but in 2010.

The LPWG reviewed whether any new information on other pelagic species (eg. wahoo, king mackerel…) was available to be analyzed, but none was forthcoming hence it was agreed that this year the group would not conduct any new or update past assessments.

Training in fisheries statistical analyses
The LPWG considered that beyond the need for supporting training for single species assessment there is also a need to train CRFM scientists in techniques related to the assessment of the entire ecosystem. The LPWG examined the accomplishments of the FAO-LAPE project and its possible application to the future work to be done by the LPWG as it moves towards providing assessments that follow the principles of ecosystem-based fishery management. Specifically, the LPWG proposes to use the results of the LAPE Project as a source of data and models that can support training session on ecosystem categorizing tools. This training would allow the LPWG to embark in future evaluations of the health of the entire pelagic ecosystem and not restrict itself to individual stocks. With the view of kick starting this process the LPWG constructed a time series of the average trophic level of fish harvest from 1979-2008 by the St. Vincent and the Grenadines fleet. This preliminary assessment is included in Addendum 5.

The plenary session of the present meeting, supported the type of analyses that were reported in appendix 5, and the initiative of the LPWG to start thinking about analyses at the ecosystem level and with a broader focus than the current single-species assessments. Except for the LPWG none of the other group indicated that they give any great consideration to this idea in their deliberations. The plenary session also agreed that other CRFM scientific working groups should consider some of the available ecosystem tools in their analyses as the next necessary step in getting a better understanding of many of the Region's fisheries.

General Recommendations
Three major recommendations are made by the LPWG: continuing the exploration of ecosystem indicators, conducting a dolphinfish assessment in 2010 and postponing the blackfin tuna and Spanish mackerel assessment until at least 2011. More details on these recommendations are provided below.

- The LPWG recommends using the results of the LAPE project to start developing ecosystem indicators for the pelagic ecosystem. This would be a very useful way to learn more about the fishery ecosystem as opposed to continuing to focus our attention on single species analyses. This may be done in several ways:
    - Communicating results of single species CRFM assessments to LAPE scientists so that the models developed by LAPE can continuously be updated.
    - Spend the time looking at the assumptions made by the LAPE project, making corrections where required and transmitting these to LAPE scientists.
    - Take some ownership of the modelling effort by LAPE and re-run their regional ECOPATH model by making and effort of changing some of the parameters to

answer different questions that they did not consider during the LAPE project and that are of interest to the LPWG.

- Conduct a dolphinfish assessment in 2010 making sure that this time it includes some of the other key regional fishery fleets that were not considered in the prior assessment (i.e. Trinidad and Tobago, France and Venezuela).
    - During the intersession, LPWG members should help convince these other countries to supply the data or facilitate their participation at the CRFM Scientific Meeting. The opportunity might be there for one of the members of the LPWG to attend the GCFI or the ICCAT-SCRS to develop appropriate network to get information on the dolphinfish from Venezuela and other relevant countries attending GCFI.
    - The group should to set up an inter-sessional meeting through video conferencing prior to a dolphinfish assessment and invite France, Venezuela, etc, to discuss what other available data these countries might have. This should probably be done early in the last quarter of 2009.
- Postpone the Spanish mackerel and blackfin tuna assessments until at least 2011 when we can better assess the success of the video-conferencing efforts to involve other countries.

Addendum 1 to LPWG Report: Preliminary review of historical billfish catch data reported by Trinidad and Tobago

Louanna Martin[6], David Die

SUMMARY

A method is proposed and justification presented for the preliminary revision of longline billfish catch data reported by Trinidad and Tobago over the period 1983 to 2007

KEYWORDS

Fishery statistics, billfish, Atlantic blue marlin, Atlantic white marlin, Atlantic sailfish, Longbill spearfish, Black marlin

Introduction

Prior to 2001, Trinidad and Tobago reported some catches of billfish as unclassified billfish, even though it also reported catches of blue marlin, black marlin, sailfish and spearfish. Unclassified catches contained a mixture of species that were not separated by the longline fleet in their landing reports as well as in fishing tournament reports. As a result, reports to ICCAT made prior to 2001 did not include a complete breakdown of the catches of the different billfish species for Trinidad and Tobago. Since 2001, Trinidad and Tobago has been reporting most of its billfish landings separated by species; only 4% of the landings were reported as unclassified billfish.

Trinidad and Tobago wishes the SCRS to acknowledge inconsistencies between the data reported to ICCAT by Trinidad and Tobago and the existing Task I data and to revise its billfish catch data to more accurately reflect the composition of the catches reported as unclassified billfish. In order to facilitate the revision, this paper presents a method for the disaggregation of Trinidad and Tobago's unclassified billfish catch data and utilises this method to revise the Country's historical longline billfish catch data. The paper also highlights inconsistencies between reported and Task I data.

The longline fleet

As a result of restrictions in the national legislation, the Trinidad and Tobago longline fleet of the 1980s and 1990s was considered as comprising vessels that were both locally flagged and foreign flagged; the commonality being that the vessels were all locally owned. The 1993 national report indicates the numbers of vessels in various categories: Taiwanese-flagged vessels, vessels flagged within the region (mainly St Vincent and the Grenadines) and local vessels. The fleet of the 1980s and 1990s was also described as comprising locally-owned locally-flagged and locally-owned foreign-flagged longliners; the foreign flags were mainly USA, St Vincent and the Grenadines and the British Virgin Islands (Fisheries Division, 2001; Fisheries Division, 1998). In 2002 the data for these vessels flagged in USA, St Vincent and the Grenadines and the British Virgin Islands were included in the Task I database as Trinidad and Tobago catch upon confirmation that those countries had not previously reported the catches. The designation 'locally-owned foreign-flagged' no longer applied after the Government of Trinidad and Tobago amended the restrictive legislation.

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National reports to ICCAT ceased to use the designation ‘locally-owned foreign-flagged’ beginning with the report for the year 2001. The number of vessels reported in each fleet category by year for the period 1989 to 2001 is given in Table 1.

The Taiwanese-flagged longliners were reported to have fished mainly on the high seas and in the South Atlantic targeting, albacore. During the 1980s and 1990s the locally-owned longliners fished mainly off Trinidad and Tobago’s east coast – and continue to so do, targeting yellowfin tuna and swordfish.

Catch reporting of billfish

From 1993 until 2000 Trinidad and Tobago reported some billfish catches as unclassified billfish. It appears that some of these reported catches were allocated to a single species of billfish by ICCAT. These inconsistencies between the reports provided by Trinidad and Tobago and the data contained in Task I are illustrated in Table 2. It appears that the aggregated billfish catches reported by Trinidad and Tobago were assigned solely to blue marlin in the Task I database by ICCAT. Inconsistencies related to other species-gear-year combinations between Task I data and reports provided by Trinidad and Tobago were also identified and are illustrated in Tables 2 and 3.

Atlantic white marlin was captured by Trinidad and Tobago prior to 2001 as indicated in national reports and reporting tables, however – with respect to Trinidad and Tobago – the species does not appear in the Task I ICCAT database. The 1997 National Report gives the catches of Trinidad and Tobago longliners as well as quantities categorization by locally-owned foreign flagged vessels. Included in Table 1 of the Report – titled “Landings of the Trinidad and Tobago longliners for the period January-December 1997” – is the grouping ‘marlin (*Makaira sp., Tetrapterus sp.*)’. The 2002 Reporting Table submitted by Trinidad and Tobago includes a note indicating that billfish data reported previously – meaning prior to 2001 – comprised mainly white marlin and blue marlin. Additionally, the submission of catch data, for the period 1983 to 1991, under the category ‘*Marlin sp.*’ In the 1993 National Report is an indication of the presence of blue and white marlin. Sailfish was always separated in the landings and was not included in the billfish unclassified category.

The inclusion of catches of black marlin for the period 2005-2007 may be the result of misidentification of the species since the species is not likely to be caught in north Atlantic where the fleet fishes. These figures most likely represent catches of blue marlin.

Revised estimates of billfish catch

Based on the fleet and data considerations outlined, the Trinidad and Tobago Task I landings data for billfish species caught by longliners were revised by applying proportional multipliers to BIL (unclassified billfish) catches as originally reported. The multipliers were derived by determining the proportion of each of BUM, SPF and WHM of the total longline catches of BUM, SPF and WHM for the period 2001-2007 the only period for which data are disaggregated for these species. Although longline, recreational and artisanal catches were reported as unclassified billfish, only longline unclassified billfish catch data are disaggregated in this paper. Further revision of the methodology and the data will be undertaken as more data mining is undertaken.

Because Sailfish was always separated, the category billfish unclassified was calculated to represent a mixture of blue marlin, white marlin and spearfish.

The catch reported as BLM for the period 2005-2007 was re-assigned to BUM.

The percentages of blue marlin, white marlin and spearfish landed by the Trinidad and Tobago fleet during the period 2001-2007 were, 60.21%, 39.78% and 0.01% respectively. These percentages were used to disaggregate the catch of unclassified billfish reported for the periods 1983-2000, 2003 and 2005 (Table 4). It is therefore proposed that preliminary revision of Trinidad and Tobago's historical billfish data should be reflected in the Task I database as shown in Tables 5a and 5b.

Acknowledgements

We wish to thank Dr Susan Singh-Renton for her support and guidance as convenor of the Fifth Annual CRFM Scientific Meeting which facilitated the completion of this paper and for her insightful review of the paper. Many thanks are extended also to Elizabeth Mohammed for her constructive review of the paper and suggestions for future refinement of the methodology. We wish to express our gratitude to the participants of the Fifth Annual CRFM Scientific Meeting for their support.

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Table 1: Trinidad and Tobago longliner fleet categorization: reported number of vessels by year

	Category of longliner as identified in National Reports and Task I Statistics				
Year	Local	Other foreign	Taiwanese	Locally-owned locally flagged	Locally-owned foreign flagged
1989	9	14	21		
1990	10	29	25		
1991	10	29	25		
1992	10	29	25		
1993				12	Not available
1994				12	6
1995				14	6
1996				14	7
1997				18	8
1998				17	7
1999				18	5
2000				19	Not available
2001				9	

Table 2: Comparison of Trinidad and Tobago's reported catches with Task I data for the period 1993-2000 (Data depicted as TT Report correspond to figures included in the official Trinidad and Tobago submissions to ICCAT; Task I figures correspond to values obtained from Task I as downloaded from the ICCAT website in June 2009)

(MT)	Fleet/Gear code	1993	1994	1995	1996	1997	1998	1999	2000
TT Report – BIL	LL	2.6	26.6	45.7	20.5	81	24.7	32.8	9.1
	Recreatnl	0.5	0.3			1.2	1.2	0.5	
	Total	**3.1**	**26.9**	**45.7**	**20.5**	**82.2**	**25**	**33.3**	**9.1**
Task I – BIL		No catches are assigned to BIL for the period 1993-2000							
	Total								
TT Report – BUM	LL								
	Artisanal								45.7
	Recreatnl	0.4			1.6				
	Total				**1.6**				**45.7**
Task I – BUM	LL	3	8	10	11	14	25	18	9
	LLFB		19	1	10	4		0.3	
	SURF			35		62	45	15	46
	Total	**3**	**27**	**46**	**21**	**81**	**70**	**33**	**55**
TT Report – SAI	LL	0.8	2.1	0.5	3.5	10.4	24.7	36.8	2.9
	Recreatnl	0.4	0.3	0.5	0.04	0.03	0.3	0.09	0.5
	Total	**1.2**	**2.4**	**1**	**3.5**	**10.4**	**25**	**36.9**	**3.4**
Task I – SAI	LL	56	101	101	103	10	7	4	3
	LLFB				1	1			
	SPOR								1
	Total	**56**	**101**	**101**	**103**	**11**	**7**	**4**	**3**
TT Report – SPF		No catches were reported							
	Total								
Task I – SPF	LL	62							
	Total	**62**							

Table 3: Comparison of Trinidad and Tobago's reported catches with Task I data for the period 1983-1992 (Data depicted as TT Report correspond to figures included in the official Trinidad and Tobago submissions to ICCAT; Art. = Artisanal, Rec. = Recreational; Task I figures correspond to values obtained from Task I as downloaded from the ICCAT website in June 2009).

(MT)	Fleet/Gear Code	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
TT Report – BIL	LL	21.2	31.6	4	70	153.1	74	18.8	15.6	7.1	
	Total	**21.2**	**31.6**	**4**	**70**	**153.1**	**74**	**18.8**	**15.6**	**7.1**	
Task I – BIL	LL	21	32	4	70	153	74	19	16	7	
	Total	**21**	**32**	**4**	**70**	**153**	**74**	**19**	**16**	**7**	
TT Report – BLM	LL	1	5.7	2.4	16.2	0.4		25.5	1.8		
	Total	**1**	**5.7**	**2.4**	**16.2**	**0.4**		**25.5**	**1.8**		
Task I – BLM	LL	1	6	2	16			26	2		
	Total	**1**	**6**	**2**	**16**			**26**	**2**		
TT Report – BUM	LL	1.7	0.2					0.9			
	Rec.	0.1	0.5	0.5	0.5	0.5	0.2	0.6	1.1	1.6	0.5
	Total	**1.8**	**0.7**	**0.5**	**0.5**	**0.5**	**0.2**	**1.5**	**1.1**	**1.6**	**0.5**
Task I – BUM	LL	3	7	3	17	1		27	3	4	3
	SPOR		1			1		1	1	2	1
	Total	**3**	**8**	**3**	**17**	**2**		**28**	**4**	**6**	**4**
TT Report – SAI	LL	64.4	57.7	14.1	24.1	34.8	23.7	8.8	3.6	1.2	
	Art.							0.7	2	1.3	2.2
	Rec.	0.2	0.1	0.2	0.6	0.4	0.3	0.5	0.9	0.2	0.5
	Total	**64.6**	**57.8**	**14.3**	**24.7**	**35.2**	**24**	**10**	**6.5**	**2.7**	**2.7**
Task I – SAI	LL	64	58	14	24	35	24	9	6	3	2
	SPOR				1			1	1		
	UNCL							1	2	1	2
	Total	**64**	**58**	**14**	**25**	**35**	**24**	**11**	**9**	**4**	**4**
TT Report – SPF	LL				53.4	74.6	9.7	6.7	1		

	Total				**53.4**	**74.6**	**9.7**	**6.7**	**1**		
Task I – SPF	LL				54	75	10	7	1		
	Total				**54**	**75**	**10**	**7**	**1**		

Table 4: Disaggregation of <u>longline</u>, unclassified billfish catches reported by Trinidad and Tobago for the period 1983 to 2000

(MT)	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
BUM	12.815	19.053	2.383	42.163	92.218	44.525	11.343	9.395	4.292
WHM	8.467	12.588	1.574	27.857	60.928	29.417	7.494	6.207	2.836
SPF	0.002	0.004	0.000	0.008	0.017	0.008	0.002	0.002	0.001
(MT)	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
BUM		1.565	16.015	27.515	12.342	48.769	14.871	19.749	5.479
WHM		1.034	10.581	18.179	8.154	32.221	9.825	13.047	3.620
SPF		0.000	0.003	0.005	0.002	0.009	0.003	0.004	0.001

Table 5a: Billfish catches for Trinidad and Tobago for all gears and species for the period 1983-1995. Shaded cells are those that have been modified.

(MT)		1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
BIL	LL													
	SURF													
	RR											0.500	0.300	
	Total											0.500	0.300	
BLM	LL	0.966	5.676	2.410	16.272	0.446		25.538	1.844					
	SURF													
	RR													
	Total	0.966	5.676	2.410	16.272	0.446		25.538	1.844					
BUM	LL	14.536	19.250	2.383	42.163	92.218	44.525	12.257	9.396	4.292		1.565	16.015	27.515
	SURF													
	RR	0.155	0.525	0.469	0.487	0.538	0.232	0.604	1.136	1.620	0.538	0.450		
	Total	14.691	19.775	2.852	42.650	92.756	44.757	12.861	10.532	5.912	0.538	2.015	16.015	27.515
SAI	LL	64.415	57.688	14.094	24.158	34.766	23.683	8.810	3.587	1.203		0.800	2.100	0.500
	SURF							0.688	2.017	1.347	2.173			
	RR	0.243	0.078	0.175	0.621	0.386	0.302	0.549	0.905	0.227	0.490	0.400	0.300	0.500
	Total	64.658	57.766	14.269	24.779	35.152	23.985	10.047	6.509	2.777	2.663	1.200	2.400	1.000
SPF	LL	0.002	0.004	0.001	53.889	74.602	9.674	6.654	1.000	0.001		0.000	0.003	0.005
	SURF													
	RR													
	Total	0.002	0.004	0.001	53.889	74.602	9.674	6.654	1.002	0.001		0.000	0.003	0.005
WHM	LL	8.468	12.589	1.574	27.857	60.928	29.418	7.495	6.208	2.836		1.034	10.581	18.179
	SURF													
	RR													
	Total	8.468	12.589	1.574	27.857	60.928	29.418	7.495	6.208	2.836		1.034	10.581	18.179

Table 5b: Billfish catches for Trinidad and Tobago for all gears and species for the period 1996-2007. Shaded cells are those that have been modified.

(MT)		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
BIL	LL												
	SURF								4.782	3.297	6.598		
	RR		1.200	1.200	0.500								
	Total		1.200	1.200	0.500				4.782	3.297	6.598		
BLM	LL												
	SURF												
	RR												
	To												
BUM	LL	12.343	48.769	14.872	19.748	5.479	14.000	9.000	8.662	10.132	6.725	11.704	13.770
	SURF					45.700		7.000					
	RR	1.600					3.000		0.220	0.744	0.153	0.286	0.757
	Total	13.943	48.769	14.872	19.748	51.179	17.000	16.000	8.882	10.876	6.878	11.99	14.527
SAI	LL	3.500	10.400	24.700	36.800	2.900	7.000	6.000	7.356	10.341	8.505	17.228	12.998
	SURF							0.080	0.049	0.049	0.049	0.049	0.049
	RR	0.040	0.030	0.300	0.090	0.500		0.090	0.179	0.046			
	Total	3.540	10.430	25.000	36.890	3.400	7.000	6.170	7.584	10.436	8.554	17.277	13.047
SPF	LL	0.002	0.009	0.003	0.004	0.001	0.000	0.000	0.001	0.000	0.000	0.013	0.000
	SURF												
	RR												
	Total	0.002	0.009	0.003	0.004	0.001	0.000	0.000	0.001	0.000	0.000	0.013	0.000
WHM	LL	8.155	32.222	9.826	13.048	3.620	2.250	5.000	12.315	5.854	5.933	5.437	12.099
	SURF												
	RR												
	Total	8.155	32.222	9.826	13.048	3.620	2.250	5.000	12.315	5.854	5.933	5.437	12.099

Addendum 2 to LPWG Report: ICCAT Statistics for Caribbean Countries: Some Revisions and Clarifications

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SUMMARY

During the ICCAT sponsored Caribbean Data Training Workshop, held in Georgetown, Guyana, February 16-20, 2009 a review of ICCAT data identified several issues pertaining Task 1 data. This paper represents a compilation of the responses to these issues provided by some Caribbean countries.

Rationale

During the ICCAT sponsored Caribbean Data Training Workshop, held in Georgetown, Guyana, February 16-20, 2009 *a review of ICCAT data identified several issues pertaining Task 1 data*. At that meeting it was agreed that scientists from countries identified in the list of issues would seek to provide responses to ICCAT. During the CRFM Fifth Annual Scientific Meeting participating countries took the decision to submit a joint response to these issues to the ICCAT SCRS Committee. This paper therefore represents a compilation of the responses to these issues by some Caribbean countries. For each country the issue identified at the Guyana meeting is listed as the heading, then an explanation is given on the issue and finally a recommendation is made regarding how the ICCAT data should be adjusted.

Grenada – Catches reported as UN (unclassified) gear should be reviewed

Prior to the 1980's most species of importance to ICCAT were captured off the west coast using handlines (a-la-vive). In 1980, longlining was introduced to the west coast and since then, these species were captured using longlines.

Recommendation (s):

ICCAT should adjust data as follows:

a) Before 1980, main gear - Handline
b) After 1980, main gear - Longline

Dominica – Confirm the catch of major tuna species for 1990 – 2003

For the years 1990 to 2000, landings of ICCAT species by Dominican fishing vessels came from vessels using trolling. The only exceptions to this were yellowfin tuna and swordfish which were caught using surface longlines. Afterwards, from 2001, catches were mainly due to hand lines around the newly introduced Fish Aggregating Devices (FADs). This method is currently used to capture some of the larger tuna species along with marlin and swordfish. However, species such as wahoo, skipjack and blackfin tuna continue to be caught by trolling.

Recommendation(s):

ICCAT should adjust data as follows:

a) 1990 -2000 all species except YFT and Swordfish the main gear was trolling
b) 1990 – 2000 YFT and Swordfish were caught using longlines
c) From 2001 all species except wahoo, skipjack and blackfin were caught using handlines.
d) From 2001 wahoo, skipjack and blackfin were caught by trolling

St. Vincent and the Grenadines – Large catches of YFT, ALB and BET in 2000, No reports prior to 2000

St. Vincent and the Grenadines confirms that a significant portion of catches for YFT, ALB, and BET and some other species prior to 2000 were reported to ICCAT under the NEI flag list. It is only after 2000 that SVG began reporting catches for its high seas fleet of vessels to ICCAT. Before 2000 catches reported represented effort from the local artisanal fleet only. However, it is known that SVG operated a tuna high-seas fishing fleet during the period 1990-1999.

Recommendation(s):

a) St. Vincent and the Grenadines will endeavour to collect information from agents of high-seas vessels to obtain catches by species for the period 1990 – 1999. It is not known whether these catches can be compiled or if such data is still available.

St. Lucia – Update all UN gear to TR and change BFT to Black Fin Tuna.

St. Lucia confirms that the main gear for fishing tuna and tuna-like species is trolling.

Recommendation (s):

ICCAT should adjust data as follows:

a) All UN gear should be changed to TR (Trolling) since this is the main gear for major tuna spp.
b) BFT catch series should be changed to Black Fin tuna because BFT reports were likely to be resulting from miss-coding of species.

Trinidad & Tobago – Review of the recreational catch series for 1990 - 2007. Check catch of BET 1991 and ALB 1992. Raise sample data to total catch. Provide estimates of species break down for unclassified billfish reports.

A Separate SCRS paper (Martin, 2009) has been prepared to address changes to Task I billfish data from Trinidad and Tobago.

Barbados – Update gear definition (UN) for all major tuna spp. Search for 2004/2005 catch of ALB, BET, BLM. Replace carry-overs with catch data SWO (2003/05).

No resolution to these issues.

Turks and Caicos Islands – Review recreational catch series for BUM from 2003 & review SWO catches could likely be BUM.

Upon review of the recreational catches since 2003, the TCI has determined that the recreational catches were indeed BUM. However, since 2007, the TCI has had two (2) commercial vessels that have captured SWO for local use. The following are catches of SWO for local use:

2007	0.22 MT
2008	0.06MT
2009	0.08MT

Addendum 3 to LPWG Report: Proposal - Assistance for the improvement of port and at-sea sampling programs for ICCAT species at four Caribbean CPCs

Background

During the Caribbean data training workshop held in Guyana in February 2009 (ICCAT 2009), several participating countries had an opportunity to review the quality of their national statistical contributions to the ICCAT database. Taking into account their national data reporting obligations to ICCAT, and the need to monitor and control overall compliance with ICCAT recommendations these countries then also considered options for improving their national statistical monitoring programs. Among the priority tasks identified, four developing CPCs (Barbados, Belize, St. Vincent and the Grenadines and Trinidad and Tobago) confirmed the need to improve sampling of their commercial tuna fishing fleets, particularly at high priority landing locations such as the trans-shipment ports in Trinidad and Tobago.

Rationale

The present proposal seeks to address this need through the establishment of a port sampling program, at these trans-shipment ports and complementing current sampling to other components of the fleets and components of the catches that are not presently properly covered, namely landings in Tobago and size data collection from the landings in Trinidad and Barbados. The program aims at achieving acceptable and appropriate statistical coverage (ICCAT 2008) of the key tuna and tuna-like landings and transhipments of these four CPCs.

Description of longline operations at four Caribbean CPCs

Landings of longline-caught tuna and tuna-like species at Trinidad and Tobago ports

The Trinidad and Tobago longline fleet utilizes landing sites at Port of Spain and Chaguaramas to offload their catches. This fleet currently consists of 24 vessels, ranging in size from 13.9 to 23.5 m LOA. During 2003-2007, the average reported annual landings of this fleet were around 500 mt. The landings take place at the trans-shipment ports of Port of Spain and Chaguaramas as well as at other sites in Port of Spain and Chaguaramas which are in close proximity to the trans-shipment ports.

Longline fishing vessels of Belize and St. Vincent and the Grenadines, that are licensed to operate within the ICCAT Convention Area, offload or trans-ship their catches at these same trans-shipment ports in Trinidad and Tobago. Companies operating fishing vessels flagged with Belize and St. Vincent and the Grenadines have a leasing arrangement with the authorities in Trinidad and Tobago to use the Port of Spain port and at least one Belizean vessel is known to utilize the port at Chaguaramas. The ports operate 24 hours everyday of the week, although most landing and trans-shipment in Port of Spain take place during 0800-1800h. Vessels are downloaded one at a time at each trans-shipment port.

At these ports, catches of target species such as large tunas and swordfish are usually transhipped and exported to the USA either chilled or frozen, while bycatch species such as billfish are sold in the local market or shipped to neighbouring islands like Barbados. In the period 2000-2007, the total amount of major tuna species (sensu ICCAT[7]) trans-shipped by Belizean and St Vincent vessels at the port in Trinidad and Tobago, represented, according to ICCAT task I records[8], 32,500

[7] Includes large tunas, such as yellowfin tuna, albacore, bigeye tuna, important billfish, such as blue marlin, white marlin, sailfish and swordfish

[8] This assumes that all reported landings of longliners from Belize and St. Vincent are landed in Trinidad and Tobago.

mt, or an average of 4,000 MT a year. In addition to transhipment of catches, the vessels utilize the transhipment port for other services, e.g. to replenish food, fuel and crew, as well as vessel maintenance and repair services.

Tobago longline fleet
Tobago has just commissioned a new 22 m longliner that will be based at Castara. The vessel is due to start fishing operations in 2009 and it is imperative that its catches are properly monitored and reported to ICCAT.

Barbados longline fleet
The Barbados longline fishing fleet consists of 36 vessels, ranging in size from 12 to 23 m LOA. During 2000-2007, reported landings for this fleet of major tuna species (sensu ICCAT) were 1,789, thus an annual average of about 220 mt. The main landing site for these vessels is the Bridgetown Fisheries Complex (Mahon and Mc Conney 2004). The only other important landing site is the Oistins Fishing Complex.

Table 1: Summary of longline fleet characteristics and operations for each of the four named CPCs.

Type of data & information	**Country**			
	Barbados	Belize	St. Vincent and the Grenadines	Trinidad and Tobago
Numbers of vessels	36	14	34	24
Number of vessels > 24 m LOA	0	14	19	0
General fishing areas	EEZ and adjacent high seas	Between 0-30° S, 0-30° N 0-60° W	Two main areas: (i) Between 5-20° N and 30-60°W (ii) Between 20-30° S and 30-45°W	Between: 8-13° N and 50-62° W
Top five species landed 2000-2007	YFT SAI SWO WHM BUM	YFT SWO ALB BET SAI	YFT ALB BET SKJ SAI	YFT SWO BET ALB BUM
Average annual catches (mt) of major tuna species	220	200	3,800	500
Key landing/ transhipment locations	Bridgetown Oistins	Port of Spain and Chaguaramas (Trinidad and Tobago)	Port of Spain and Chaguaramas (Trinidad and Tobago)	Port of Spain and Chaguaramas

Method
Assistance is required to improve the sampling program in all four CPCs. This assistance involves the development of a port sampling program at the ports of Port of Spain and Chaguaramas, in Trinidad, in Bridgetown, Barbados and at the port of Castara in Tobago. Details on these activities are provided below.

Port sampling in Trinidad
There is a need to establish a data collection system for longline vessels transhipping and landing their catch at the ports of Chaguaramas and Port of Spain. There is also a need to collate available historical data on these transhipments.

Paper records of transhipments are available in Trinidad. These records need to be digitized to help revise the historical time series of longline landings that are known to be incomplete for the fleets of St. Vincent and the Grenadines (no data available prior to 2000), Belize (few data prior to 2005), and Trinidad and Tobago (prior to 1994). Data will be entered in an ACCESS database and provided to each of the countries for which landings from their vessels are available. A summary of all historical landings will also be provided to ICCAT and the CRFM.

Vessel arrivals at the transhipment port are irregular. Usually, a vessel captain contacts the port manager 24 to 48 hours in advance to advise that the vessel needs to come into port. While transhipment operations may be irregular, a single operation could involve significant quantities of fish. On the other hand, local longline vessels land smaller catches, but these landings are made more regularly.

Based on present limited knowledge of the actual daily variation in vessel arrivals and landing levels at the various landing locations, it is proposed that six data collectors will be needed to conduct sampling full-time throughout the year. Four data collectors are to be allocated to sampling at the transhipment ports in view of the greater landings at this location, while the other two data collectors are to be assigned to the other landing locations in Port of Spain and Chaguaramas where the local vessels from Trinidad also land. Sampling will aim to achieve up to 30% coverage of landings. Historical data available will be used to develop a stratified sampling design that will provide the most accurate and precise estimates of landings by species possible. Strata considered will be the port, the flag, the vessel category (more or less than 24 m) and the vessel. For the Trinidad fleet, that lands more regularly, month and day of the week will be additional factors used in the stratification, because it will not be possible to cover all landings every day.

The following data will be collected for every landing sampled:

- Fishing effort (length of trip, length of longline, number of hooks, vessel length, vessel horsepower)
- Catch (total landing for all ICCAT species/species group)
- Location of fishing operations (latitude and longitude at 5 degree level or higher)

A random sample of all categories of species landed (as separated by each vessel eg, yellowfin tuna, swordfish, billfish, sharks) will be obtained for more detailed investigation. For those categories that have large landings the random sample will be limited to 50 individual fish. For all others an attempt will be made to sample all individuals. For each individual fish the species, weight, landing state (dressed, whole, frozen etc…) and length of each individual will be recorded. Whenever it is possible to distinguish the sex it will also be recorded.

Port sampling in Castara Tobago
A single data collector will be based in Castara and will be charged with monitoring every landing conducted by the new longline vessel. Data collected will follow the same procedures outline for the sampling in Trinidad, except that every landing will be monitored. Data collected in Tobago will be shared with the Fisheries Division in Trinidad for inclusion in the common database of port landings for the project.

Port sampling in Barbados
The data collector will conduct random representative dockside sampling of longliner landings to collect the following information and data:

- Total counts of the numbers of individuals of each species in the catch. Note that aggregated catch weights of the main groups (e.g. tunas and billfishes) are already routinely collected at the market and this information will be used to disaggregate the landings to the required species level.
- Appropriate morphometric data (body length, weight etc.) of representative samples of the landed carcasses of each species. Landed state will also necessarily be noted.
- Key trip information such as fishing location (latitude and longitude at 5 degree level or higher) and effort information (length of trip, length of longline, number of hooks, vessel length, vessel horsepower) via interviews with the respective vessel captains.

Sampling will aim to achieve at least 30% coverage of all landings.

Recruitment and supervision of personnel

Trinidad-based collectors
The six data collectors be recruited by the Fisheries Division in Trinidad and Tobago and be also based at the Fisheries Division. They will be supervised by Ms. Louanna Martin, the officer in Trinidad and Tobago, who deals with ICCAT statistics.

Tobago collector
The Department of Marine Resources and Fisheries, Tobago House of Assembly will recruit the collector. Direct supervision will be done by the officer in charge of pelagic species in Tobago, Mr. Garth Ottley.

Barbados collector
The Barbados Fisheries Division will recruit the collector. Direct supervision will be done by the fisheries officer in charge of pelagic species Mr. Christopher Parker.

Program coordination
Ms Louanna Martin, Trinidad and Tobago's ICCAT correspondent, will be the main coordinator of the program and will be responsible for the implementation of all port sampling in Trinidad and Tobago, and the overall reporting of the entire program. Mr. Christopher Parker will be responsible for the sampling program in Barbados. Mr. Leslie Straker will be the liaison officer between the program and the St. Vincent and the Grenadines fleet. Mrs. Valarie Manza will be the liaison officer between the program and the Belizean fleet.

It is proposed to establish a Memorandum of Understanding (MOU) between Trinidad and Tobago and Belize, and also one between Trinidad and Tobago and St. Vincent and the Grenadines. The purpose of these MOUs is to define the roles, responsibilities, and relations of the Parties concerned, with special emphasis on collection, computerization and reporting of data during the port sampling program.

Once data collectors from Trinidad have received training and are ready to start data collection the program coordinator will facilitate a visit of the fisheries officers of St. Vincent and the Grenadines and Belize to Port of Spain. During the visits the officers will supervise the sampling of the catches of their national vessels and the correct application of the procedures established in the respective MOUs.

Training of data collectors

At the beginning of the program all the data collectors based in Trinidad and Tobago and Barbados will need to attend a training session in Port of Spain, Trinidad. The session will provide training on sampling procedures (including on the implementation of stratified random sampling), species identification and biological sampling methods.

Reporting

Overall reporting of the program progress will be the responsibility of Ms. Louana Martin, but the supervising officers from Tobago and Barbados will have the responsibility of transmitting the data to her in a timely manner. Reporting of progress will be provided to the ICCAT subcommittee on statistics every year during the meeting of the SCRS. Additionally, the overall program coordinator will provide reports of transhipments made by vessels of Belize and St. Vincent and the Grenadines to the respective officers of each of these countries prior to the deadline for data submission to ICCAT.

Project Staff

Program Coordinator	Louanna Martin	Trinidad and Tobago Fisheries Division
Project leader Barbados	Christopher Parker	Barbados Fisheries Division
Project leader St. Vincent	Leslie Straker	St. Vincent & Grenadines Fisheries Division
Project leader Belize	Valarie Manza	International Merchant Marine Registry, Belize
Port data collectors (6)	TBA	Trinidad and Tobago Fisheries Division
Port data collector (1)	TBA	Tobago Dept. Marine Resources and Fisheries
At-sea observer (1)	TBA	Barbados Fisheries Division

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Budget

Item	Cost per unit (US$) and justification	Total cost (2-year period)	
		ICCAT	CPC (in kind)
Data collector recruitment costs (advertising, interviewing, communication)	Barbados – ($250) Trinidad and Tobago ($750)	$1,000	
Data collating and digitizing of trans-shipment records (6 months salary data entry)[3]	Trinidad and Tobago – $800 @ month	$4,800	
Data collector monthly salary [9]	Barbados – $1,600 @ 24 months Trinidad and Tobago – $849 @ 24 months (7 collectors x 12 months X 2 years)	$38,400 $142,632	
Workshop for training data collectors,	Airfares – (Barbados –Trinidad (2) $200,Tobago-Trinidad (2) $200) Belize- Trinidad (1) $1200 Accommodation – $120 @ day (4 days x 6 person = $ 2,880) Per diem – $50 @ day (5 days x 6 person = $ 1500) Workshop consumables $500	$6,480	
Transport costs for port visits	Trinidad and Tobago – $79 per month (7 collectors x12 months x 2 years)	$13,272	
Coordination travel (once)	Airfares – (St. Vincent -Trinidad, $200, Belize-Trinidad $ 1200) Accommodation – $120 @ day (2 days x 2 persons = $480) Per diem – $50 @ day (3 days x 2 person = $300)	$2,180	
Insurance – personal security for collectors in high risk ports	6 person x @$500 year x 2 years	$6,000	
Production of data forms (In-kind contribution)	Barbados – Trinidad and Tobago		$500 $650
Cost and maintenance of data collection equipment	Barbados – Trinidad and Tobago –		$1,000 $1,000
Data entry costs	Barbados – 4 person months of data entry Trinidad and Tobago – 6 person months of data entry		$5,300 $6,300
Inter-country MOU/communication/ reporting costs	Fishery officer's salary 1 person month		$1,500
Project coordination and supervision of collectors	Trinidad and Tobago 2 months Barbados 1 month St. Vincent & Grenadine and Belize 0.25 months		$5,250 $2,600
Total		**$214,764**	**$24,100**

[9] includes obligatory Government contribution to national insurance scheme

Addendum 4 to LPWG Report: Research Strategy Turks and Caicos Islands (TCI) Fin Fish Fishery

Project Significance
This project is to obtain data in the multifaceted Turks and Caicos Islands fin-fish fishery that can used to conduct assessments and establish reference points, while providing insight as to the importance and influence of the recreational sport fishery. It can also provide direction for amending fishery regulations for sustainable exploitation.

Background
The whole of the Turks and Caicos Islands (TCI) is supported largely by a tourism industry. However, with the potential impacts from economic downturns, many individuals turn to the fisheries as form of economic appease.

The Turks and Caicos Islands base commercial fishing on the shallow water banks, primarily the Caicos Bank and the Turks Bank. The Mouchoir Bank is considered within the territorial water of the TCI, but currently used only for the purpose of capture of fin fish. The vessels most often utilized in the TCI are small retrofitted V-hull boats ranging in length from 18 ft-20 ft with an 85-115 hp out board engine. Larger vessels rigged with electronic reels and/or traps are in limited number due to the effects of Hurricane Ike in September 2008.

Commercial fishermen from the TCI often work more than one fishery at a time. Using only free diving methods with no underwater breather apparatus, fishers are found diving in depths ranging from 3 meters to 30 meters. The normal day for a fisher entails leaving the dock between 7:00 and 8:00 a.m. and return between 4:00 and 5:00 pm, considered 1 boat-day. Commercial fishermen are found to be opportunistic in their catch. During the open season of lobster, fishermen largely capture spiny lobster and land them whole. Until recently fishers would re-prioritize capture and work the queen conch fishery at the beginning of the next annual year.

Since 1999, the commercial fisheries have directly employed an average of 377 fishers per year. In 2008/2009 fishing season, the number of commercially licensed persons was at 366. Similarly the number of commercially licensed vessels, average 154 licensed vessels but in 2008-2009 there were 175 commercially licensed vessels.

When referring to the catch & effort, effort is measured by the number of days at sea and catch is measured in pounds. The larger individual boats carry between 5-12 men on the vessel each day. Smaller vessels carry between 1-3 people on board. However, upon review, the TCI needs to be able to collect more than one type of effort, such as number of lines, hooks, etc.

Until recently, fin fish have been a secondary thought for economic gain. The fin fishery has taken three separate avenues including commercial capture for local sales (i.e. restaurants/ hotels), sport fishing for tourism attractions and the mixture of the two (visitors capture for personal consumption). The DECR is now in a state of urgency to promote sustainable development/exploitation of fin-fish resources.

Project Goals and Methods
Overall AIM: Guided by agreed management objectives noted in the Fisheries Management Plan (FMP), develop scientifically-based management advice for the commercial, subsistence, sport and migratory fin fish.

Objective
The objective of the Fin-fish fishery is to exploit in a sustainable manner. As such, management requires research activities, analysis methods and data collection to determine exploitation rates.

Task 1: Define different sectors of the Fin fish fishery (ex. Commercial, subsistence, sport/recreational and migratory)

Methods: Identify all aspects to the Fin fish fishery through review of the Fishery Management Plan and current usage of the fishery (ex. Commercial, Subsistence, Recreational sport and Migratory)

Task 2: Identify key species to each sector and design sampling for data collection

Methods: Conduct a frame survey to determine the priority species based on importance to the fishery and/or conservation status (i.e. threatened or endangered).

Commercially Exploited Fin-fish Fishery	Grouper (*Serranidae*) Triggerfish (*Balistidae*) Jacks (*Carangidae*) Mackerel (*Scombridae*)	Grunt (*Haemulidae*) Snapper (*Lutjanidae*) Hogfish (*Labridae*)
Underexploited/Commercial Fin-fish Fishery	Parrotfish (*Scaridae*) Porgy (*Sparidae*) Boxfish (*Ostraciontidae*) Red Snappers	Tunas (*Scombroidei*) Billfish (*Istiophoridae*) Swordfish (*Xiphius gladius*)
Subsistance Fin-fish Fishery	Grunts (Haemulidae) Squirrelfish (Holocentridae) Barracuda (Sphyaenidae)	
Sport-Fishing Finfish Fishery	Bonefish (*Albulidae)* Tunas *(Scombroidei*) Billfish (I*stiophoridae*) Swordfish (*Xiphius gladius*)	
Migratory Fin-fish Fishery	Tunas *(Scombroidei*) Billfish (I*stiophoridae*) Swordfish (*Xiphius gladius)*	

Task 3: Implement a data collection program for the fin-fish fishery specific to each sectors including collection of catch, effort, biological (size, frequency), economical and distributional data

Method 1: Commercial and subsistence
All vessels that are at sea for extended periods must complete a log book specific to its catch on any trip. It must be established within the regulations that any vessel participating in the fin-fish fishery while at sea for more than 1 working day must complete a log book and supply it to the DECR upon return. As the catch is landed, conservation officers can verify the catch, while landings are the processing facilities.

Vessels that work as day trips at secondary landing sites can also provide information. However, this catch will have to be collected via stratified sampling methodology. As a fisher returns to shore, a conservation officer and/or scientific officer can complete a collection sheet.

Both logbooks and collection sheets will obtain information regarding catch, effort, gear type, biological (length, weight, etc.) and distribution (gps location of catch).

Method 2: Economical information pertaining to Commercial catch
Baseline information is essential to conducting a stock assessment. However, often times a fishery is driven by economical means. While catch can be utilized for subsistence, it is the commercial catch that drives the fin-fish fishery at the local markets. In order to obtain relevant information regarding the economics, a purchase/retail receipt will be created for the processors to complete with each catch that is transferred through their operation. The receipt will consist of a landing date with reference to a logbook as well as information pertaining to purchase price of product, cost of resources and local market value.

Method 3: Recreational Sport
Often sport fisheries are based on a catch and release concept. Since the number one industry in the Turks and Caicos Islands is tourism, it would then allow for the introduction of sport fishing via tourism. Islanders are actively perusing this industry, but the DECR is unaware as to the extent of the fishery and the availability of the stocks. In 2004 and in 2006, the DECR had attempted to collect information from the sport fishery via various means. However, with limited means, data collection was unable to be established.

This object can have two very different forms of data collection for consideration. The first is the collection by observation specifically for bonefish. As observed in the Bahamas, much time and money can be wasted through labour intensive data collection. Especially, if all you wish to determine is an overall abundance of a fishery such as "bonefish" or flats fishing. In 2004, the Rosenstiel School in the Florida Keys was able to determine that if you utilize tour guides that are familiar with the fishery; visual observations can provide a good estimate of population numbers. This would allow for tour operators, while on site to provide estimates of schooling numbers. Tourists would also be able to be involved with estimates of schooling numbers.

The second form of data collection for highly migratory species can be through more labour intensive means. There is a need for biological information on these sport fisheries. Sport fishers and their guides can provide valuable information upon capture before release. This is an area that data has not been collected because of "no landings". However, the addition of this information can provide insight as to the status of the population and biological growth. If the fish is landed on boat, measures can be taken and documented. However, if the fisher does not land fish near the vessel, but releases the fish immediately, information can be estimated. All information can then be documented and for future assessments.

Method 4: Migratory species
Migratory species such as Tuna and Tuna-like species (ICCAT) have not been a highly desired fish within the TCI waters. Often local fishers have chosen to consume reef fish as compared to migratory species. However, growth in tourism and knowledge of the species has created an increased interest in migratory species. The DECR is now requiring any and all information pertaining to migratory species to be catalogued. Two forms of data collection are required to collect as much information with these species including the visiting tourist (i.e. sport and/or recreational) and sport tournaments.

The first form of data collection must be obtained at the landing docks as visiting tourist land his/her catch. According to legislation, tourists are allowed a bag limit of 10 lbs, but migratory species are often larger than 10 lbs. Tourists have now been able to catch these migratory species while on licensed sport fishing vessels, where the guide (belonger) has no bag limit. Information from these catches has fallen through the cracks. It is necessary for the DECR to be able to estimate landings specific from sport/recreational fishers. Conservation officers and scientific officers will collect the same type of information that was collected for commercial and non-commercial catches, but at less familiar landing sites such as sport fishing vessel docks. The information collected will be catalogued and used for future assessments.

The second form of data collection must be obtained from the sport fishing tournaments. If a fishing tournament is to take place, the DECR is to be informed of its activities. Over the past years, the organizers of the tournaments have been very helpful with providing information as to the participants' vessels and their catch (estimates for release). DECR have been given permission to attend the activities as an observer, but has not been utilized to the fullest. It is now expected that conservation officers and scientific officers will be in attendance at registration of the tournament (to gather the vessel information) and placed as observers on differing boats throughout the tournament.

Task 4: Determine carrying capacity of fin-fish stocks by completing stock assessments
Methods: Undertake an annual assessment on priority species as pertaining to the TCI Fin-fish fishery through the aid of international bodies such as Caribbean Regional Fisheries Mechanism (CRFM) and International Commission for the Conservation of Atlantic Tuna and Tuna-like species (ICCAT).

Task 5: Establish reference points (MSY and reference limits) to guide management
Methods: Conduct a review of data and determine appropriate biological, economical and distributional reference points. These reviews can be through the aid of international bodies such as Caribbean Regional Fisheries Mechanism (CRFM) and International Commission for the Conservation of Atlantic Tuna and Tuna-like species (ICCAT).

Task 6: Ascertain need for appropriate management measures to ensure sustainable domestic use of the fin-fish fishery resources
Methods: Develop and implement monitoring program to collect consumption data from all establishments in TCI which sells marine products e.g. restaurants, hotels, supermarkets, fish-markets etc. This information related to the purchase/retail receipt form can provide insight as to the economical incentives to the fin-fish fishery.

	Turks and Caicos Islands (DECR) **Recreational Fishing Data Form**					
Tournament Information						
Name of Tournament:		Location of Tournament:			Dates of tournament:	
Description of Vessel:						
Vessel Name:	Flag Country of Vessel:	Registration/ Licence Number		LOA (m)	Engine Size/Type	Name of Captain/Guide
Description of Gear:						
Longline □ Handline □ Trolling □ Rod/Reel □		Number of lines:		Number of hooks per line:		Hook size (brand & size)
Line Class Test (lbs): 10 □ 30 □ 50 □ 80 □ 100 □		Gear depth 0-50ft □ 50-100ft □ 100-200ft □ >200ft□				
Trip Information						
Date & time trip started:		Date & Time trip finished:		Duration of fishing (hrs):		
Fishing Activity						
Species Hooked	Location of catch Lat. (N or S) Long. (E or W)	Fish Fork Length	Fish Whole Weight	Release Live Yes = Y No=N	Angler's Name	Appr. Size of Schooling
1)		in/cm/m	lbs/g/kg	Y / N		1□ 2-10□ 10-100□ 100-500□ 500-1000□ >1000□
2)		in/cm/m	lbs/g/kg	Y / N		1□ 2-10□ 10-100□ 100-500□ 500-1000□ >1000□
3)		in/cm/m	lbs/g/kg	Y / N		1□ 2-10□ 10-100□ 100-500□ 500-1000□ >1000□
4)		in/cm/m	lbs/g/kg	Y / N		1□ 2-10□ 10-100□ 100-500□ 500-1000□ >1000□
5)		in/cm/m	lbs/g/kg	Y / N		1□ 2-10□ 10-100□ 100-500□ 500-1000□ >1000□
6)		in/cm/m	lbs/g/kg	Y / N		1□ 2-10□ 10-100□ 100-500□ 500-1000□ >1000□
7)		in/cm/m	lbs/g/kg	Y / N		1□ 2-10□ 10-100□ 100-500□ 500-1000□ >1000□
8)		in/cm/m	lbs/g/kg	Y / N		1□ 2-10□ 10-100□ 100-500□ 500-1000□ >1000□
9)		in/cm/m	lbs/g/kg	Y / N		1□ 2-10□ 10-100□ 100-500□ 500-1000□ >1000□
10)		in/cm/m	lbs/g/kg	Y / N		1□ 2-10□ 10-100□ 100-500□ 500-1000□ >1000□
11)		in/cm/m	lbs/g/kg	Y / N		1□ 2-10□ 10-100□ 100-500□ 500-1000□ >1000□
12)		in/cm/m	lbs/g/kg	Y / N		1□ 2-10□ 10-100□ 100-500□ 500-1000□ >1000□
13)		in/cm/m	lbs/g/kg	Y / N		1□ 2-10□ 10-100□ 100-500□ 500-1000□ >1000□
14)		in/cm/m	lbs/g/kg	Y / N		1□ 2-10□ 10-100□ 100-500□ 500-1000□ >1000□
15)		in/cm/m	lbs/g/kg	Y / N		1□ 2-10□ 10-100□ 100-500□ 500-1000□ >1000□
OTHER OBSERVATIONS/NOTES:						

Addendum 5 to LPWG Report: Exploratory Analyses of Average Trophic Level of Landings by year for St. Vincent and the Grenadines (1979 -2008)

Cheryl Jardine-Jackson, Leslie Straker, and Sheena Gonsalves

Background

The trophic level of an organism is its position in a food chain. Levels are numbered according to how far particular organisms are along the chain from the primary producers (plants) at level 1, to herbivores (level 2), to predators (level 3), and to carnivores or top carnivores (level 4 or 5). Fish at higher trophic levels are typically of higher economic value. The estimation of fractional trophic level is essential for the management of fisheries resources as well as for qualifying the ecosystem effects of fishing. The Marine Trophic Index can be calculated from existing fish catch data and is therefore a widely applicable indicator of both ecosystem integrity and the sustainable use of living resources.

St. Vincent and the Grenadines have collected over 30 years of catch data from the various landing sites throughout the country. Some catch and effort, socio-economic and biological information have also been collected on various species and fisheries. However, most of our assessment efforts have been focused on analyses at the single species and single fishery level. Realizing the importance of adopting a more holistic approach to fisheries management it is necessary to engage in assessments that attempt to give is information at the ecosystem level

Method

1. Landings data from 1979-2008 were used in the analyses
2. The trophic level of the individual species was taken from FishBase. For the most part, levels compiled from the individual food items method were used in the analyses. The relative trophic contribution of each species to the overall yearly trophic level of landings was calculated using the formula:

   (Trophic level of species x species catch) / Total catch for that year

3. These individual relative trophic contributions wee then summed to give the total trophic level of landings for each year

Results

1. The mean trophic level over the thirty year period was 3.75
2. Except for 1998 – 2000 there was no marked deviation from the mean-yearly trophic level
3. There is no discernable trend of average trophic level of landings over the years

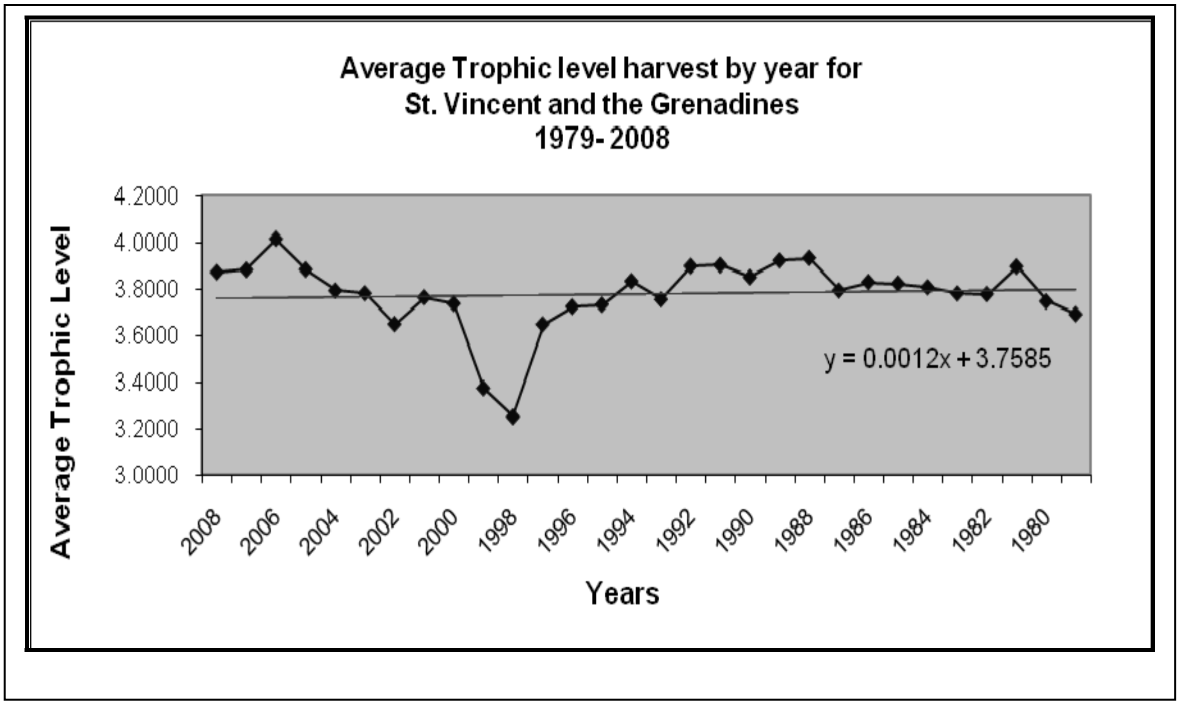

Fig. 1: Average tropic level harvest by year for St. Vincent & the Grenadines 1979-2008

Discussion

Consideration must be given to the following issues:

1. The fishery has predominantly been small scale over the years and the technology has been very slow to evolve.

2. Jacks and Robins, two species with trophic levels less than the yearly average trophic level continue to account for more than 50 % of the annual fish catch by weight.

3. Changes in data collection methodology over time.

4. From 1979-1992 represent landings at the New Kingstown market only and 1993-2008 represent landings for the entire country.

5.3 Reef and Slope Fish Resource Working Group (RSWG)

Chairman: John A. Jeffers (Montserrat)
John A. Jeffers (Montserrat); Nancie Cummings (NMFS, SEFSC- Miami, FL USA)

A. Overview

The chairman of the Reef and Slope Working Group (RSWG) for the Fifth Annual Scientific Meeting of the CRFM was the only member present. Inter-sessional tasks identified by the RSWG at the Fourth Annual Scientific Meeting included: developing an analysis data set for mutton snapper from Belize, for parrotfishes from St. Kitts and Nevis, species to be determined from St. Lucia, and developing data sets for red hind and queen triggerfish from Montserrat. The RSWG group commenced the work with data from only one country, Montserrat, as no other data sets were made available for the meeting. At the opening of the Fifth Annual Meeting, the Chairperson stressed the importance of the various working groups to consider regional agencies and countries involved in similar work.

B. Fishery Reports

5.3.1 The Red Hind (*Epinephelus guttatus*) and Queen Triggerfish (*Balistes vetula*) fisheries of Montserrat

5.3.1.1 Management Objectives

Red hind and Queen triggerfish are considered as important components of the demersal reef and slope fisheries in Montserrat. The demand for these species has increased over the past five years as compared with other demersal caught species. The Montserrat Fisheries Division has noted the following management objectives for the reef and slope fishery:

- Manage the fisheries stocks to maintain sustainability at the national and at a regional level;
- Implement management measures as needed to ensure viability of the resources through effort controls, size limits, closed seasons, MPA's;
- Maximize fishers revenue while assuring acceptable levels of stock sizes;
- Minimize impacts on habitat and fishery resources to optimize future stock health.

5.3.1.2 Status of Stock

The status of the Red hind and Queen triggerfish stocks are currently unknown.

5.3.1.3 Management Advice

Until a detailed stock assessment is conducted there are no recommended changes to the fishery. However there may be a need to implement corrective measures in the future in order to achieve sustainability.

Sustainability of the RSF resources can only be achieved if the recommendations from the scientific meeting are implemented successfully within the desired time frame in order for a full evaluation of the resources to be conducted.

5.3.1.4 Statistics and Research Recommendations

<u>Data Quality</u>

Several tasks were identified, which if completed during the 2009/2010 inter-sessional period, should improve the data quality significantly and the management advice generated from analyses of these data.

- The current landings data collection form should be modified to account for discards, spatial area of catch, quantity and type of gear used;
- Develop protocols to improve the timeliness of landings data availability from fishers who may not be accessible during normal working hours;
- The historical landings data needs to be computerized including developing quality control and assurance protocols to ensure an accurate time series of data;
- Generate preliminary summaries of the computerized data to use in evaluating the sufficiency of data for future stock assessment evaluations for the multispecies RSF;
- Funding is needed to support these tasks and to provide for the purchase of a computer dedicated to the data collection program and for the data entry and quality control/assurance;
- The fishable area for the RSF has been reduced in recent years due to volcanic activity; there is a need to quantify the current amount of RSF fishable area and to document any potential ongoing threats (e.g., mud flows, sedimentation) to the marine environment.

Biological data collection

Several critical needs were identified pertaining to biological data collections. These data needs are required in order to describe catch at size and to evaluate seasonal changes in maturity of the RSF species.

- Catch length frequency sampling should be implemented during the 2009/2010 period and continued as an ongoing data collection priority;
- Routine biological data collections (length/weight, maturity, ageing), should be implemented. Species to be studied should be identified during the 2009/2010 inter-sessional period and should be based on examinations of the landings data. Attention should be given to prioritization of species at both the national and the regional level;
- Information on spawning timing and areas needs to be documented as soon as possible. It is recommended to conduct a survey of the local fishers as a starting point to obtain this information as well as investigate fishing on spawning aggregations;
- Conduct a literature search at the national and regional level to document information on growth, mortality, spawning, maturation, fecundity.

Other data collection

- Conduct a literature search to document and compile a list of all research in volcanic activity and the impacts it has on the marine/fishery environment;

5.3.1.5 Data Analysis Summary

While there was no assessment there were several issues discussed. There is a critical need to have the data fully computerized so that a full analysis can be conducted in 2010 of the RSF. The quantity of discards and reason for discarding must be documented in order to provide accurate information on total catch.

The preliminary analyses of the summary CPUE data (Lbs per trip vs Trips) showed a positive relationship between catch and effort supporting further analyses of the complete time series when the data become available. In addition, the results of the ANOVA supports further examination of the raw data to identify additional auxiliary data to use in describing the variability in CPUE (e.g, # of crew, vessel fishing power, area (ground) fished). The time series of data analyzed at this meeting, 2004-2008, is insufficient to allow long term changes in the Red Hind and Queen Triggerfish fisheries to be quantified.

Exact information on fishing location is not available however it is known that since the onset of volcanic activity that fishers have moved to new fishing locations.

5.3.1.6 Special Notes

Preliminary examinations of summary CPUE data for Red Hind and Queen Triggerfish from the Montserrat pot fisheries were conducted at this meeting. Future analyses of these RSF fisheries can be strengthened if the data improvement recommendations are implemented in a timely manner.

Every year a significant number of traps are lost or destroyed with a high percentage of these traps continuing to fish for extended periods. This emphasizes the need to quantify the long term impacts on fishery resources from these ghost fishing traps as relates to number of lost traps and quantity of catch.

The ongoing volcanic activity associated with continuous mudflows has had a negative influence on fishery production areas, as well as nursery habitats. The impacts from other natural events such as hurricanes and surging seas also impact fishery production and nursery habitats.

Given the fluid nature of the marine environment there is a need to document various events that influencing negatively on the marine environment and more so the fisheries and habitats associated with the fisheries, on an ongoing basis.

5.3.1.7 Policy Summary

The policy of the Montserrat government as it relates to the RSF is to ensure the fishery resources are sustainable. As part of this objective, it is planned that in 2010, training of some RSF fishers will be done to educate them into pelagic fisheries operations, in an attempt to reduce RSF effort.

5.3.1.8 Scientific Assessments

Background or Description of the Fishery

The reef and slope fishery (RSF) is a small artisanal fishery accounting for about 40 % to 60% of the national landings. Fishing has been carried out for generations using mainly trap and lines, although occasionally spear gun and gillnets are used. The harvest is composed of a variety of reeffish species up to sometimes 20 species or more. The dominant species include snappers, groupers, soldier fish, parrot fishes, etc. Typically, the local harvest only accounts for some 60% of the national demand for fish.

The fleet is often removed from the water once the threat of a storm is imminent due to the absence of a safe harbour. The RSF fleet is made up of about 33 vessels, about 12-30 feet in length. The majority of vessels utilize a single engine, engine size ranges from 25-225 hp. There has been of recent a move towards fibreglass construction, with about 23 vessels being of fibreglass construction. About 10% of the vessels are equipped with electronic navigation and sonar gear. Two types of traps are in use: 1) the Z- trap and 2) the rectangular design with all traps using a mesh size of 1.5 inch or greater. Some traps are equipped with biodegradable escape panels. Traps are set individually and retrieved manually. Average soak time between trap hauls ranges from 3-5 days. The vessel operator is not usually involved in the setting and retrieval of the traps. Most vessels utilize a crew of two to set and retrieve the gear. Baiting has become a more common practice since about 2004 than previously observed for this fishery. Frequently used baits include: dried and smoked cattle skins, skins of the trigger fish, dried coconut, the entire rabbit intestine (aka agouti), and occasionally tins of sardines with a small hole punched allowing the oil and meat to filter out.

Two types of line fishing occur: 1) bottom longline and 2) handline. With hand line fishing vessels, often the vessel operator is involved in the fishing operation. When retrieving the bottom longline, two crew members are usually involved. The number of bottom long line sets varies depending on the depth and the distance from shore.

The RSF fishery operates mainly in the Montserrat territorial sea (TTS) defined as 3 nautical miles nm or less from shore. However, it is known that some vessels fish beyond the TTS. Since 1996 maritime access controls have restricted the movement of vessels, fishing and non-fishing, within the Maritime Exclusion Zone because of pyroclastic flows on the eastern and western flanks of the Soufriere Hills Volcano. Nearly two-thirds of the island is considered to fall within the Exclusion Zone. According to a survey done by the Department of Earth Science University of Bristol up to 30km offshore has been affected by volcanic ash entering the marine environment by the movement of sediments.

In the recent years the RSF is experiencing several problems including: 1) attracting younger fishers due to more lucrative employment options, 2) migration of fishers off island, 3) destruction of fishing grounds due to on-going volcanic activities, and 4) difficulty in obtaining gear due to high costs and transportation constraints, 5) absence of Regulations to enforce certain provisions of the act, and 6) high demand of fresh fish and the absence of adequate storage facilities for fishers.

This fishery is more susceptible to ciguatera.

Overall Assessment Objectives

Sampled landings were used to begin preliminary evaluations of stock status of Red hind and Queen triggerfish.

Data Used

The Montserrat fisheries division has collected information on landings since the early 1990's. Data collection occurs at the main landing site i.e. Carr's Bay / Little Bay, Mondays through Fridays during working hours i.e. 8-4pm. However fishers are encouraged to provide the data should they arrive after normal working hours. Information on after-hours landings is usually obtained through three means: 1) telephone contacts or 2) fishers inform the fisheries division through office visit, or 3) interviews in the field by data collectors. About 95% of all RSF landings occur at the Carr's Bay/Little Bay site and about 98% of all catches are landed whole. In some cases actual weights are recorded where-as in other cases estimates are used.

For this evaluation, summary data representing the total sampled weight and the number of total trips sampled were available from 2004 through 2008 by year and by month. Future evaluations and analyses will consider earlier years as the data become available.

Analysis 1

Objectives

As previous stock evaluations of the Red Hind and Queen Trigger fish stocks for Montserrat have not been conducted, focus was directed towards identifying changes in the fishery.

Method/Models/Data

The summary landings and effort data for red hind and queen triggerfish pot fishery were reviewed and although the individual catch and effort observations were not available at this time it was decided to present the overall trends as part of a preliminary analysis of the data.
Several summaries of the data were considered:

a. Calculations of total landings by year and the percentage landings of red hind and of queen triggerfish from the RSF fishery indicated that from 2004 through 2008 about 95% or more of the red hind and queen trigger fish are from pots thus supporting further analyses using the data from pot only to evaluate changes in the fishery. It was decided to use the summary landings and effort data (CPUE) to investigate changes in the red hind and queen triggerfish resources.

b. Two measures of effort were considered in developing the CPUE index: 1) number trips per year and month stratum and also 2) number trips x number soak days per stratum. Plots of the summary observations of landings (pounds) per trip vs number of trips indicated a stronger linear relationship than for the second effort measure for both red hind and queen triggerfish (R=0.32 vs 0.26 Red hind and r= 0.37 v s 0.23 Queen triggerfish), therefore number of trips per stratus was selected as the effort measure. (Figs. 1a, 1b – red hind and Figs. 2a, 2b Queen triggerfish).

c. CPUE was then calculated as the sum of the pot landings divided by the sum of the number of pot trips landing red hind or landing queen trigger fish for each year and month partition in the data. Since the individual strata observations were not available these initial summaries of CPUE by necessity were calculated at the stratum levels. It recognized that this measure of CPUE does not provide information on the variability in CPUE between vessels or within vessels within a year or between trips, however, it was considered useful in these preliminary analyses of the Montserrat red hind and queen triggerfish resources.

d. As an aid in better understanding the red hind and queen trigger fish stock condition CPUE was also calculated by year and by month and a two factor analysis of variance (ANOVA) carried out to determine the significance of these factors, year and month, in explaining the variability in CPUE. Thus, calculations of the summary CPUE observations were made by year and month and by year were made and the results plotted to examine for trends. For the summary CPUE data only two variables, year and month, were available for use in explaining the variability in CPUE.

e. Next a general linear model (GLM) modeling approach was used to further investigate the summary red hind and queen trigger fish CPUE observations. CPUE (lbs per trip) was assumed to be log normally distributed. A base model was fitted to the summary year, month CPUE observations from 2004-2008, months = January-December. A second model was also fitted to the year, and period (season) summary observations with periods defined as :1) December-February, 2) March-May, 3) June-August, and 4) September-November. The objective of this analysis was to explore the use of the independent variables year, and month in explaining red hind and Queen triggerfish CPUE trends.

Red Hind Pot Fishery Summary Results

Red hind CPUE ranged from 16.9 lbs per trip (2007) to 28 lbs per trip (2005) over the five year period, 2004-2008 (Fig. 3a). Red hind pot effort varied from 166 trips per year (2007) to 316 trips per year (2005) (Fig. 3b). This trend in red hind pot effort suggests an overall decline in the number of trips landing red hind from pots since 2004.

Visual inspection of the summary CPUE trends by year and month showed large variability between months both within year and across years (Fig. 3b).

Results of the ANOVA are shown in Table 1 for red hind and indicate that year was significant in describing the variability in CPUE (lbs per trip) however month was not as important as year.

Results of the preliminary GLM analyses fit to the year- month data and to the year- period data both indicated a significant year effect in the summary red hind data in both model fits, however neither month nor period was significant in the overall model. The model fit results did indicate that some individual month and period terms were significant however no distinct patterns were clear as to defining groups of months. In the overall fit to the lognormal model, the year-month model was better than was the fit to the year- period data (r=0.66 Year-Month model vs r=0.61 Year-Period model). Thus, the final model selected for the preliminary Red Hind Pot fishery analysis was the Year-Month model. General results of the model fit are presented in Table 2 and plotted results for the estimated CPUE and 0.95 % Confidence intervals are presented in Fig. 4.

Queen Triggerfish Pot Fishery Summary Results

Queen triggerfish CPUE ranged from 12.6 lbs per trip (2008) to 22.4 lbs per trip (2005) over the five year period, 2004-2008 (Fig. 5a). Queen triggerfish pot effort ranged from 155 trips per year (2008) to 314 trips per year (2005) (Fig. 5a). As with red hind pot fishery, the data suggest an overall decline in the number of trips landing Queen triggerfish from the pot fishery. Results of the ANOVA are shown in Table 3 for queen triggerfish and indicate that year was significant in describing the variability in CPUE (lbs per trip) however month was not as important as year.

Visual inspection of the summary CPUE trends by year and month showed large variability between months both within year and across years in the queen triggerfish summary CPUE data (Fig. 5b).

Results of the ANOVA are shown in Table 4 for queen trigger fish and indicate that year was significant in describing the variability in CPUE (lbs per trip) however month was not as important as year. Plotted results for the estimated CPUE and 0.95 % Confidence intervals are presented in Fig. 6. This observation was also evidenced in the Red Hind data.

Results of the preliminary GLM analyses fit to the year- month data and to the year- period data both indicated a significant year effect in the summary red hind data in both model fits. Month was not significant in the overall model. The model fit results did indicate that some individual month terms were significant; however no distinct patterns were clear as to defining groups of months. Future examinations of the Queen triggerfish CPUE should explore the use of other independent variables to explain the variability in CPUE.

Discussion

One of the major causes of the observed and predicted declines in the 2007 CPUE (seen in both species is due to an upsurge in economic activity on the island. This economic upturn resulted in a number of fishers moving into a more lucrative construction industry.

In March 2008, a western storm impacted approximately 75% of all traps on the western and northern areas of the island, based on a survey conducted by the fishery division. These traps were not replaced until early 2009 thus explaining the reduction in effort observed in 2008.

Technical Analysis Recommendations

Several tasks were identified as important for completing during the inter-sessional period.

- Re-evaluate red hind and Queen triggerfish CPUE trends after historical landings data are computerized
    - Steps:
        - Investigate importance of a variety of independent variables to use in explaining CPUE
        - Explore multi-species CPUE models
        - Incorporate size information into analyses
        - Evaluate impacts of fishing on size structure of catches
    - Explore use of ParFish to obtain information on stock status in near term
    - Can compare ParFish results to results from more detailed analyses of CPUE, latter assumes all the previous identified data/analysis tasks will be completed in a timely fashion

        - Initiate Analyses of Size frequency data- data collections to begin during intercessional period
        - Quantify Spawning Season and periodicity
        - Document known spawning areas (from fisher survey)
        - Document quantity of current fishable habitat
        - Quantify discards and reason for discarding

Management

Until a detailed stock assessment is conducted there are no recommended changes to the fishery. However there may be a need to implement corrective measures in the future in-order to achieve sustainability.

Table 1: Two way Analysis of variance (ANOVA) results for Red Hind CPUE (Lbs per trip)-dependent variable, factors are year and month.

ANOVA							
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**	**Results**
Year	1072.39	4	268.0974	6.47079	0.000348	2.583667	**Significant**
Month	481.5557	11	43.77779	1.056619	0.416502	2.014046	**Not Significant**
Error	1823.006	44	41.43195				
Total	3376.951	59					

Table 2: General results of the GLM model fitted to the Year-Month summary Red Hind CPUE data.

Class Level Information

Class	*Levels*	*Values*
Year	5	0 1 2 3 4
Month	12	APRIL AUGUST DECEMBER FEBRUARY JANUARY JULY JUNE MARCH MAY NOVEMBER OCTOBER SEPTEMBER

Source	*DF*	*Sum of Squares*	*Mean Square*	*F Value*	*Pr > F*
Model	15	3.33655495	0.22243700	2.19	0.0226
Error	43	4.36177841	0.10143671		
Corrected Total	58	7.69833337			

R-Square	*Coeff Var*	*Root MSE*	*lncr Mean*
0.433413	10.37138	0.318491	3.070867

Source	*DF*	*Type III SS*	*Mean Square*	*F Value*	*Pr > F*
Year	4	2.13574715	0.53393679	5.26	0.0015
Month	11	1.15058145	0.10459831	1.03	0.4369

Table 3: Two way Analysis of variance (ANOVA) results for Queen Triggerfish CPUE (Lbs Per Trip)-dependent variable, factors are year and month.

ANOVA							
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***	**Result**
Years	840.889	4	210.2222	7.933584	6.62E-05	2.583667	**Significant**
Month	174.8747	11	15.8977	0.599964	0.818433	2.014046	**Not Significant**
Error	1165.902	44	26.49777				
Total	2181.665	59					

Table 4: General results of the GLM model fitted to the Year-Month summary Queen Triggerfish CPUE data.

Class Level Information

Class	*Levels*	*Values*
CYEAR	5	2004 2005 2006 2007 2008
Month	12	APRIL AUGUST DECEMBER FEBRUARY JANUARY JULY JUNE MARCH MAY NOVEMBER OCTOBER SEPTEMBER

Source	*DF*	*Sum of Squares*	*Mean Square*	*F Value*	*Pr > F*
Model	15	4.99838352	0.33322557	2.50	0.0094
Error	44	5.87245779	0.13346495		
Corrected Total	59	10.87084131			

R-Square	*Coeff Var*	*Root MSE*	*lncr Mean*
0.459797	13.17084	0.365329	2.773768

Source	*DF*	*Type III SS*	*Mean Square*	*F Value*	*Pr > F*
CYEAR	4	3.91164606	0.97791151	7.33	0.0001
Month	11	1.08673746	0.09879431	0.74	0.6947

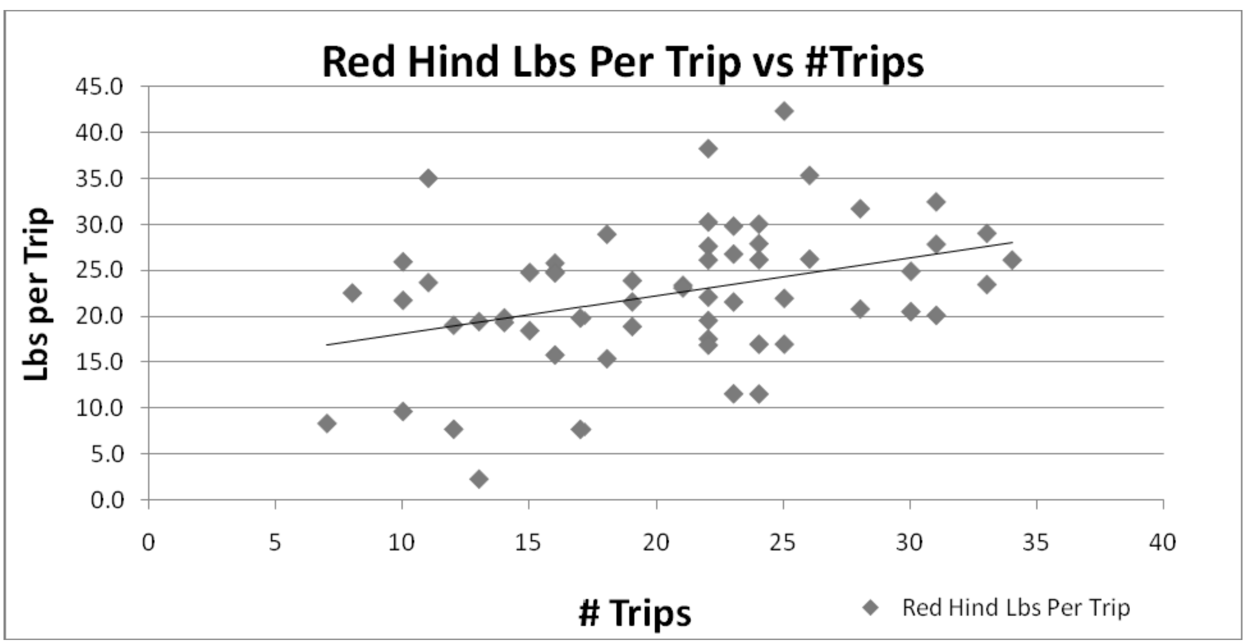

Fig 1a: Scatter plot of red hind lbs per trip for the pot fishery vs # trips (R=0.32).

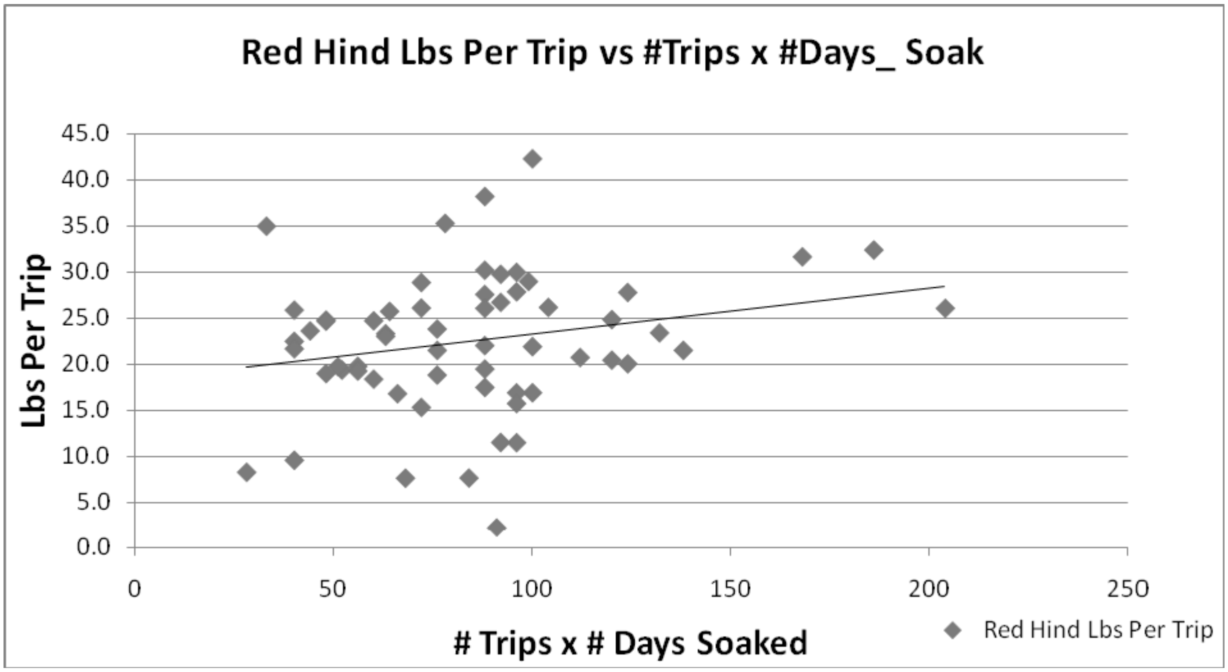

Fig. 1b: Scatter plot of red hind lbs per trip for the pot fishery vs # trips (R=0.0.26).

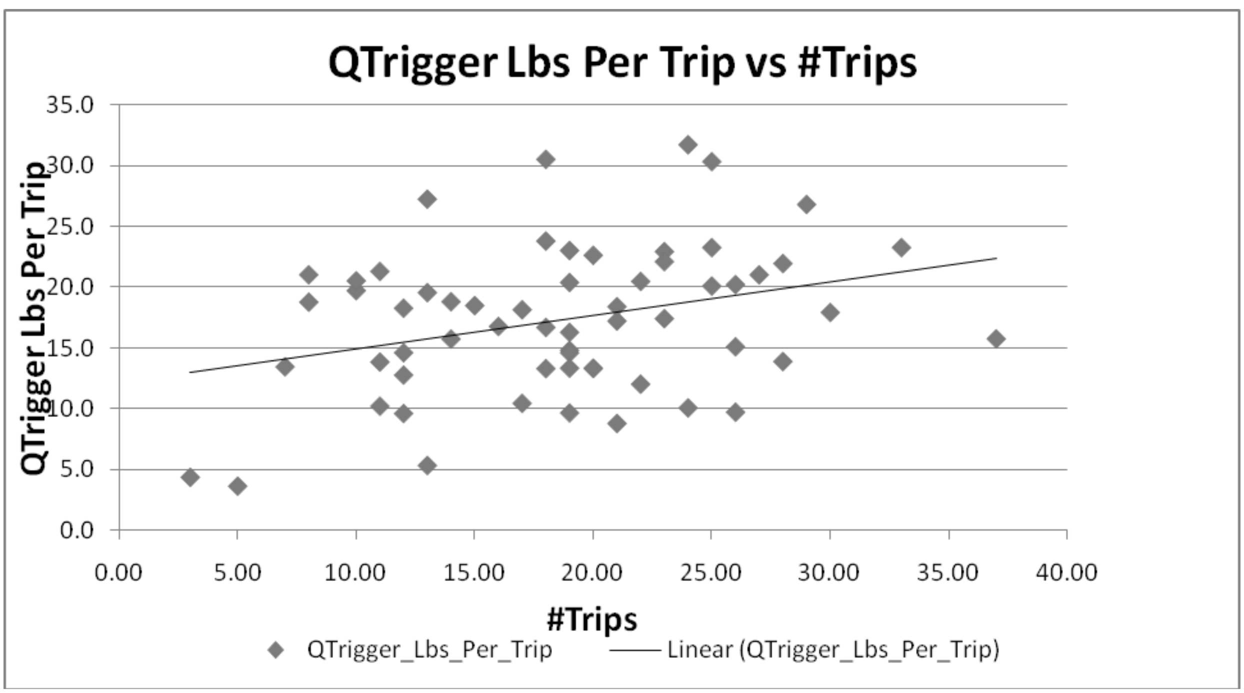

Fig 2a: Scatter plot of Queen triggerfish lbs per trip for the pot fishery vs # trips (R=0.37).

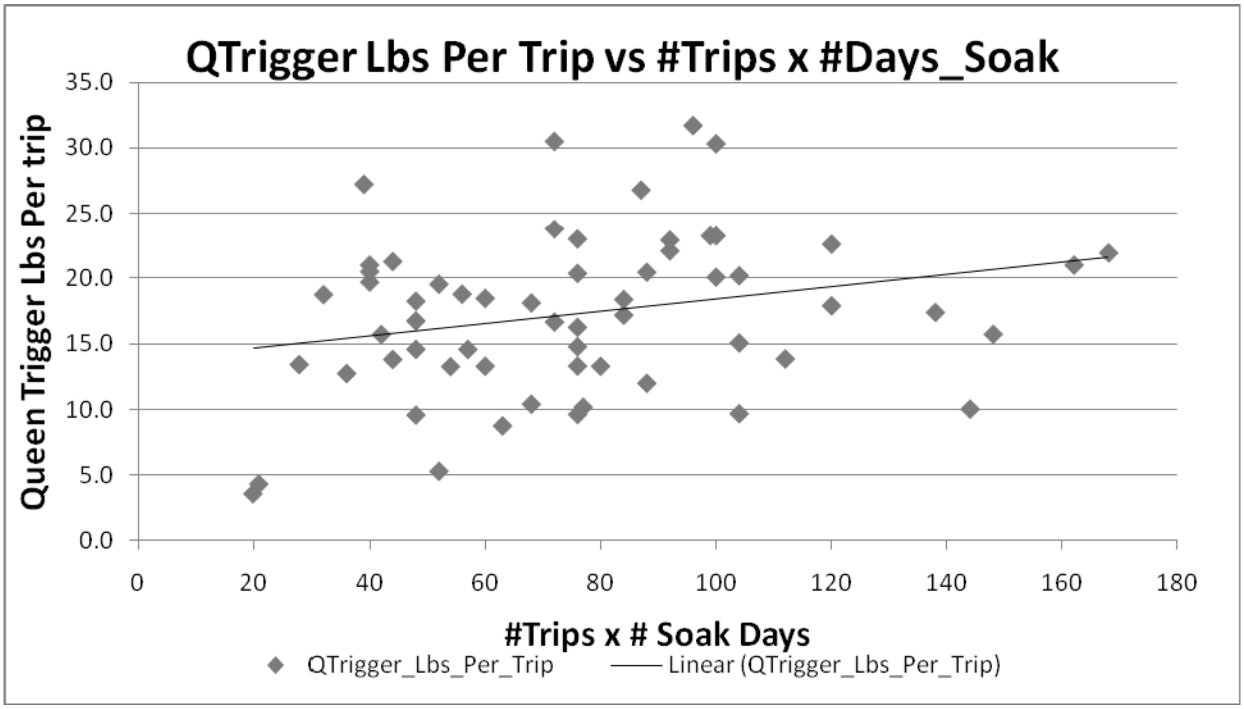

Fig. 2b: Scatter plot of Queen triggerfish lbs per trip for the pot fishery vs # trips x # Days Soaked (R=0.23).

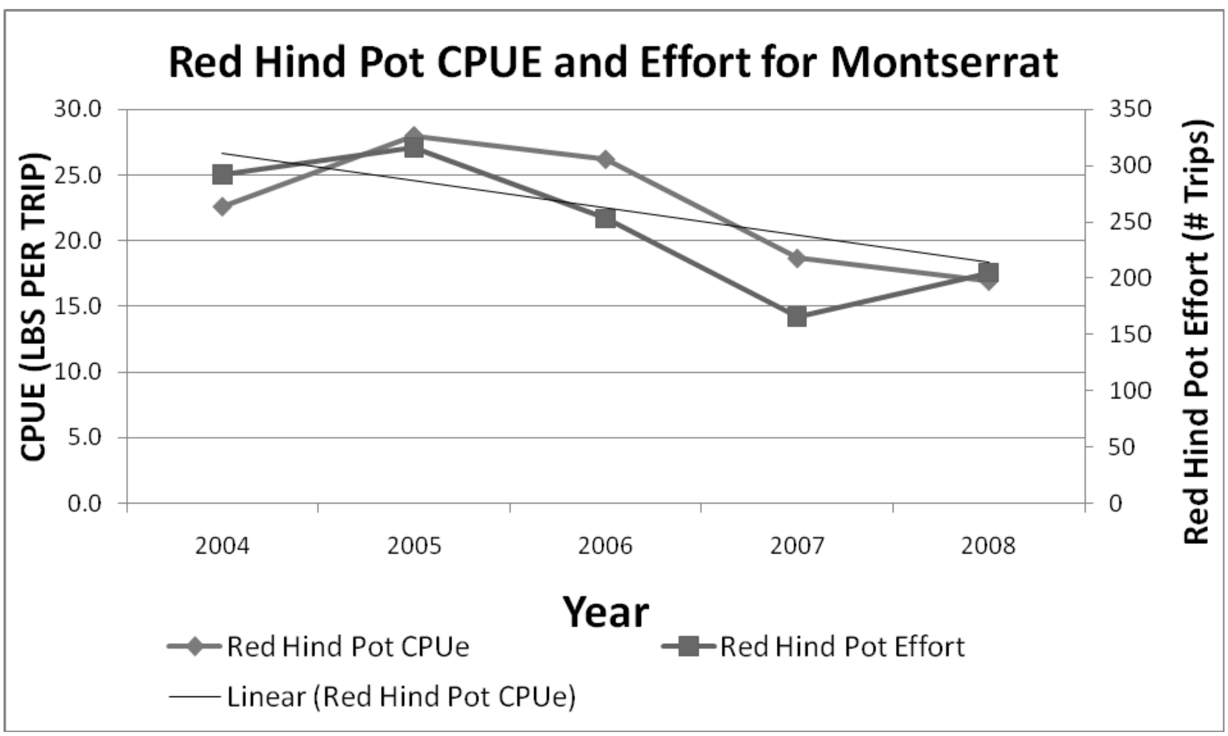

Fig. 3a: Summarized Red Hind Pot CPUE (lbs per trip) from 2004-2008.

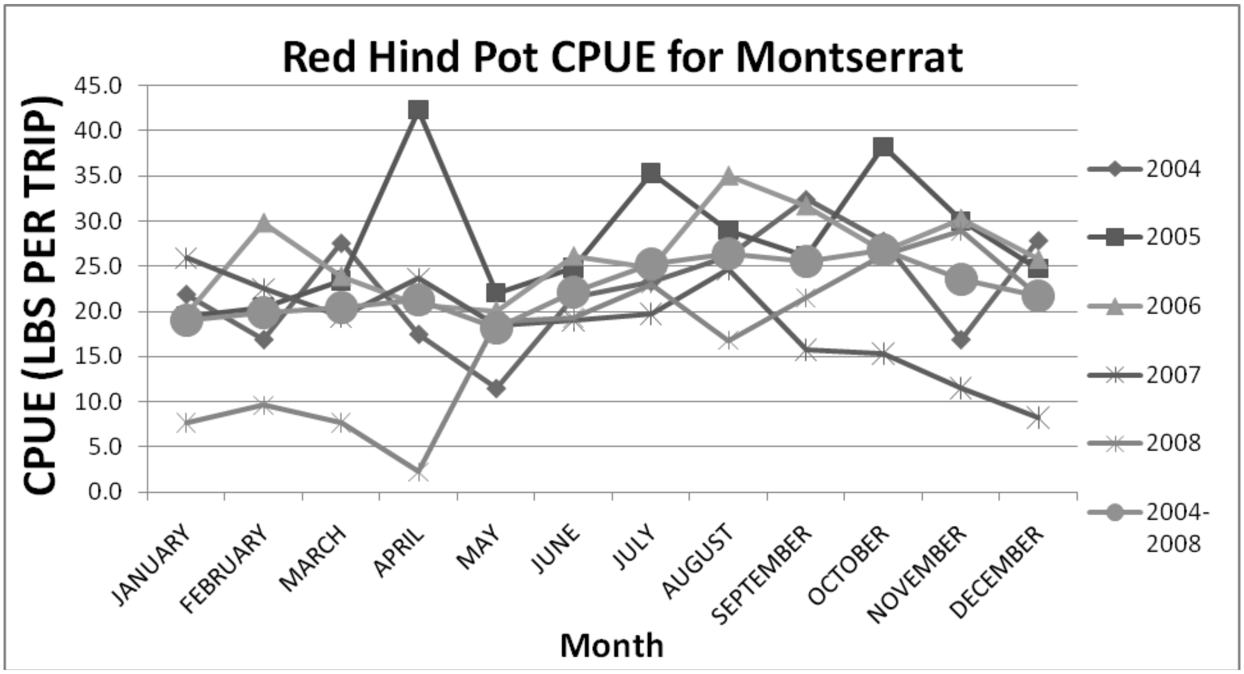

Fig. 3b: Summary Red hind CPUE (lbs per trip) by year and month for the pot fishery.

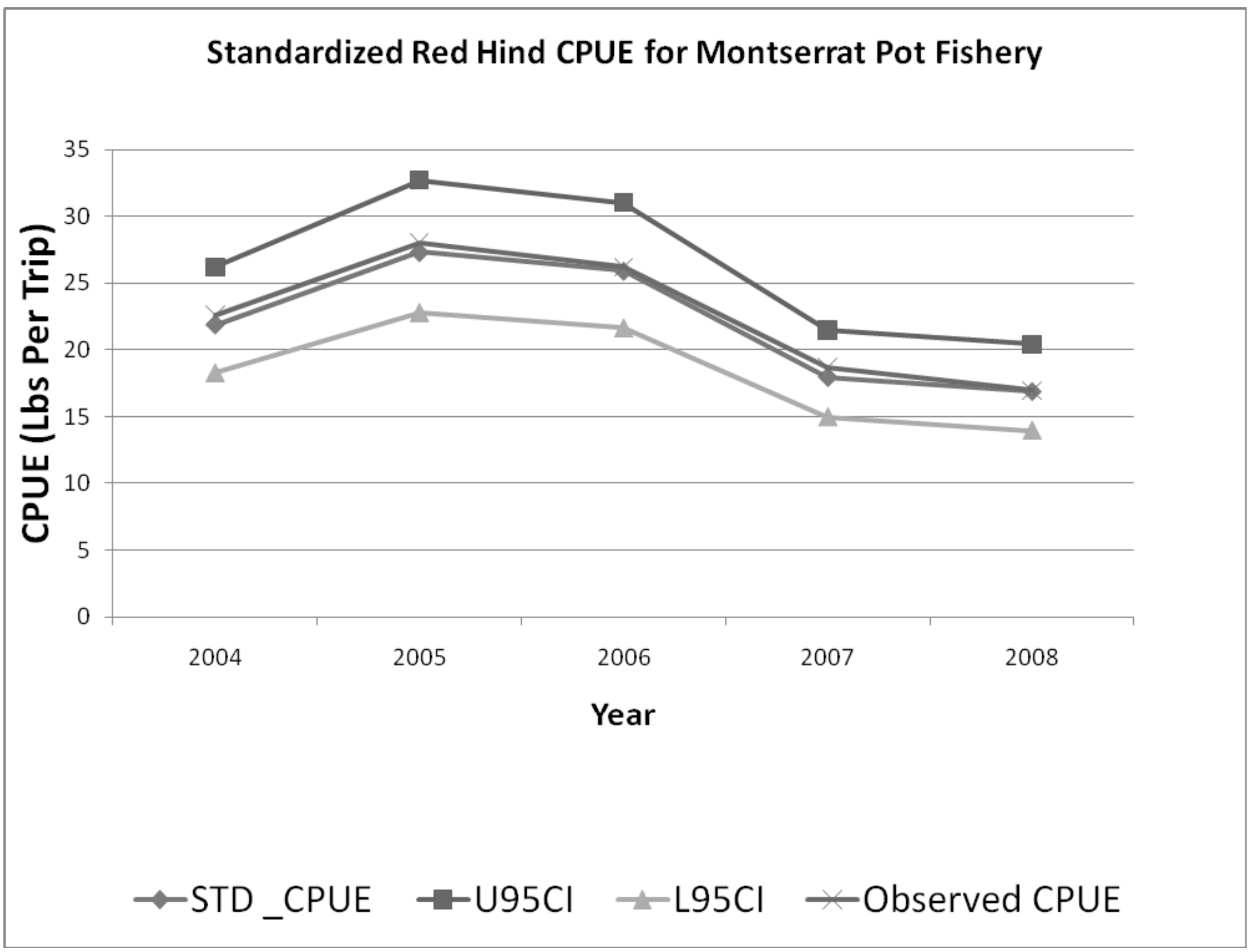

Fig. 4: Preliminary standardized and Observed CPUE and 0.95 % Confidence Intervals for Red Hind for the Montserrat Pot Fishery.

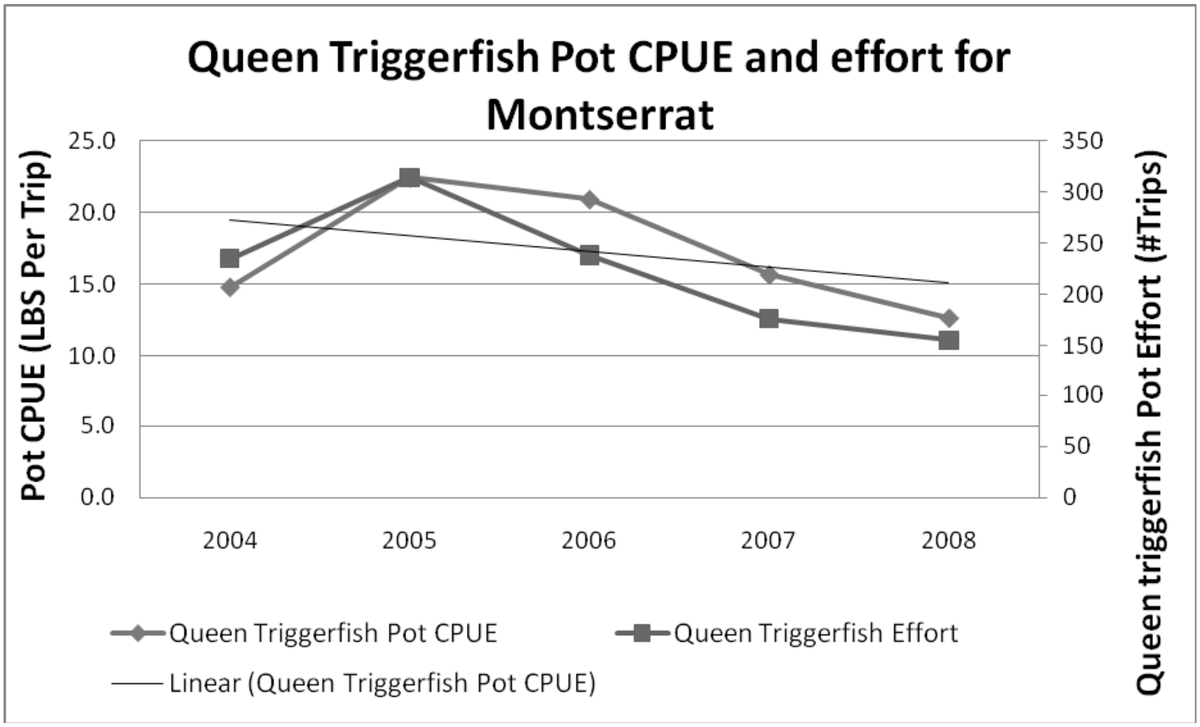

Fig. 5a: Summarized Queen Triggerfish Pot CPUE (lbs per trip) from 2004-2008.

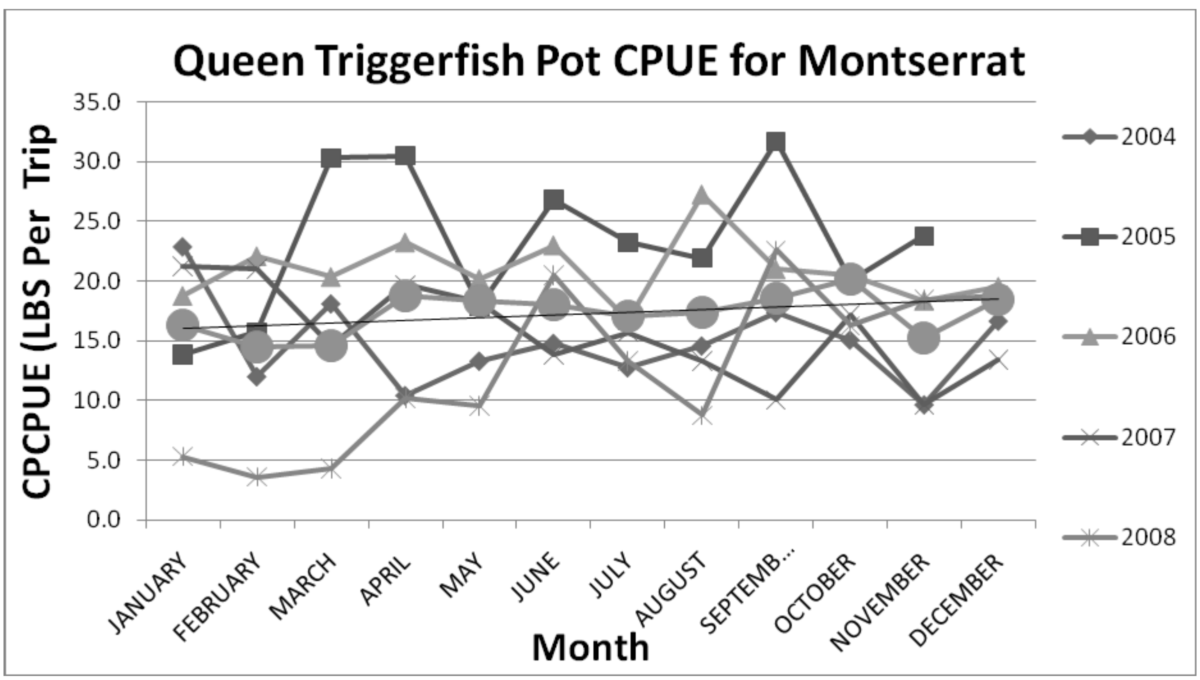

Fig. 5b: Summary Queen Triggerfish CPUE (lbs per trip) by year and month for the pot fishery.

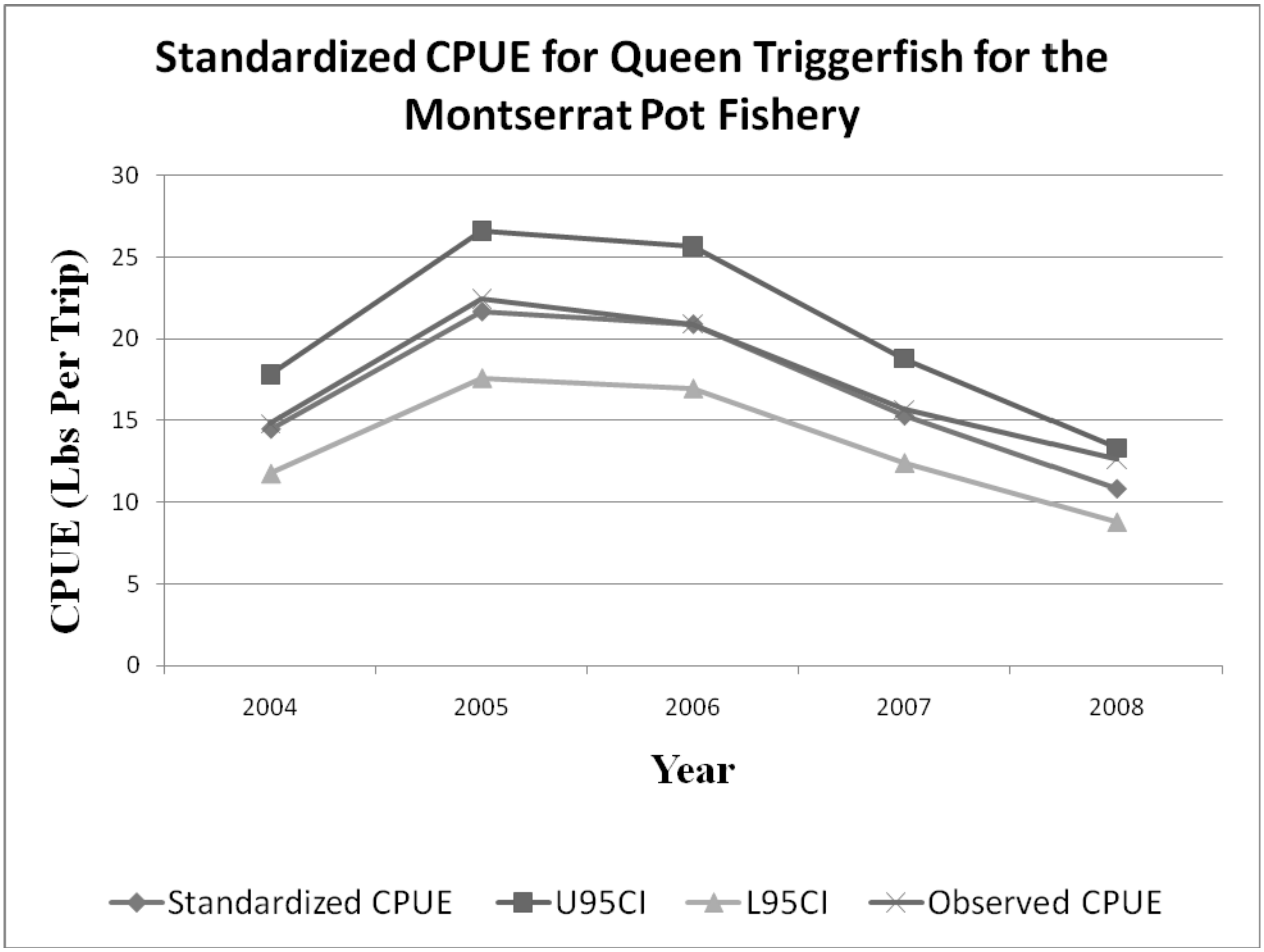

Fig. 6. Preliminary standardized and Observed CPUE and 0.95 % Confidence Intervals for the Queen Triggerfish Montserrat Pot Fishery.

5.4 Shrimp and Groundfish Resource Working Group (SGWG)

Chairperson: Lara Ferreira, Trinidad and Tobago
Colletta Derrell (Guyana); Ranjitsing Soekhradj (Suriname); Lara Ferreira (Trinidad and Tobago); Paul Medley (Consultant)

A. Overview

Report of Work Progress since 2008 Meeting

At the Fourth Annual CRFM Scientific Meeting in 2008, 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 kroyeri*) using data from their respective national fleets. Trinidad and Tobago conducted an assessment for the whitemouth croaker (*Micropogonias furnieri*) exploited by local fleets. The following summarizes the progress of work on shrimp and groundfish for these three countries since the 2008 meeting.

Guyana & Suriname

A biological data collection programme was initiated in December 2007 at two processing plants in Guyana (Noble House) and Suriname (Guiana Seafoods) by the owner of the plants, a Belgian company by the name of Morubel NV. This programme (which includes the collection of morphometric data, size composition, maturity, and landings and effort data) continued throughout the inter-sessional period with the participation of staff of the Fisheries Department in the case of Guyana. In the case of Suriname, a meeting was held between the Government and the processing companies, and the Government agreed that it would participate in the data collection programmes. The biological data collected by the processing companies were submitted to the Fisheries Departments in the two countries. The landings and effort data were computerized by the Fisheries Departments. Some analysis of the morphometric data was conducted to determine length and weight conversions.

The Department of Fisheries in Guyana obtained landing data by size category and month from the three other seabob processing companies in Guyana. Rainfall data for the period 1996 to 2008 and Essequibo River outflow data for the period 1998 to 2007 were also obtained from the Hydrometeorological Department of the Ministry of Agriculture, Guyana. The Fisheries Department in Suriname obtained landing data by size category and month for 2008 from the second seabob processing company in Suriname, namely Namoona.

Trinidad & Tobago

Trinidad and Tobago had previously agreed to test the ParFish (Participatory Fisheries Stock Assessment) methodology which was identified for consideration under the Methods Working Group as being particularly appropriate for data-poor fisheries. The Government of Trinidad and Tobago contracted Dr. Paul Medley for a two-week period in April/May 2008 to brief Fisheries Division staff on the methodology and to conduct training in carrying out the ParFish interviews. The shrimp trawl fishery was used for the case study. A total of 43 interviews were conducted with fisherfolk in the artisanal, semi-industrial and industrial shrimp trawl fisheries over the period April to October 2008.

Report on Relevant Activities/Plans of Other International Fisheries Organizations.

In 2008, plans were being made by the FAO to host a meeting of the WECAFC (Western Central Atlantic Fishery Commission) ad hoc Working Group on the Shrimp and Groundfish Resources of the Brazil-Guianas Shelf on the constraints to fisheries management in the subregion and their resolution. In preparation for the Workshop, the FAO had a matrix/spreadsheet prepared which summarized for each member country the status of the various shrimp and groundfish fisheries and the recommendations (national and regional) made for the management of these fisheries based on the reports of the assessment and related workshops of the Ad hoc Working Group held over the period 1986 to 2005. The matrix was disseminated to member countries of the WECAFC Group for completion regarding the status of implementation of recommendations, constraints and potential solutions. Countries were also requested to prepare a national report for which a table of contents was provided. No responses were received from countries as at the end of 2008.

The Chair of the CRFM Shrimp and Groundfish Working Group (SGWG), who was involved in the preparation of the matrix, provided an electronic copy of the matrix to the members of the SGWG present at the 2009 meeting as they were not familiar with the matrix and had not previously seen it. It was agreed that they would take it to their superiors in their respective countries in an attempt to follow-up on the activity. The Chair of the SGWG will continue to liaise with the members of the SGWG with regard to the completion of the matrix.

Tasks to be Addressed at 2009 Meeting.

Guyana & Suriname

- Assessments of Atlantic seabob (*Xiphopenaeus kroyeri*) are to be conducted for Guyana and Suriname separately as well as jointly.
- Effect of river outflow on productivity is to be examined.
- Morphometric relationships are to be determined for the seabob resources for Guyana and Suriname separately, and then compared to determine whether they are significantly different.
- Size compositions are to be analysed to determine growth parameter estimates.
- The management unit with regard to the seabob stock is to be identified.
- Recommendations with respect to harvest control rules and reference points are to be produced.
- The most appropriate time for a closed season in each of the two countries is to be determined.

Trinidad and Tobago

- Data obtained from the ParFish interviews conducted for the shrimp trawl fishery are to be analysed.
- ParFish data are to be incorporated into a Bayesian biomass dynamics model for Trinidad and Tobago and Venezuela. This model will be a modification of the biomass dynamics model developed for Trinidad and Tobago-Venezuela at the 2006 CRFM Scientific Meeting (Ferreira and Medley, 2006), and the 2005 bilateral Trinidad and Tobago-Venezuela meeting held under the auspices of the FAO/WECAFC Ad Hoc Working Group on the Shrimp and Groundfish Resources of the Guianas-Brazil Continental Shelf (Medley *et al*, 2006).

Relevant Policy/Management Objectives, Fishery Characteristics/Trends and Available Data for Fishery Analyses/Assessments Identified in the previous section.

Guyana

A closed season from September to October which was recommended by the trawler association has been in place since 2003. However, analyses conducted in 2007 based on the best available information suggested that a closed season in May would be effective in protecting the pulse of recruitment rather than the current closed season. Further investigations on growth rates and patterns of recruitment are required to verify and refine this advice.

Suriname

The Government of Suriname in collaboration with the two seabob processing plants intends to seek MSC (Marine Stewardship Council) Certification which is a requirement to export the seabob internationally. MSC certification requires that fisheries stocks are identified and assessed.

Available Data for Assessments

Guyana

- Data received from only one of the four seabob processing companies were considered complete. The other three companies failed to provide good quality data and hence the data submitted were used only for estimating total catch.
- Catch and CPUE for 2000 to 2008.
- Total catch for 1998 to 2008.
- Total catch for 1985 to 1997 from FAO FIGIS database.
- Biological data as described in an earlier section of this report.

Suriname

- Landings by month and size category for 1998 to 2008 available. (Data for 1998 to 2006 to be verified.)
- Catch and CPUE for 1998 to 2008.
- Total catch for 1998 to 2008.
- Total catch for 1989 to 1997 from FAO FIGIS database.
- Biological data as described in an earlier section of this report.

Fisheries Statistical and Assessment Analyses Conducted.

Guyana and Suriname

The following analyses were conducted for the countries separately:

- A catch and effort biomass dynamics model was fitted using Bayesian framework.
- Analysis of size composition data was conducted to determine the optimum closed season.
- Morphometric relationships were determined using the following measurements/data: total weight; tail weight; peeled tail weight; carapace length; tail length; sex.
- Various other exploratory analyses were done including cross-correlations for river outflow.
- Although explored using morphometrics, CPUE indices and size compositions, no evidence was found indicating that the stocks between Suriname and Guyana were shared, therefore separate assessments were undertaken.

Trinidad and Tobago

- Preliminary analyses of ParFish interview data were conducted.

A number of tasks identified in Agenda Item (3) were not completed due to lack of time. These tasks should be continued during the inter-sessional period and at the next scientific meeting.

Other Tasks Conducted.

This agenda item was not applicable.

Review and Adoption of Fishery Analysis Reports and Other Technical Documents.

Reports of the assessments of the seabob (*Xiphopenaeus kroyeri*) fisheries of Guyana and Suriname were adopted by the SGWG and are provided in part B of this report.

Issues and Recommendations Re: Data, Methods, Training for DMTWG.

- Basic training/refresher course in data manipulation and management to include such items as: look up functions; data query tools; pivot tables; basic introduction to SQL or Microsoft Query. This training should be targeted at officers in the region involved in stock assessment work and who attend the CRFM Scientific Meetings. Such training would facilitate improved data preparation and analysis during the inter-sessional period.

- Ageing of priority species of groundfish assessed and/or identified for assessment at previous scientific meetings would be useful for obtaining growth curves. As such, funding should be allocated to the Regional Age and Growth Lab to facilitate the ageing of these species. Funding may also be required to assist member countries in obtaining the necessary fish samples.

- Analysis of the ParFish interviews conducted for the shrimp trawl fishery of Trinidad and Tobago, and the incorporation of the data into an updated and modified biomass dynamics model for Trinidad and Tobago and Venezuela using a Bayesian framework should be completed during the inter-sessional period. This activity will require the technical assistance of Dr. Paul Medley, for which funding will be requested from the CRFM. The results of the ParFish interviews and assessment should be presented to the fishing communities.

Inter-sessional Work Plan

General

- More interaction is required among SGWG members during the inter-sessional period. This can be done via electronic mail, Skype, netmeeting site or video conferencing.

- The Stock Assessment Parameters Profile for five species of Western Atlantic Tropical Shrimp, first developed by the Government of Trinidad and Tobago under an FAO/UNDP Project TRI/91/001 and subsequently updated, will be circulated among the members of the SGWG for update with new information obtained from assessments conducted at this workshop as well as any other relevant information.

Guyana & Suriname

- Catch and effort data for Suriname is to be verified. Catch and effort data series is to be extended as far back as possible prior to 2002 in the case of Guyana, and 1998 in the case of Suriname.

- Attempts should be made to hold a bilateral meeting to review and update the assessments conducted for Suriname and Guyana at the 2009 meeting, including sensitivity analyses and projections. In order to conduct the sensitivity analyses, the key parameters that introduce the most uncertainty into the assessments must be identified. Size composition data can be used to estimate growth and mortality, and this information can be used to improve the assessment. Training in the assessment methodology should also be conducted for the members of the SGWG. The fishing industry should also be invited to the meeting to review and comment on the data and assessments. Funding for this bilateral meeting would need to be explored with the CRFM and the seabob processing companies.

- A system should be developed to obtain more accurate data from the seabob processing companies in Guyana and Suriname. A standardized computer entry data sheet should be developed as well as a database for the catch and effort and size composition data. Technical assistance will be required for this activity. Options as to how this can be achieved will be explored.

Trinidad and Tobago

- Parfish trials were conducted inter-sessionally, and the details are included in the DMTWG report, this Volume.

General Recommendations

- The shrimp and groundfish resources are shared by the countries on the Brazil-Guianas Continental Shelf. As some of these countries are not members of the CRFM (Venezuela, French Guiana, Brazil), it is recommended that the CRFM network with the FAO/WECAFC ad hoc Working Group on Shrimp and Groundfish Resources of the Brazil-Guianas Continental Shelf.

- Member countries should ensure that their representatives are provided with laptops powerful enough to run the assessment models at the scientific meetings.

Review and Adoption of Working Group Report.
The Working Group Report was reviewed and adopted by the members of the SGWG.

Adjournment.
The meeting of the SGWG adjourned at 7.30 pm on June 16, 2009

References

Ferreira, L. and P. Medley. (2006). The shrimp fisheries shared by Trinidad & Tobago and Venezuela. In: *Report of Second Annual Scientific Meeting – Port of Spain, Trinidad and Tobago, 13-22 March 2006*. *CRFM Fishery Report* – 2006, Volume **1**. pp. 93-111.

Medley, P., J. Alió, L. Ferreira and L. Marcano. (2006). Assessment of shrimp stocks shared by Trinidad and Tobago and Venezuela. In *FAO/Western Central Atlantic Fishery Commission Report of Workshop on the Assessment of Shrimp and Groundfish Fisheries on the Brazil-Guianas Shelf. Port of Spain, Trinidad and Tobago, 11-22 April, 2005*. Rome: FAO. (DRAFT).

B. Fishery Reports

5.4.1 Guyana Seabob (*Xiphopenaeus kroyeri*) Fishery

5.4.1.1 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 stabilize 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.

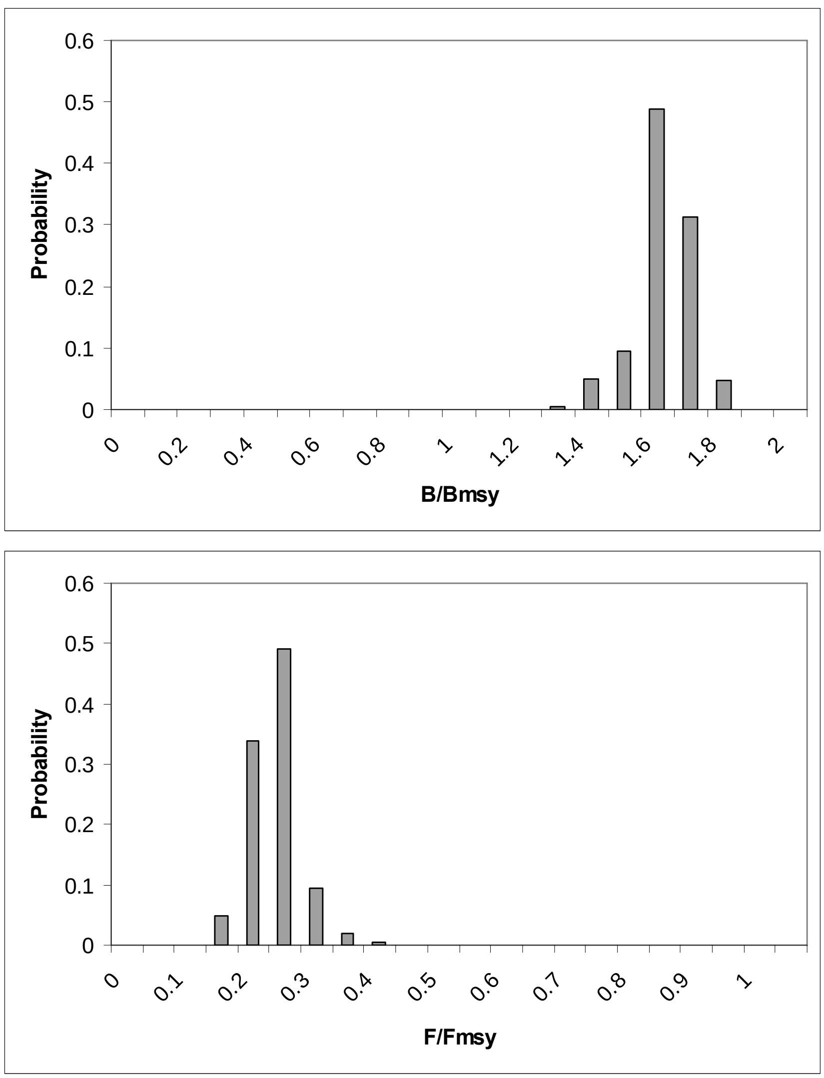

Fig. 1: Probability estimates based on the Monte Carlo integration of the posterior biomass dynamics model fitted to the catch and effort data.

5.4.1.2 Status of Stock

There is no evidence from the catch and effort data that the stock is overfished and or that overfishing is occurring. The CPUE time series shows a shallow decline but still remains high relative to the start of the series. Furthermore, despite much higher catches reported for 2004 and 2005, the CPUE showed little reaction with a slight dip followed by recovery.

The stock assessment indicates that the stock is well above the MSY level ($B/B_{MSY} > 1.0$) and the 2008 catch (10100t) was well below the MSY level ($F/F_{MSY} < 1.0$; Fig. 1).

5.4.1.3 Management Advice

It is recommended to adopt reference points and a harvest control rule within the fisheries management plan to ensure that the fishing is sustainable. The reference points and harvest control rule have been proposed based on the maximum sustainable yield point (MSY).

Limit reference point: Biomass at 60% of the MSY estimate
Target reference point: Biomass 120% of the MSY estimate (consistent with the management objectives).

The reference points (biomass, yield and fishing mortality at MSY) have been estimated from the annual catch and effort time series. However, given the very short time series of data, the estimates cannot be made with high accuracy and remain uncertain. Therefore the reference points are considered preliminary and need to be verified through further research. The results also need to be confirmed through analysis of the size composition data.

To maintain the stock at the target level, a trigger reference point is required. For Guyana, under the current management objectives, the trigger point would be at MSY. The trigger point identifies when management action is required to reduce the exploitation rate and rebuild the stock. The trigger point will also need to take into account the uncertainty associated with the monitoring variables chosen as part of the harvest control rule.

Controls to maintain the stock around the target level need to be defined, as do the controls applied to reduce fishing mortality as the limit reference point is approached. These could include a closed season, export catch limits and fishing effort control.

A harvest control rule should have the following properties:

- It should maintain a harvest rate which should keep at or around the target level in the long term.
- It should reduce the harvest rate as the stock approaches the limit level.
- Fishing should be minimized if the stock falls below the limit.

In addition, the following property may also be considered useful:

-
- The harvest control rule should limit year-to-year fluctuations in the control measures to levels acceptable to the fishing industry wherever possible. This will help industry to plan for and maintain a suitable level of catching and processing capacity commensurate with the productivity of the resource.

To protect recruits to the fishery and allow them to grow, a closed season would be most valuable if set in September/October. The smallest seabob are landed in September (Fig. 2), so the largest increase in yield-per-recruit would be obtained from closure at this time. However, alternative closure times (May or June) may still be warranted if special protection is required for the spawning stock. This is a departure from previous advice due to a significant improvement in the available data on size composition. Previously, average size estimates depended upon commercial size categories which appear to have been inaccurate. Direct scientific sampling of size composition was available at this meeting.

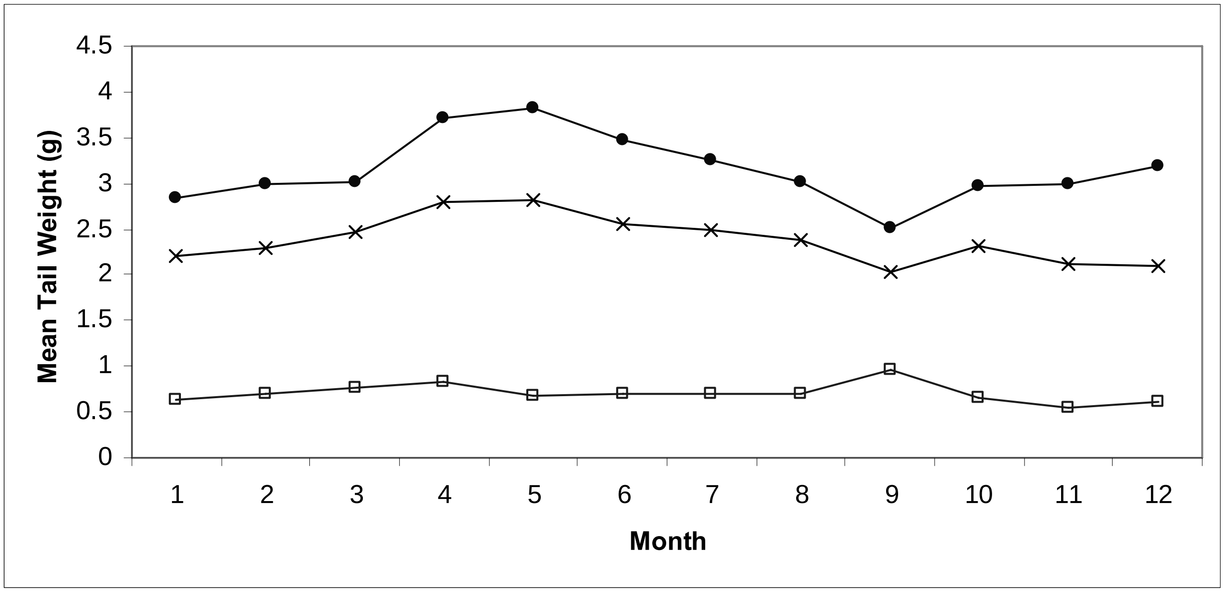

Fig. 2: Mean tail weight (g) for females (●), males (×) and juveniles (□) in Guyana by month. There is clear seasonality with maximum size reached in April/May and declining to a minimum in September when most immature seabob are encountered.

5.4.1.4 Statistics and Research Recommendations

Data Quality

Annual total catch data were available for the period 1998-2008 and monthly catch and effort data available for 2000-2008 (Fig. 3). There remains considerable uncertainty over the data accuracy. There have been very significant increases in catch during the time series without a corresponding significant drop in catch per unit effort. One reason for this is that there could be errors in data provided by the processors. This needs urgent attention as the stock assessment depends on these historical data.

Morphometric and size frequency data were also available, but there was insufficient time at the meeting to carry out a thorough examination of these data. The morphometric data were collected in December 2007 to estimate various length and weight relationships useful for conversion purposes. The size frequency data cover December 2007 to June 2008 so far, and consist of random samples taken from the landed catch before processing in the Noble House processing facility. These data have been collected by the processors for the purposes of stock assessment and have been used to consider alternative season closures.

Additional catch data were obtained from the FAO FIGIS database. These data are not likely to be very accurate, but were sufficient to allow catches to be estimated back to the start of the fishery. The level of precision of these data was adequate for this analysis, but need to be improved for future assessments to increase accuracy of the management advice.

Research

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

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

5.4.1.5 Stock Assessment Summary

Bayesian Statistics and the Monte Carlo (Sample importance resample algorithm) methods were used to estimate maximum sustainable yield (MSY)[10], replacement yield[11], current biomass relative to biomass at MSY, and current fishing mortality relative to fishing mortality at MSY. The assessment used the logistic surplus-yield model fitted to the total catch 1985-2008 and catch and effort 2000-2008.

Catch per unit effort (CPUE)[12] was used as an index of stock abundance. The measure of effort used was the number of days at sea, which would include steaming time. The CPUE index appears to be declining each year (Fig. 3) indicating a small decline in stock size since the start of the series.

The results indicate a reasonable fit of the model (Fig. 4), but it should be noted that although the model explained the negative trend in the CPUE, this trend only formed a small part of the variation in CPUE. The number of CPUE data points (8) was limited and with only a decreasing trend, so that the priors may have influence on the results. The rate of increase is negatively correlated with the estimate of abundance, so a higher rate of increase would imply lower biomass.

The maximum sustainable yield suggested most likely values would be between 22,000-34,000 t $year^{-1}$ (Table 1; Fig. 5). The assessment depends upon the accuracy of the available data and is heavily influenced by the high catches in 2004 and 2005. If these are overestimates, the state of the stock may well be re-evaluated downwards. A sensitivity analysis replaced 2004 and 2005 total catches with the lower 2003 catch, and repeated the assessment. In this analysis, the assessment also indicated that the stock was not overfished, albeit the overall biomass was lower.

The assessment indicates that the stock is not overfished ($B/B_{MSY} > 1.0$) and overfishing is not occurring ($F/F_{MSY} < 1.0$). The working group does not endorse this conclusion without verification of the data.

River outflow and rainfall data were examined with the intention of using these environmental data as an indicator of productivity. This index was not incorporated at this time, but will form the subject of ongoing research to improve the stock assessment.

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[10] **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.
[11] **Replacement Yield** is the yield/catch taken from a stock which keeps the stock at the current size.
[12] **CPUE** is the quantity of fish caught (in number or in weight) with one standard unit of fishing effort.

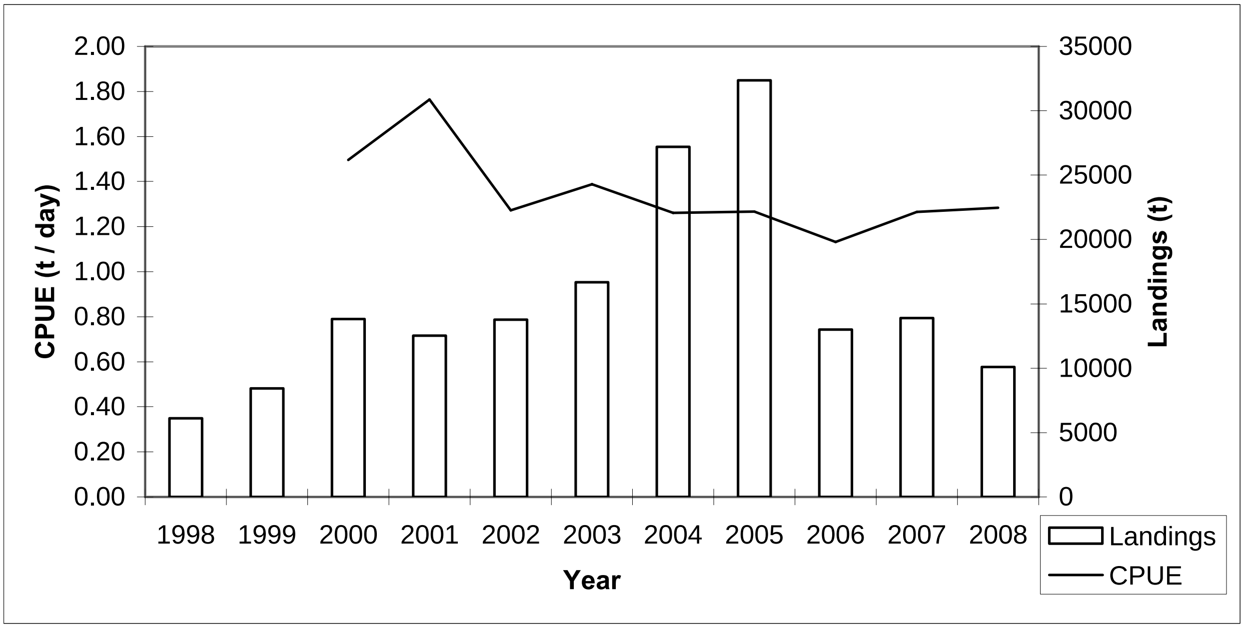


Fig. 3: The CPUE abundance index and landings of Guyana seabob 1998-2008. The CPUE shows an overall negative trend. Total effort data are unavailable for this fishery.

Table 1: Summary of results from fitting the logistic biomass dynamics model to the available catch and effort data 1985-2008. While the rate of increase (r) seems reasonable for a fast growing species, the biomass is much higher than the prior would suggest (based on a survey by Pezzuto *et al.* (2008) of a bay with an exploited seabob stock in Brazil). With a large biomass and relatively low catch, the state of the stock is estimated as likely to be above MSY and increasing.

Parameter	Lower Percentile 0.05	Median 0.5	Upper Percentile 0.95
r	0.57	0.68	0.93
B_∞	142387	149564	157540
B_{now}	0.75	0.82	0.91
MSY (t)	21424	25483	34676
	0.57	0.68	0.93
Current Yield (t)		10100	
Replacement Yield (t)	11784	14959	16076
B/BMSY	1.50	1.64	1.81
F/FMSY	0.19	0.27	0.34

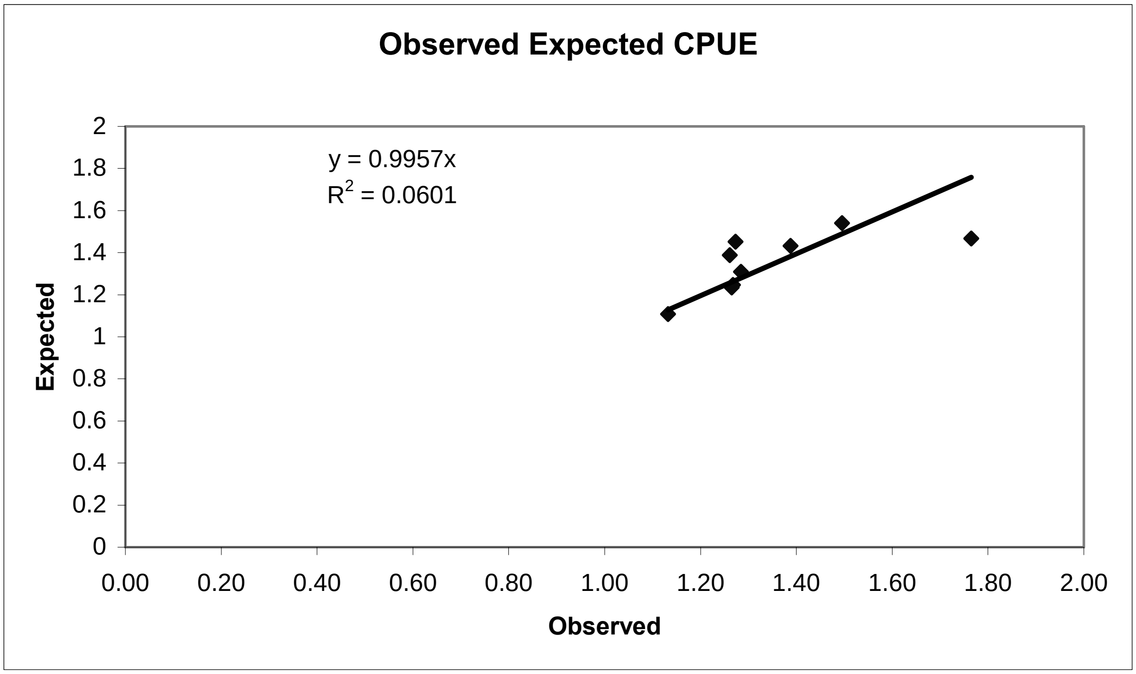
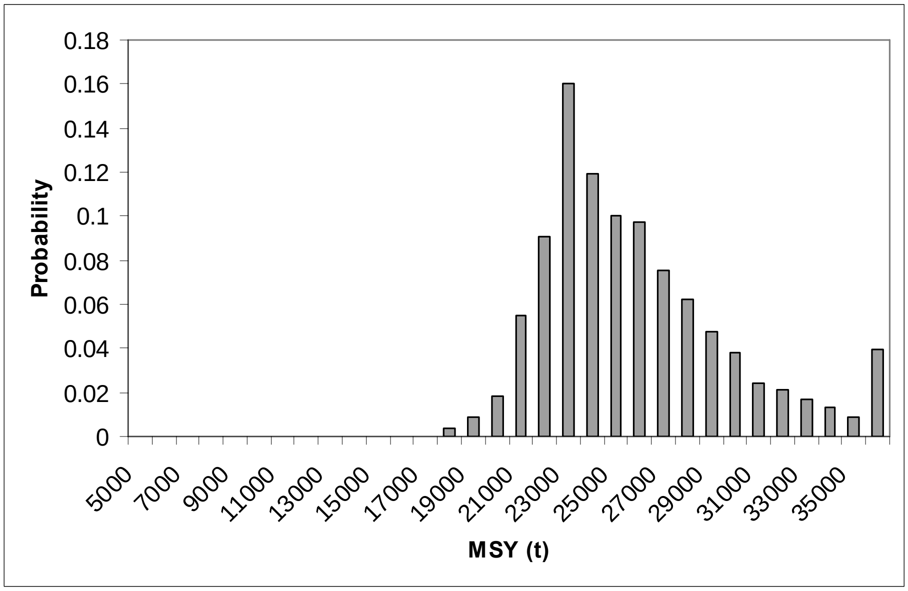


Fig. 4: Observed and expected CPUE from the model fit. The residuals show no obvious pattern around the regression line going through the origin, but the observed CPUE in 2001 was much higher than the expected from the model leading to the apparent outlier below the regression line.



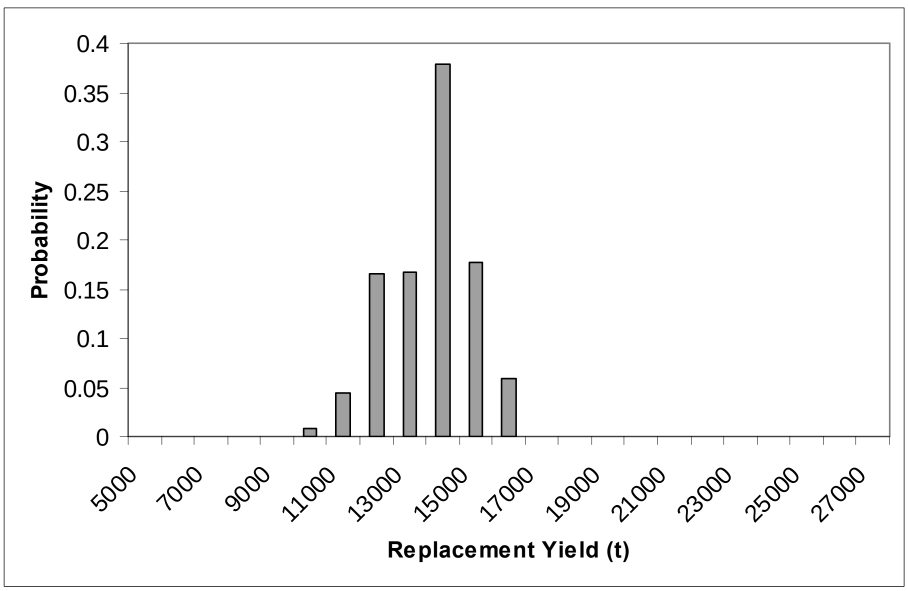


Fig. 5: Maximum sustainable yield and current replacement yield probability estimates for the Guyana seabob fishery.

As well as a standard stock assessment, the available size composition data were used to examine the effect a closed season of one month may have on yield. A simple function based on yield-per-recruit was used to estimate the change in yield for the size composition being selected in each month (Fig. 6). The most appropriate month for a closure will have the highest YPR score. In this case, the most appropriate month is clearly September when the smallest shrimp have been recorded in the sampling in that month.

Although the YPR scores for all months are negative, indicating that a closed season is not useful to increase yield-per-recruit, this conclusion is unreliable. To be valid the absolute YPR scores require parameters such as fishing mortality which were unavailable, so “reasonable” values were used rather than estimated values. The interpretation of the best month for closure, remains valid since this is not sensitive to the parameters, but depends primarily upon the size of shrimp being landed in each month.

It should be noted that this only considers yield-per-recruit (calculating gains in biomass against losses from mortality), not other considerations such as effort reduction to decrease fishing mortality.

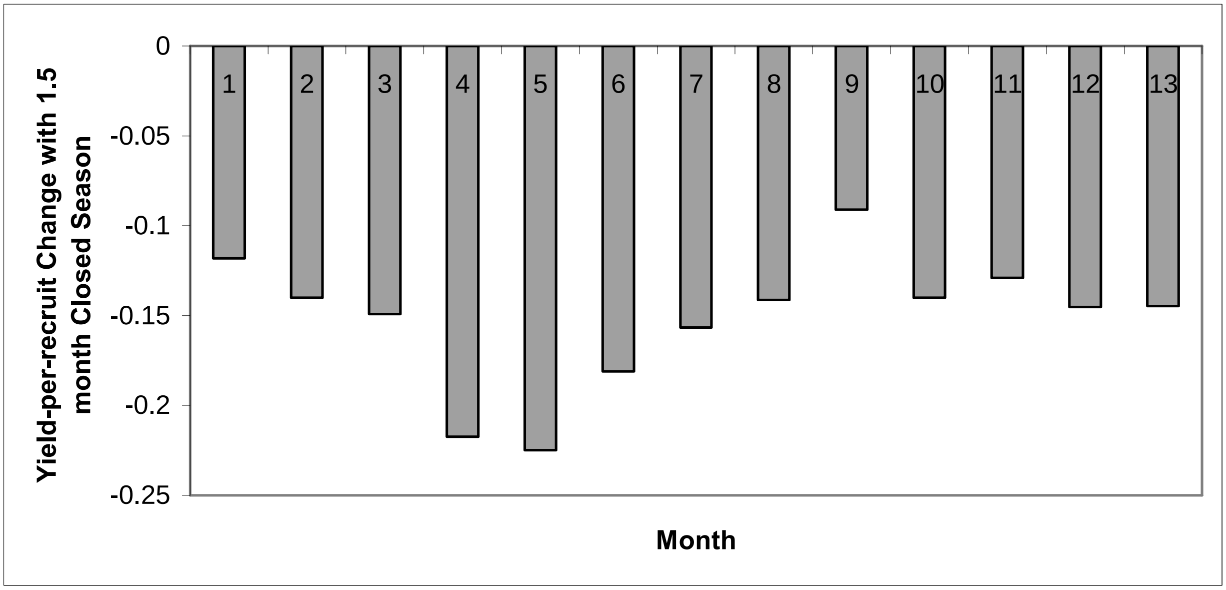


Fig. 6: Relative advantages to starting a closed season in the different months of the year based on the change in yield-per-recruit.

5.4.1.6 Special Comments

As a direct result of the better data provided to this meeting on the size composition of the landings, the closed season advice has changed from previous assessments. The new data are much more accurate and therefore the advice is more reliable. The working group would like to encourage further data collection initiatives of this type and continued improvements in the co-operation with the fishing industry.

It is likely that with improvements in the catch and effort data the state of the stock will be revised downward. This is based on the view of the working group that the biomass estimate in this model is currently too high.

The biomass estimate is an accumulation over the entire year accounting for population processes, such as growth and recruitment, within the year. Therefore, this does not represent an estimate of standing stock biomass.

In the light of these two points, this biomass estimate should not be used for decisions on the further development of the fishery or expansion in exploitation.

5.4.1.7 Policy Summary

The policy is 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.

5.4.2 Suriname Seabob (*Xiphopenaeus kroyeri*) Fishery

5.4.2.1 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.

5.4.2.2 Status of Stock

The assessment indicates that the stock is not overfished ($B/B_{MSY} > 1.0$) and overfishing is not occurring ($F/F_{MSY} < 1.0$; Fig. 7). This conclusion depends, among other things, upon a reasonably accurate time series of total catch which needs to be verified.

Best estimates				
Current Yield	**MSY (t)**	**Replacement Yield**	**B/BMSY**	**F/FMSY**
8224	8881	7981	1.28	0.77

5.4.2.3 Management Advice

It is recommended to adopt reference points and a harvest control rule within the fisheries management plan to ensure that the fishing is sustainable. New provisional reference points and a harvest control rule have been proposed based on the maximum sustainable yield point (MSY).

Limit reference point: Biomass at 60% of the MSY estimate
Target reference point: Biomass 120% of the MSY estimate

The reference points (biomass, yield and fishing mortality at MSY) have been estimated from the annual catch and effort time series. CPUE can therefore be used as a proxy for the biomass.

The CPUE expected at MSY is 1.46 t day^{-1}, whereas current CPUE is 1.87 t day^{-1}. The limit reference point will be 60% of the MSY at 0.88 t day^{-1}, so the main objective of the harvest control rule would be to maintain the catch rate above this level. However, CPUE will never be an exact measure of biomass and some error needs to be accounted for.

To maintain the stock at target levels, a trigger reference point has to be proposed, which will need to take into account the uncertainty associated with the monitoring variables chosen as part of the harvest control rule. The harvest control rule also uses proxies, CPUE and days-at-sea for biomass and fishing mortality respectively, and takes into account the uncertainty with which they are estimated.

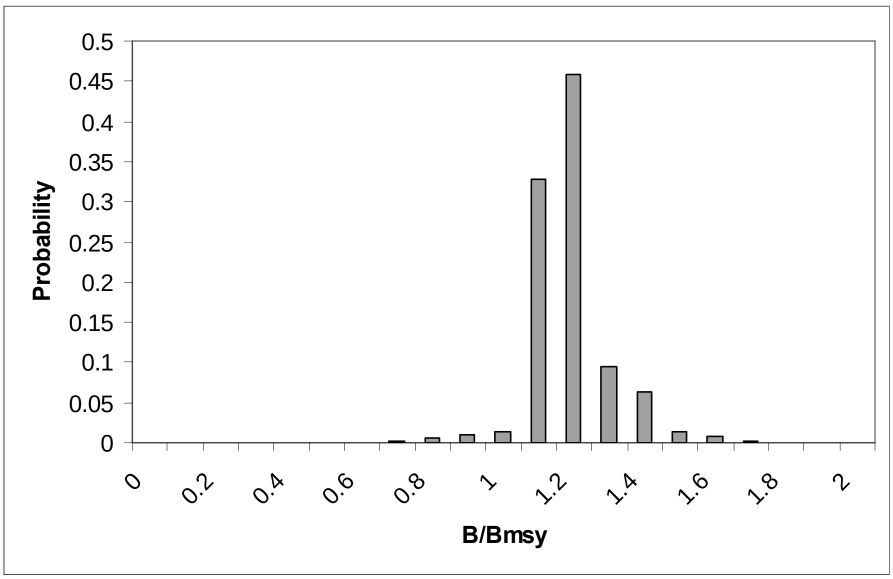
Controls to maintain the stock around the target level need to be defined, as do the controls applied to reduce fishing mortality as the limit reference point is approached. These could include a closed season, export catch limits and fishing effort control.

A harvest control rule should have the following properties:

- It should maintain a harvest rate which should keep at or around the target level in the long term.
- It should reduce the harvest rate as the stock approaches the limit level.
- Fishing should be minimized if the stock falls below the limit.

In addition, the following properties may also be considered useful:

- The harvest control rule should limit year-to-year fluctuations in the control measures to levels acceptable to the fishing industry wherever possible. This will help industry to plan for and maintain a suitable level of catching and processing capacity commensurate with the productivity of the resource.



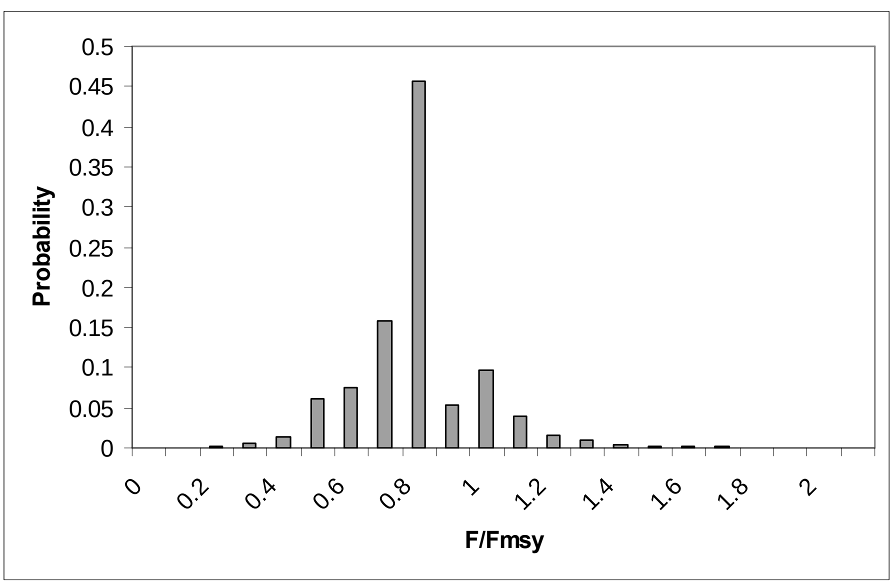


Fig. 7: Probability estimates based on the Monte Carlo integration of the posterior biomass dynamics model fitted to the catch and effort data.

5.4.2.4 Statistics and Research Recommendations

Data Quality

Annual catch and effort data were available for the period 1998-2008 and monthly data available for 2002-2008 (Fig. 8). There was uncertainty over the data accuracy. Mistakes made in assembling data became apparent when data from the same original source, which therefore should be the same, were found to be different. Differences are not large enough to invalidate the stock assessment, but nevertheless data need to be validated as quickly as possible.

Morphometric and size frequency data were also available, but there was insufficient time at the meeting to carry out a thorough examination of these data. The morphometric data were collected in December 2007 to estimate various length and weight relationships useful for conversion purposes. The size frequency data cover December 2007 to June 2008 so far, and are random samples taken from landed catch before processing in Guiana Seafoods (Suriname) and Noble House (Guyana) processing plants. These data have been collected by the processors for the purposes of stock assessment. They have been used to consider alternative season closures.

Additional catch data were obtained from the FAO FIGIS database. The level of precision of these data was considered to be sufficient to estimate catches back to the start of the fishery. The data should however be improved for future assessments to increase the accuracy of the management advice.

Research

Research is currently being undertaken on growth and mortality of seabob through the collection of detailed size frequencies. A considerable data set is already available, but analysis is incomplete. The data were reviewed and some analysis completed at the current meeting. The research should give estimates of growth rates, maximum size and mortality rates for independent comparison with the results obtained from the catch and effort data.

A further task to be completed in the intersessional period will be to develop a research plan for seabob and the seabob fishery.

5.4.2.5 Stock Assessment Summary

Bayesian Statistics and the Monte Carlo (Sample importance resample algorithm) methods were used to estimate Maximum Sustainable Yield (MSY)[13], Replaceable Yield[14], current biomass relative to biomass at MSY, and current fishing mortality relative to fishing mortality at MSY. The assessment used the logistic surplus-yield model fitted to the total catch 1989-2008 and catch and effort 1998-2008.

Catch per unit effort (CPUE)[15] was used as an index of the abundance of stock. The measure of effort used was the number of days at sea, which would include steaming time. The CPUE index appears to be declining each year (Fig. 8) indicating a small decline in stock size since the start of the series.

The results indicate a reasonable fit of the model (Fig. 9), but it should be noted that although the model explained the negative trend in the CPUE, this trend only formed a small part of the variation in CPUE. The number of data points (10) was limited and with only a decreasing trend, effectively

[13] **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.

[14] **Replacement Yield** is the yield/catch taken from a stock which keeps the stock at the current size.

[15] **CPUE** is the quantity of fish caught (in number or in weight) with one standard unit of fishing effort.

three out of four parameters could be estimated with the data, so that the informative priors will have influenced the results.

The rate of increase (*r*) is negatively correlated with the estimate of abundance, so a higher *r* would suggest lower biomass. Given the life history of this species (a small crustacean with high growth and mortality rates), the current r is probably underestimated and the biomass overestimated. However, correcting this would require improved prior information than currently available.

The maximum sustainable yield suggested most likely values would be between 8000-9000 t year^{-1} (Table 2; Fig. 10). However, the assessment also indicated that MSY could be lower than this and therefore ongoing monitoring is required.

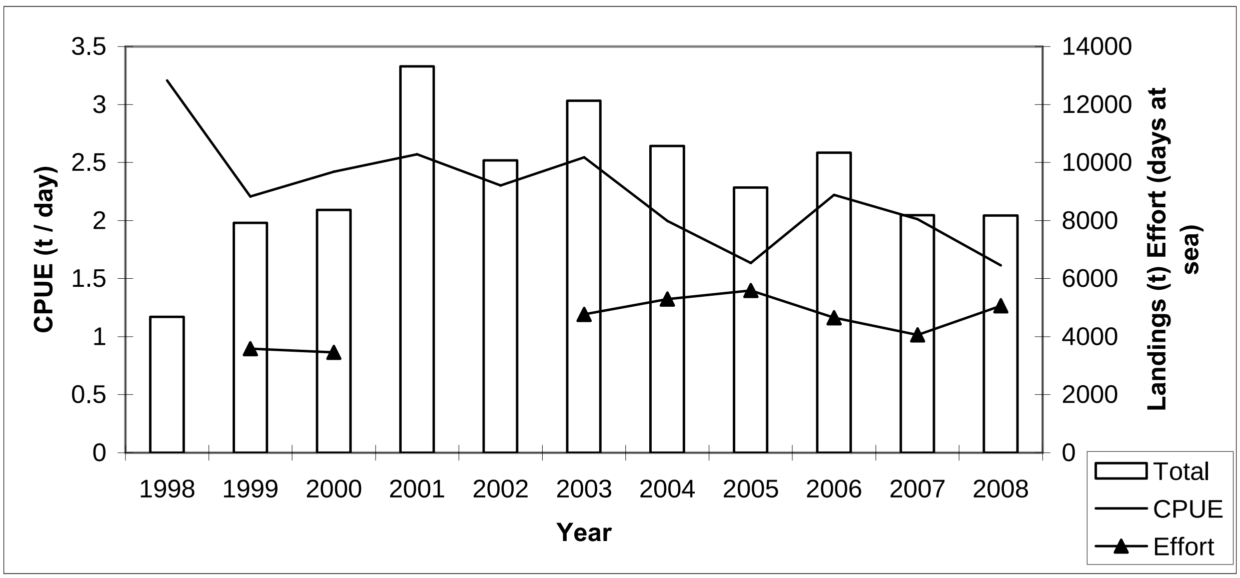


Fig. 8: The total catch and effort and CPUE time series available for Suriname seabob. The CPUE abundance index shows a continuous decline since 1998, suggesting that the stock abundance has declined over this period. The catch time series 1998-2008 has some uncertainty as to the recorded data (see Section 1.4.1). Where total effort was unavailable, the total catch is more uncertain.

Table 2: Summary of results from fitting the logistic biomass dynamics model to the available catch and effort data 1989-2008.

Parameter	Lower Percentile 0.05	Median 0.5	Upper Percentile 0.95
r	0.17	0.40	0.49
B_∞	78 625	84 303	145 093
B_{now}	0.56	0.61	0.72
MSY (t)	6 120	8 403	10 524
Current Yield (t)		8 224	
Replacement Yield (t)	5 888	8 039	8 612
B/BMSY	1.12	1.22	1.43
F/FMSY	0.57	0.82	1.17

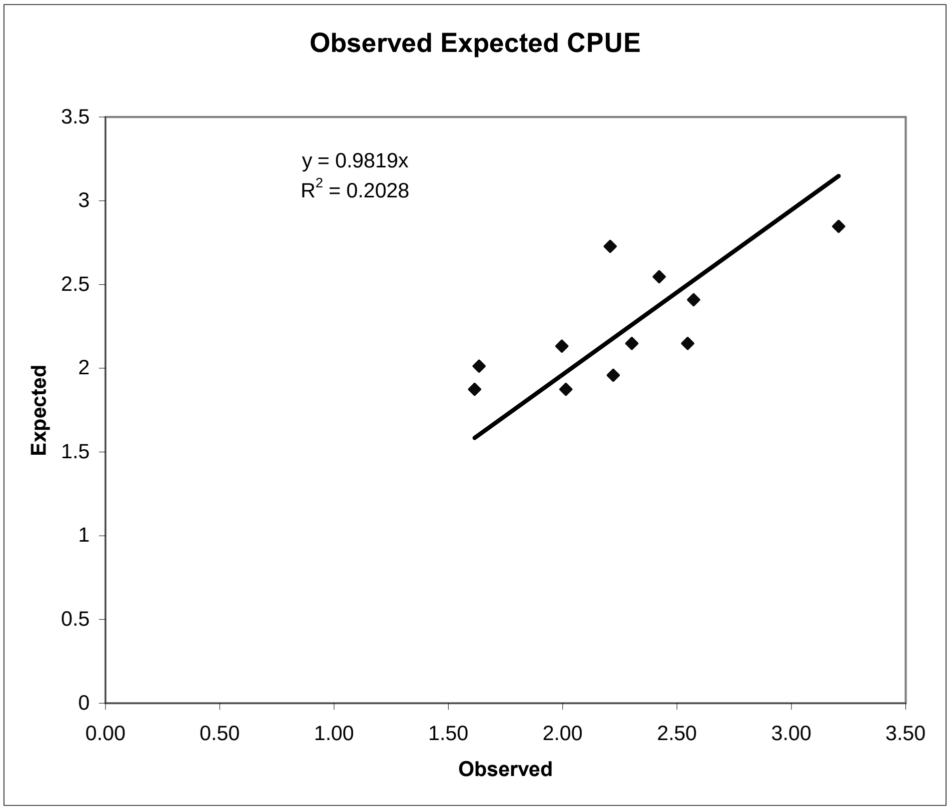
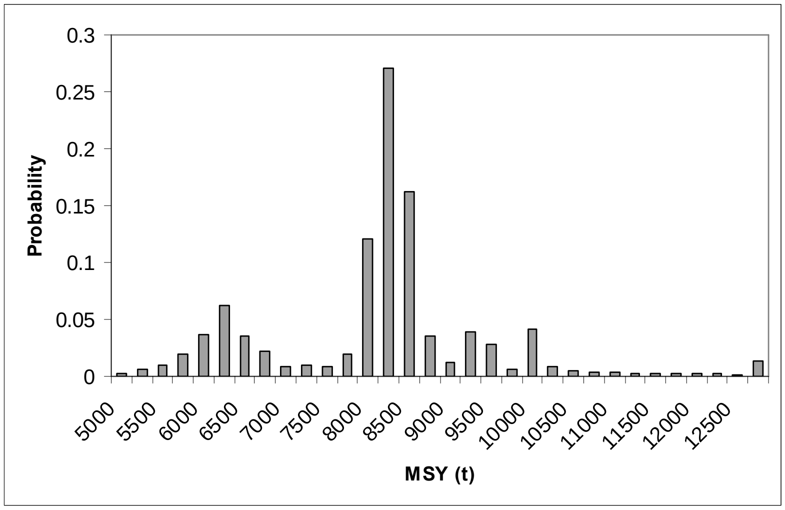


Fig. 9: Observed and expected CPUE from the model fit. The residuals show no obvious pattern around the regression line going through the origin.



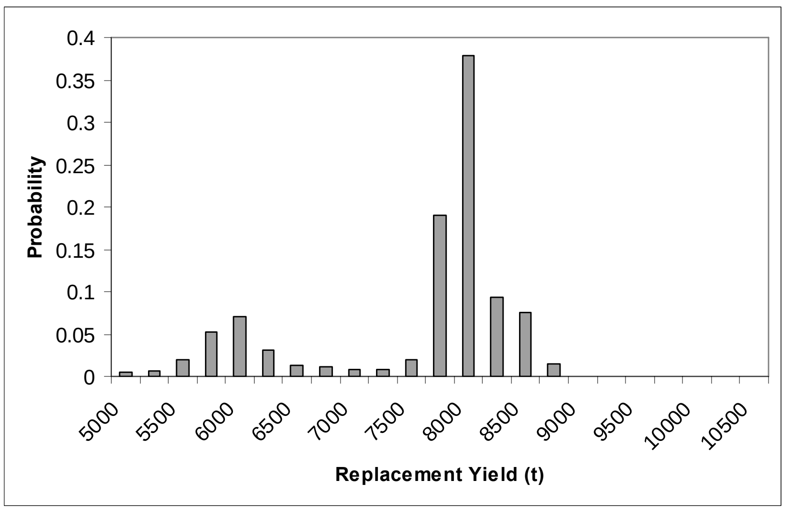


Fig. 10: Maximum sustainable yield and current replacement yield probability estimates for the Suriname seabob fishery.

As well as a standard stock assessment, the available size composition data were used to examine the effect a closed season of one month may have on yield. A simple function based on yield-per-recruit was used to estimate the change in yield for the size composition being selected in each month (Fig. 11). The most appropriate month for a closure will have the highest YPR score.

In this case, the most appropriate months are likely to be one of those from December to February. The scores for all months are negative, indicating that a closed season is not useful to increase yield-per-recruit, although it may be useful for other purposes. However, to be valid the absolute YPR scores require parameters such as fishing mortality which were unavailable, so "reasonable" values were used rather than estimated values. The interpretation of the best month for closure, should a closed season be implemented remains valid since this is not sensitive to the parameters, but depends primarily upon the size of shrimp being landed in each month.

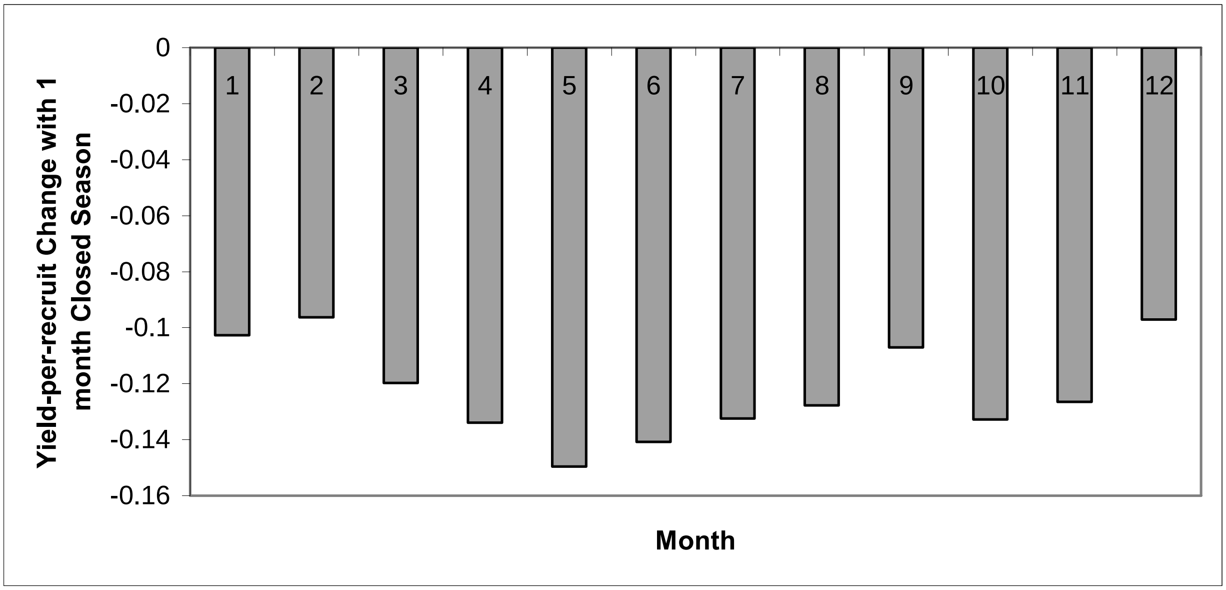


Fig. 11: Relative advantage to starting a closed season in the different months of the year based on the change in yield-per-recruit.

5.4.2.6 Special Comments

In 2008 it was recommended that Suriname and Guyana have similar programs for collecting biological data. This has been successfully achieved through a standard data collection protocol implemented in the processing facilities of Guiana Seafoods (Suriname) and Noble House Seafoods (Guyana).

The biomass estimate is an accumulation over the entire year accounting for population processes, such as growth and recruitment, within the year. Therefore, this does not represent an estimate of standing stock biomass and should not be used for decisions on the further development of the fishery or expansion in exploitation.

5.4.2.7 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. The 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.

5.4.2.8 Scientific Assessments

Background or Description of the Fishery

Suriname Seabob Fishery

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 Guiana Seafoods N.V (GSF) and Namoona with 15 vessels and 9 vessels, respectively. The 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 catch is processed by two processing plants.

There is also an artisanal fishery for seabob with about 500 vessels; this fishery uses Chinese seines.

Guyana Seabob Fishery
The industrial fishery consists of 147 shrimp trawlers, five major processing plants, nine small processing plants, and a few wharves and dry docking facilities. Forty-five shrimp trawlers exploit mainly 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 remaining 102 vessels exploit seabob (*Xiphopenaeus kroyeri*) and various finfish species (*Macrodon ancylodon, Micropogonias furnieri, Nebris microps, Arius* spp., *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 are owned by private individuals.

The penaeid shrimp vessels would spend an average of 30 days at sea per trip and do approximately 10 -12 trips per year. The seabob trawlers spend 5 - 9 days at sea per trip, but an average trip lasts 7 days. A typical seabob vessel makes 2 - 3 trips per month, and an average of 30 trips per year (see also Fisheries Management Data System Terminal Workshop, Guyana Report, St Lucia, 1999).

<u>Overall Assessment Objectives</u>
The main objective of this assessment was to update the status of the stock, define reference points and a harvest control rule for the Guyana and Suriname seabob fisheries.

<u>Data Used</u>

Name	**Description**
Total seabob landings	Reported monthly seabob landings based on processor reports 1998-2008
Catch and effort data	Reported seabob landings and days at sea per trip based on processor reports 2002-2008
Catch and effort data	Reported seabob landings and days at sea per trip extracted from the daily Guiana Seafoods N.V. processor reports 2002-2008.
Morphometric Data	In December 2007, 500 animals were sampled and measured, stratified over sex and size.
Size Composition Sampling Data	From December 2007 to June 2009, ongoing random sampling of the landed size composition from Guiana Seafoods in Suriname and Noble House Seafoods in Guyana.

Assessment 1: Construction and Review of Total Catch and CPUE Indices

Objective

Complete and check the data necessary for use in a biomass dynamics stock assessment model and assemble data in a form to which the model can be fitted.

Method/Models/Data

The primary data source is the processing facilities which report landings and exports to the relevant government departments (Table 3). These data have been assembled, but often have been reported in several formats due to the lack of a central database and data are not reported in raw form. This allows inconsistencies and mistakes to occur in the data.

In addition this year another source of information was available as catch and effort compiled directly from the daily plant and fleet reports: GSNV (processed) and NHS (processed) CPUE. These reports, which are used by the processors to manage the facility and are not usually made available, provide a reliable source of information to allow other indices to be checked. However, the indices only cover a smaller proportion of landings, so indices based on more data should be used in preference.

As well as the daily plant and fleet processed reports, estimated catches reported by the vessel captains (GSNV radio and NHS radio) were also examined from the same source. As these are estimated, they are not likely to be as accurate as the processed data, but might still be useful where they are the only data available.

The primary test for the CPUE was the comparison between GSNV (processed) and NHS (processed) CPUE and the other indices. Because these were based on individual trip data from original records, these indices should be correct. Correlations among indices based on monthly data were used to provide indications of overall coherence among indices.

In addition, correlations between hydrometric data and CPUE were used to explore the value of hydrometric data as an indicator of productivity. However, this issue was not explored fully due to a lack of time, but tests undertaken to check whether this area of research is worth pursuing.

Table 3: Data available for the assessment. All catch and effort data come from the same set of original sources, the processing facilities which report to government. However, due to the lack of a central database to manage the data, data have been compiled manually in different forms over the years almost certainly introducing mistakes. Hydrometric and rainfall data were obtained from the relevant government department.

Country	Data	Period	Source
Suriname	Monthly catch and effort	2002-2008	Namoona
Suriname	Monthly catch and effort	2003-2008	Guiana Seafoods N.V.
Suriname	Daily plant and fleet reports	2002-2008	Guiana Seafoods N.V.
Suriname	Annual catch and effort data	1998-2008	Processors
Guyana	Monthly production data	1998-2008	Processors
Guyana	Monthly catch and effort	2000-2008	Noble House Seafoods
Guyana	Daily plant and fleet reports	2001-2008	Noble House Seafoods
Guyana	Hydrometric data	1998-2007	Guyana Government
Guyana	Rainfall data	1998-2008	Guyana Government

Results and Discussion
The CPUE data were completed during the meeting with all valid data being collated for testing. As CPUE indices need not have complete coverage of the fleet, data suspected of being incorrect could be excluded. Unfortunately data were provided in processed form only for Suriname but were provided by both processing companies. Similarly, Guyana data were in processed form, but formatted correctly making treatment and preparation easier, but data were available from only one processor. In reviewing the indices many corrections were made and data compiled in standard format for continued correction and more efficient use at the next meeting.

Correlation between CPUE indices gave expected patterns, with coherence greatest between indices from the same country (Table 4). Correlations in general were high between the daily plant and fleet report data and the indices available from the government reports indicating indices were basically reliable. Some positive correlation between countries may be due to similar effects from the environment, such as seasonality.

There was a strong correlation between Namoona- and GSNV-sourced indices for Suriname which were derived from different data. This suggests that the indices are affected by the same common causes, although this is not direct evidence that both indices are following abundance, which remains a reasonable assumption.

The time series indices finally used were the NHS index, converted to an annual index for Guyana, and a combined Namoona and GSNV annual index which was shown to be consistent with the monthly index, but extended to 1998. Although these indices were shown to follow consistent trends, accuracy of the indices could be improved by continued removal of various recording errors.

Monthly landings data extending to 1998 were provided and reviewed. These data were corrected and seemed reliable for Suriname, but what appears to be unrealistic changes in landings in 2004 and 2005 in Guyana was cause for concern. These data were further examined during the stock assessment.

The cross correlation between monthly river outflow data and CPUE for Guyana indicates a positive correlation after a lag of 9-11 months (Fig. 12). However, the correlation pattern is most likely the result of general seasonality with low and high CPUE coinciding with various periods during the wet and dry season and does not imply cause and effect. The relationship is likely to be indirect through water outflow raising nutrient levels and therefore increasing food for larvae and adult seabob. This is likely to produce a broader effect than that measured on a scale of months.

To test the effect of relative rainfall among years, an annual index was calculated for 2000-2006 CPUE and river outflow data which was the longest time series available. A correlation between the indices was found after a lag on one year (Fig. 13), which, if recruitment depends on river outflow, is consistent with the life history. While of considerable interest, the result depends heavily on one year's data and therefore a longer time series would be of greater value to confirm this relationship. The river outflow index can be extended potentially to cover the CPUE series of both Guyana and Suriname by combining various indices of rainfall and hydrometric data, and this should continue during the inter-session period.

If the relationship between river outflow and recruitment can be confirmed, the result will have a profound impact on the management of the seabob stocks. The index would provide a prediction of the next year's recruitment allowing limits to be set on catches and effort in advance. In addition, the index may well explain much of the variation in the stock size, and enable a better assessment of the effect of fishing (fishing mortality). Better information would allow improved economic management of the fishery as well as, potentially, higher levels of exploitation.

Table 4: Correlation matrix among various monthly CPUE indices available at the meeting. High correlations indicated high coherence among indices. Clearly CPUE indices from the same country should not only be measuring the same population, but be derived from the same measurements within each company, so high correlations are expected.

	Suriname				Guyana		
	Namoona	GSNV	GSNV Radio	GSNV Processed	NHS	NHS Radio	NHS Processed
Namoona	1.00	0.67	0.90	0.89	*0.26*	*0.27*	*0.24*
GSNV		1.00	0.76	0.73	*0.05*	*0.12*	*0.07*
GSNV Radio			1.00	0.98	*0.28*	*0.31*	*0.28*
GSNV Processed				1.00	*0.30*	*0.34*	*0.30*
NHS					1.00	0.95	0.86
NHS Radio						1.00	0.89
NHS Processed							1.00

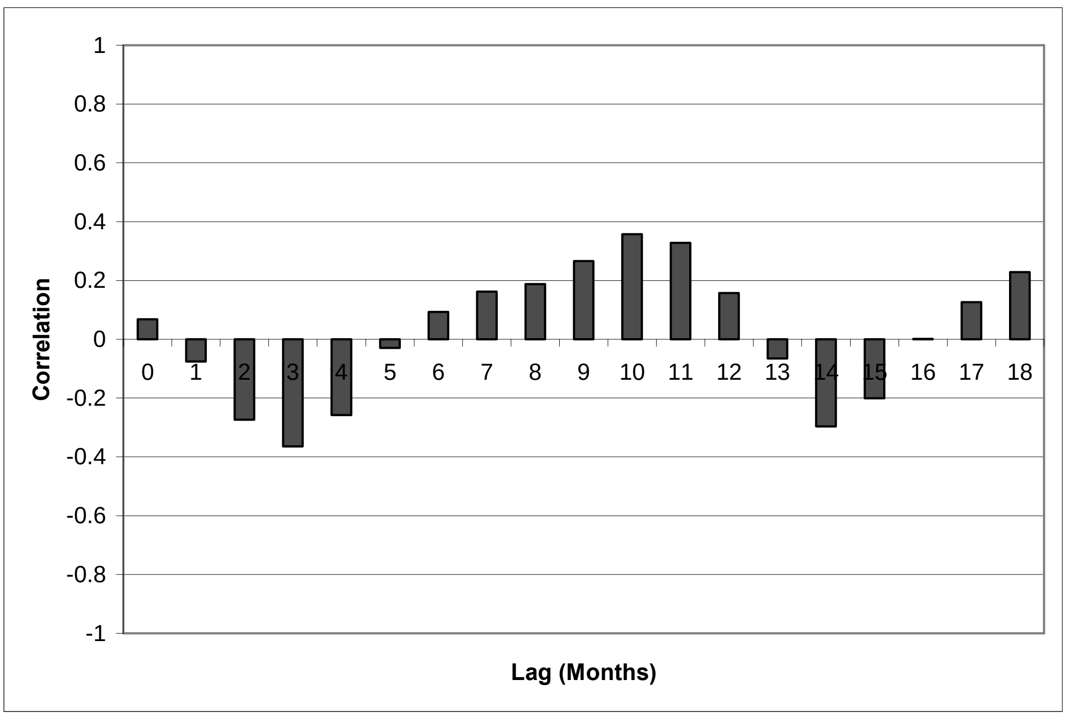


Fig. 12: Cross correlation between monthly Guyana NHS CPUE index and water outflow with the lag in months. Positive correlation occurs at a lag of 9-11 months.

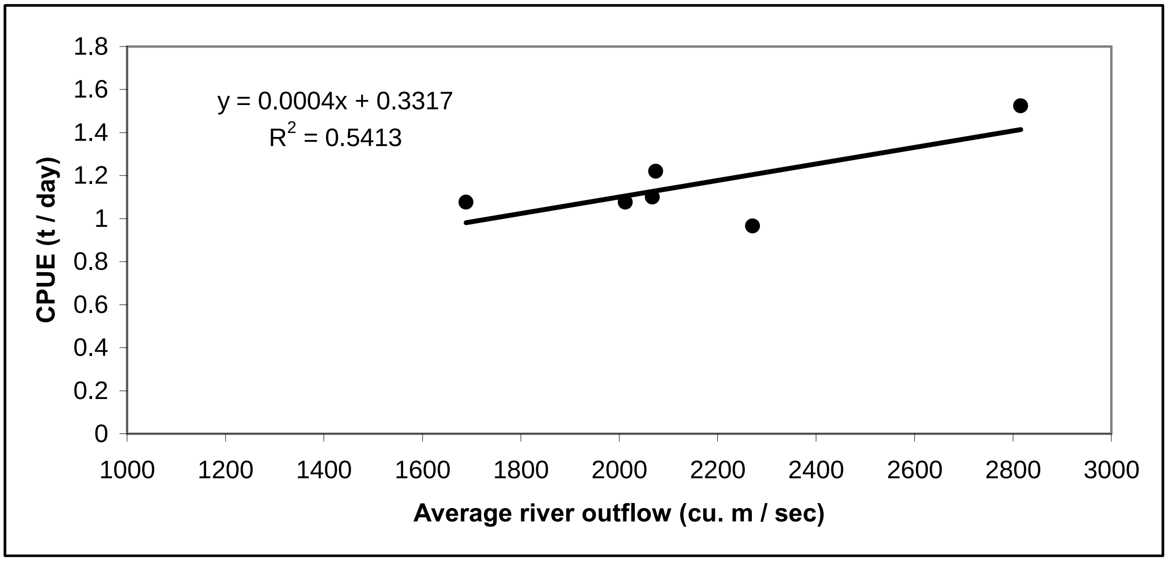


Fig. 13: Correlation between mean monthly river outflow within a year and the mean annual CPUE in the following year in Guyana. Although the correlation is strong, it depends on one or two years and may prove to be the result of chance. Nevertheless, a correlation might be expected where rivers and estuarine conditions contribute to recruitment strength, which could well be the case for seabob. Further work may allow the development of a reliable predictive recruitment index based on rainfall and river flow, which would be very valuable for management planning.

Assessment 2: Morphometric Analysis

Objective

The objective was to derive basic conversion equations for the various length and weight measurements taken of seabob.

Method/Models/Data

A number of different measures were taken on seabob individuals where the emphasis was to get a broad range of sizes. Five hundred individuals were sampled from each processing facility in Suriname and Guyana. Individuals were selected within each sex and within five broad size categories to ensure the range of sizes were covered. The size categories covered the range of sizes observed in the catch. This led to approximately 50 individuals being measured within each sex-size category. Individuals were taken, as far as possible, at random within the categories, but rejected after selection and re-sampled if not whole or if damaged. All individuals were selected at the same time of year over the period of a month December 2007 – January 2008.

The following measurements were taken:

1. Carapace length (mm): The standard measurement for crustaceans.
2. Tail length (mm): The length across the flattened back over the six segments
3. Total weight: The weight of the whole animal
4. Tail weight: The weight of the tail after being cleanly separated from the thorax.
5. Peeled weight: The weight of the tail after the exoskeleton and legs are peeled off, simulating final processing.
6. Sex and, for females, maturity/reproductive state.

Other measurements were considered, but were not relevant to the conversion requirements and therefore not taken.

Morphometric analyses were conducted in R applying standard linear regressions on weight-weight and length-length conversions as well as on Log Weight – Log Length conversions. In all cases, standard diagnostics of the fits were inspected, but only summary information is presented here.

Results and Discussion

The regressions were carried out on corrected data and relationships for all likely comparisons obtained (Table 5). Some values were clearly incorrect (outliers) most likely due to typing errors. Likely inaccurate values due to measurement errors were not removed as measurement error was important for interpretation of the final results.

Relationships between sex, location and maturity were significantly different; that is, the probability that parameters estimated for these additional relationships were zero was much less than 0.05. Therefore some improvement in the estimation may be possible if sex, maturity and/or location are known. However, these differences are still relatively small, and in most cases recording of these categories (with the exception of location) is unlikely. Hence, for example, conversion from peeled to total weight would be conducted regardless of sex or maturity. In addition, this level of accuracy would probably require measurements to be taken throughout the year as seasonal effects are likely to have as great an impact on body shape. Therefore, the simpler relationships estimated here are likely to be more robust and should be used in the general case. The data are available to develop other models if required.

Table 5: Summary of morphometric relationships, being the mean values across sex, female maturity and location (Suriname and Guyana).

	Y Variable	X Variable	Equation	a	S.E.	b	S.E.
1	Total Weight	Peeled Weight	$W_T=aW_P$	2.1285	0.00487		
2	Peeled Weight	Total Weight	$W_P=aW_T$	0.4677	0.00107		
3	Total Weight	Tail Weight	$W_T=aW_t$	1.6592	0.00361		
4	Tail Weight	Peeled Weight	$W_t=aW_P$	1.2819	0.00188	1.3897	0.02092
5	Tail Length	Carapace Length	$L_t=b\ L_c+a$	11.1228	0.4176	1.3897	0.02092
6	Peeled Weight	Carapace Length	$LnW_P=b\ LnL_c+a$	-5.5930	0.08582	2.1440	0.0291
7	Peeled Weight	Tail Length	$LnW_P=b\ LnL_t+a$	-9.5736	0.15054	2.8410	0.0401
8	Peeled Weight	Tail Length	$LnW_P=3\ LnL_t+a$	-10.1691	0.00367		
9	Total Weight	Tail Length	$LnW_T=b\ LnL_t+a$	-8.8753	0.12190	2.8466	0.0336
10	Tail Weight	Tail Length	$LnW_t=b\ LnL_t+a$	-8.9376	0.02956	2.7321	0.0296
11	Total Weight	Carapace Length	$LnW_T=b\ LnL_c+a$	-5.0857	0.08388	2.2210	0.0285
12	Tail Weight	Carapace Length	$LnW_t=b\ LnL_c+a$	-5.1997	0.08387	2.0973	0.0285

As well as estimating the relationships among body measurements, morphometric analyses were used to explore possible differences by location to review whether Suriname and Guyana might be viewed as the same stock. An example testing for differences in body shape is the relationship between tail length and tail weight. Significant effects were found for sex, place and maturity; however the interaction terms between sex and place, and log-tail length were not significant (Table 6) suggesting that, with the exception of maturity, changes to body dimensions are proportional and consistent with species being at different stages of growth and condition. The effects of both location and sex are relatively small, maturity having the biggest effect on body shape due to the presence of eggs (Table 7).

The data collection programme for the analyses discussed above has been completed. However, further morphometric studies may be useful to see whether relationships change during the season, due to for example changing condition factors and reproductive levels, and other measurements could be taken to see whether there is evidence for the separation of stocks between Suriname and Guyana.

Table 6: Analysis of variance of the regression model of log tail weight as a function of log tail length, sex, place and maturity. While there is a length – weight relationship difference between Suriname and Guyana, this difference is proportional only, implying there is no difference in shape between the seabob from the two areas. Fitting only the significant terms obtains parameter estimates implying Suriname seabob are approximately 9% larger for a given length, although this effect is small compared to maturity, and while statistically significant, the effect is clearly not large. It could easily be explained by capturing the species in a different part of its life cycle.

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	Significance
Log tail length (ltl)	1	271.622	271.622	9802.966	< 2.2e-16	***
Sex	1	0.947	0.947	34.1625	7.18E-09	***
Place	1	1.595	1.595	57.5581	8.49E-14	***
Maturity	1	0.672	0.672	24.2479	1.02E-06	***
ltl:Sex	1	0.057	0.057	2.0467	0.1529	
ltl:Place	1	0.001	0.001	0.0456	0.831	
ltl:Maturity	1	0.44	0.44	15.8644	7.38E-05	***
Residuals	863	23.912	0.028			

Table 7: Parameter estimates for the significant terms from Table 6.

	Estimate	Std. Error	t value	Pr(>|t|)	Significance
Intercept	-8.7793	0.11624	-75.528	< 2e-16	***
Log tail length (ltl)	2.67471	0.03283	81.483	< 2e-16	***
Sex: M	-0.05252	0.01311	-4.007	6.67E-05	***
Place: Suriname	0.08878	0.01178	7.539	1.20E-13	***
Maturity: True	1.16693	0.30515	3.824	0.000141	***
ltl.Maturity True	-0.293	0.08188	-3.579	0.000365	***

Assessment 3: Size Composition Analysis

Objective

The objective was to initiate the development of a size-based stock assessment which will model within season dynamics and complement the catch and effort model.

Method/Models/Data

The available data were reviewed only and no analysis was undertaken.

Proper random sampling will be implemented so that every seabob entering the facility has an equal chance of being selected. There is no practical procedure to make this possible. However, the procedure implemented was simple, and tries to be representative of the catch composition, minimise potential bias and maximise efficiency.

Approximately 200g of the catch were selected at random approximately every hour from the baskets as they enter the processing facility. This was done on every day that landings occurred, including during the closed season when special dispensation was given to carry out a small amount of fishing to get a complete picture of the size composition through the year. The total sample weight is recorded, so if above or below 200g it is not important. Most importantly, it was ensured that the sample is not selected based on size, but taken from the top of a passing basket at random.

All animals in the sample were measured for sex, maturity for females, and tail weight. The tail weight was taken as this was the most robust and easiest size measure to take. Most tails were in tact. On the rare occasion where a tail was not in tact (e.g. a segment was missing), the individual was replaced by another individual shrimp of the same size selected from the baskets. This individual was selected as the same size by eye, which on testing was found to be accurate enough. Digital scales effectively accurate to $1/10^{th}$ gram were available to measure tail weight. In addition, the total number and total weight of "white shrimp" were measured as a separate group in each sample. This species did occur in the catch, albeit only as a small proportion of the samples taken.

To be representative, smaller but more frequent samples are required. The most significant sampling problem is because similar size seabob are more likely to occur closer together in the processing batches. By spreading sampling across the day, the correlation of individuals within the samples is likely to be kept low. High correlation may introduce bias, but in any event will greatly increase effective sampling error. Therefore, this aspect of the sampling procedure is probably the most important and was rigorously observed.

For each sample, the date, the processing facility, the vessel from which the sample was taken, and the person doing the sampling were recorded. The data were entered onto a spreadsheet designed for the purpose and automatically loaded into a Foxpro database after undergoing basic checks for data integrity. These data (364,000 individual seabob measured so far by March 2009) are now available for stock assessment.

Results and Discussion

The size composition shows clear seasonality and modal progression (Figs. 14-18), suggesting that the data are suitable for estimating maximum size, growth rates and potentially total mortality. The seasonal changes in size composition (Figs. 19-20) imply the major spawning occurs during April and May coinciding with the rainy season.

Females from Suriname and Guyana are approximately the same size (Fig. 19). However, this may at least be partly because Guyana samples separate the immature shrimp which do not occur in the Suriname samples (Fig. 20). The reason for a lack of immature seabob in Suriname is not known, but could be due to the exclusion of seabob trawlers from shallow waters. If due to management control, a similar control may be recommended to Guyana.

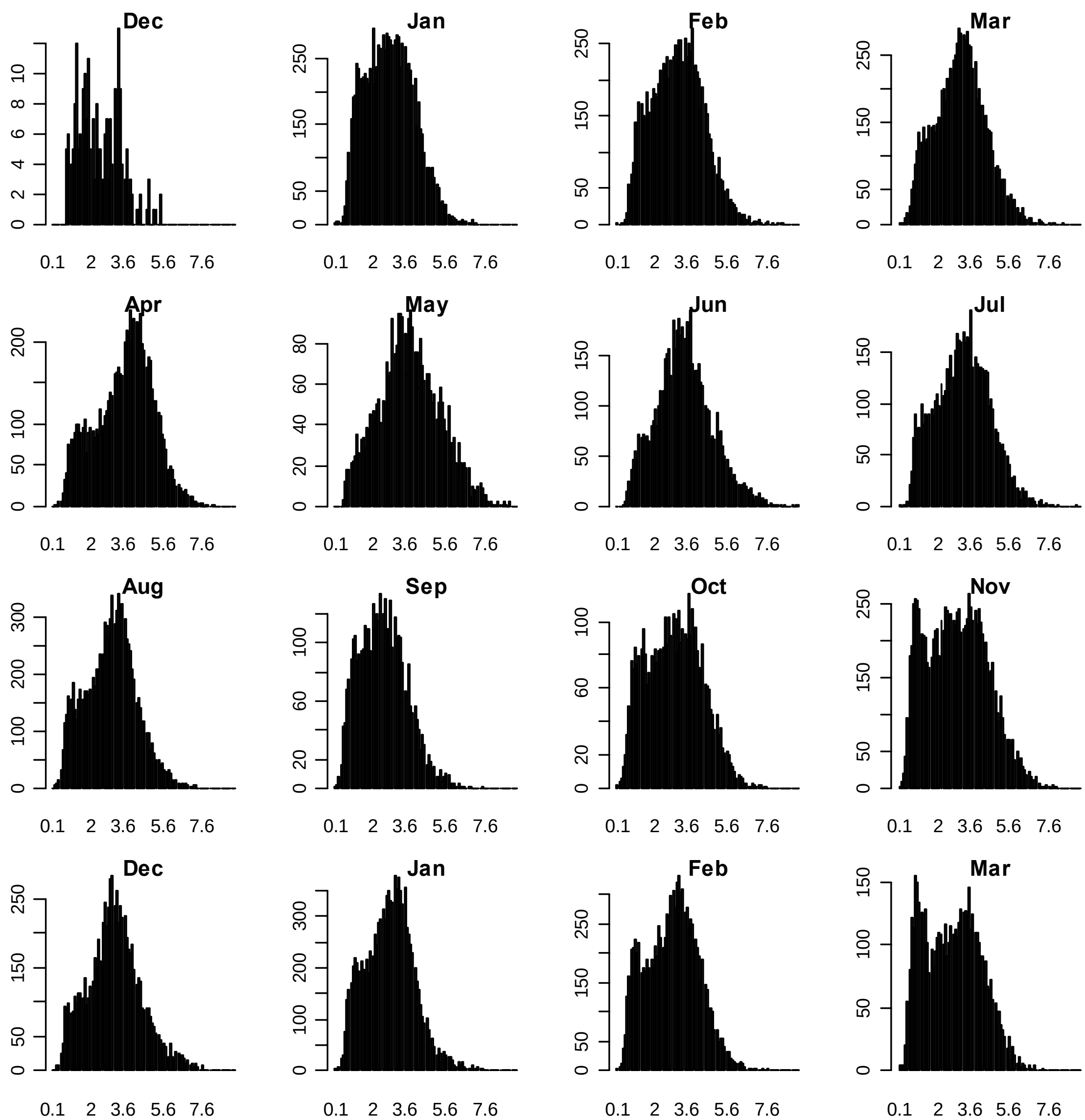


Fig. 14: Guyana female size composition (unpeeled tail weight g) December 2007 – March 2009 collected from random samples taken in the Noble House processing facility.

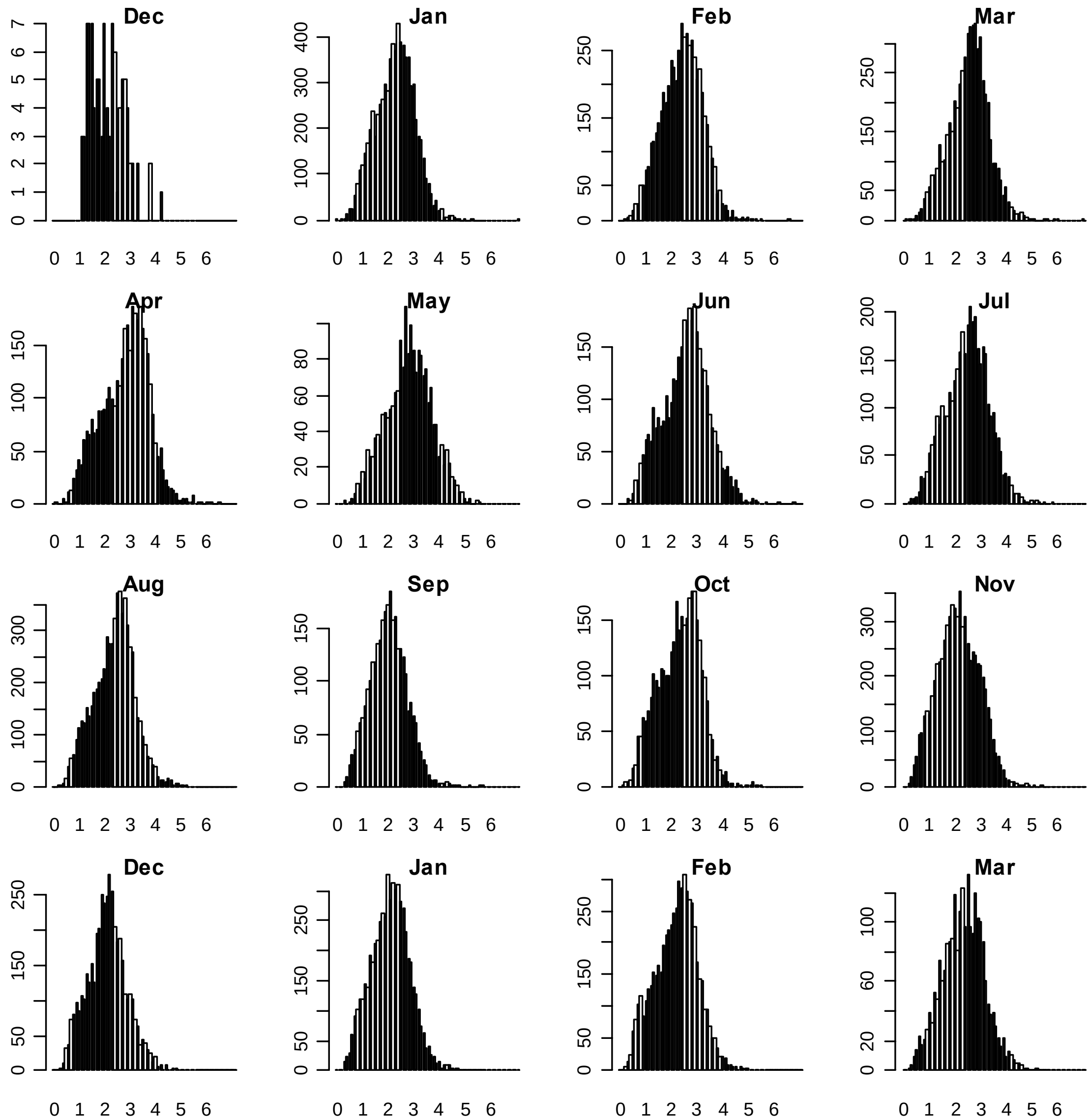


Fig. 15: Guyana male size composition (unpeeled tail weight g) from December 2007 – March 2009 collected from random samples taken in the Noble House processing facility.

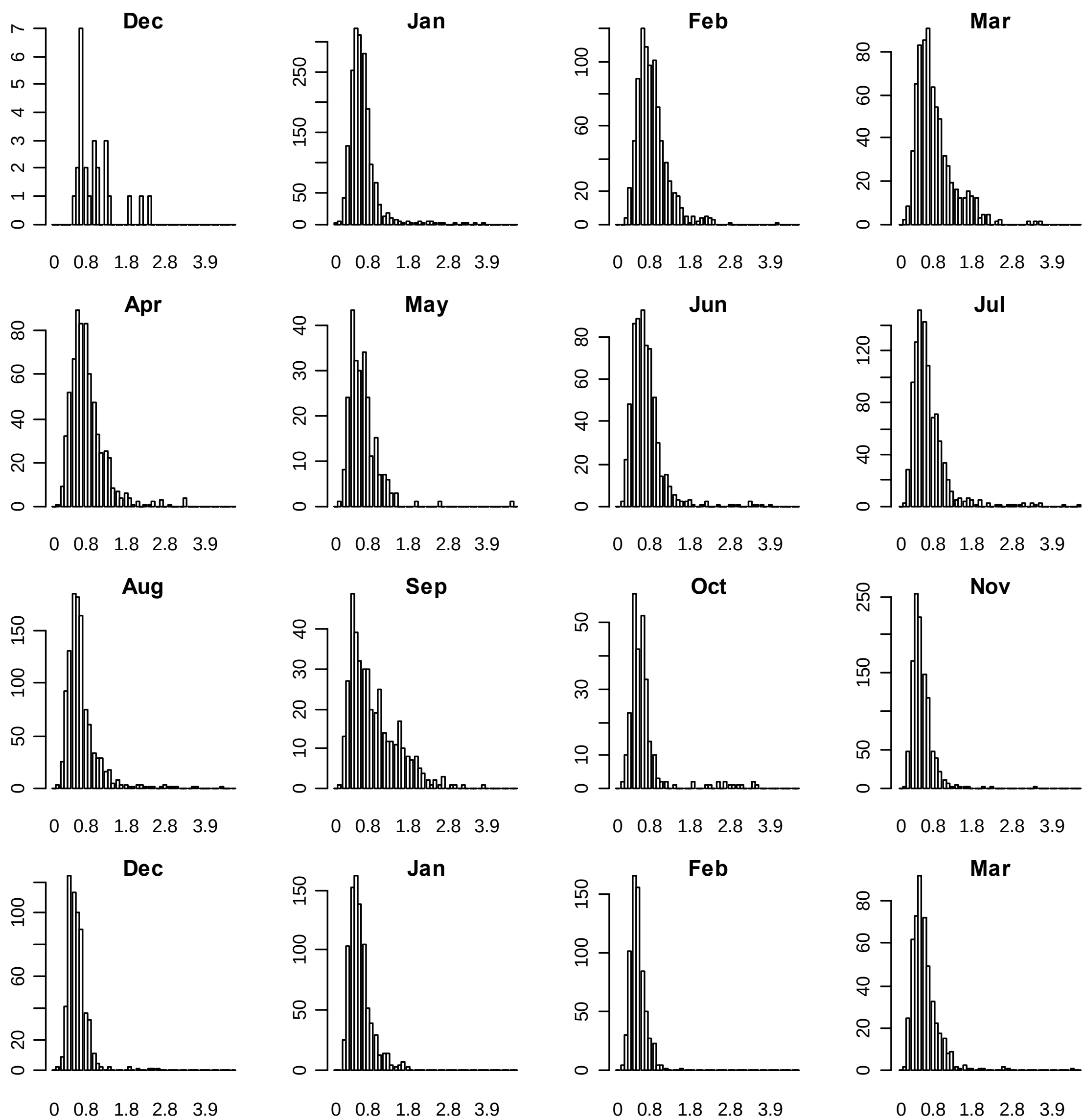


Fig. 16: Guyana immature size composition (unpeeled tail weight g) from December 2007 – March 2009 collected from random samples taken in the Noble House processing facility. These juvenile seabob could not be allocated to any sex.

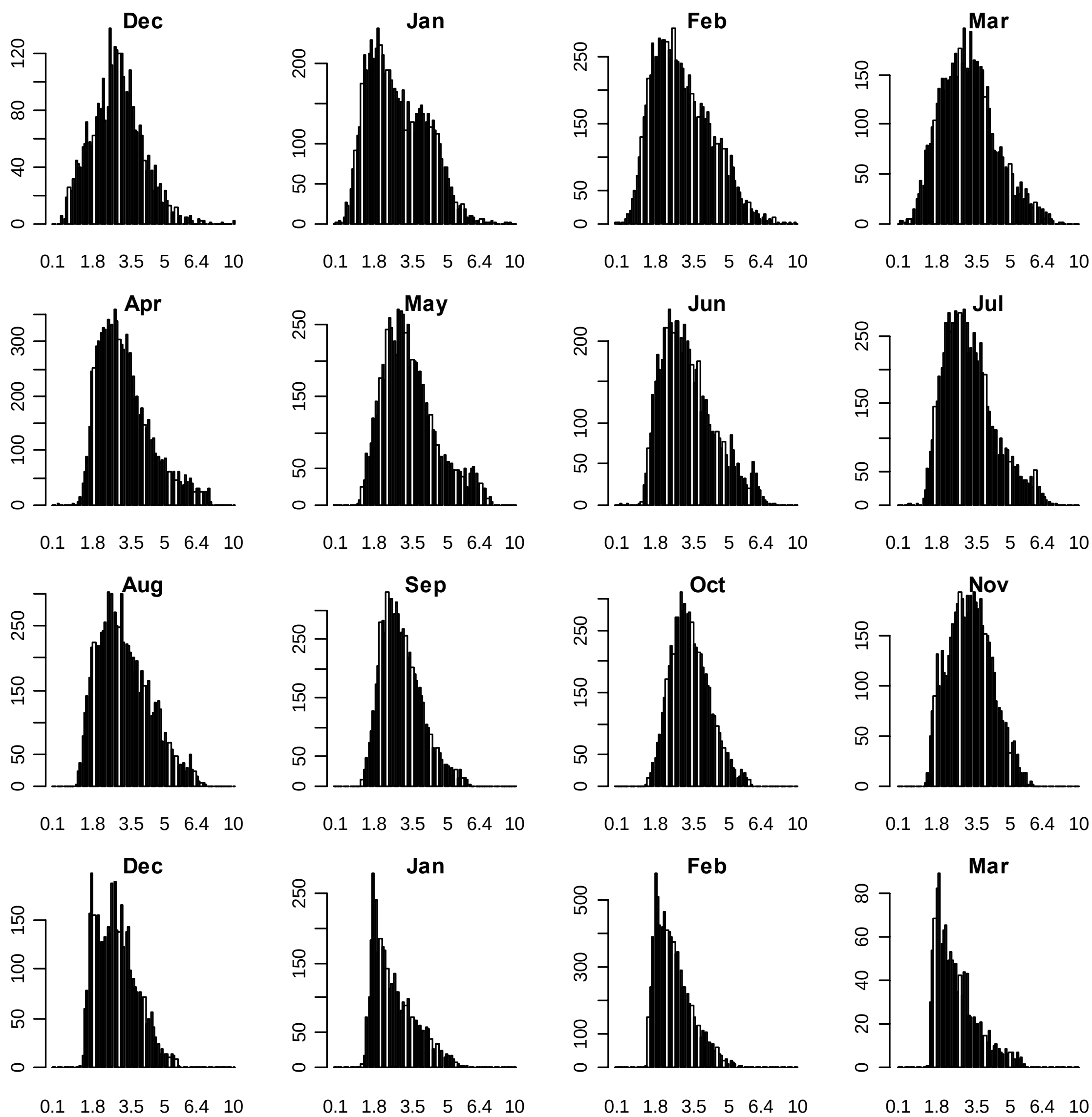


Fig. 17: Suriname female size composition (unpeeled tail weight g) for December 2007 – March 2009 collected from random samples taken in the Guiana Seafoods processing facility.

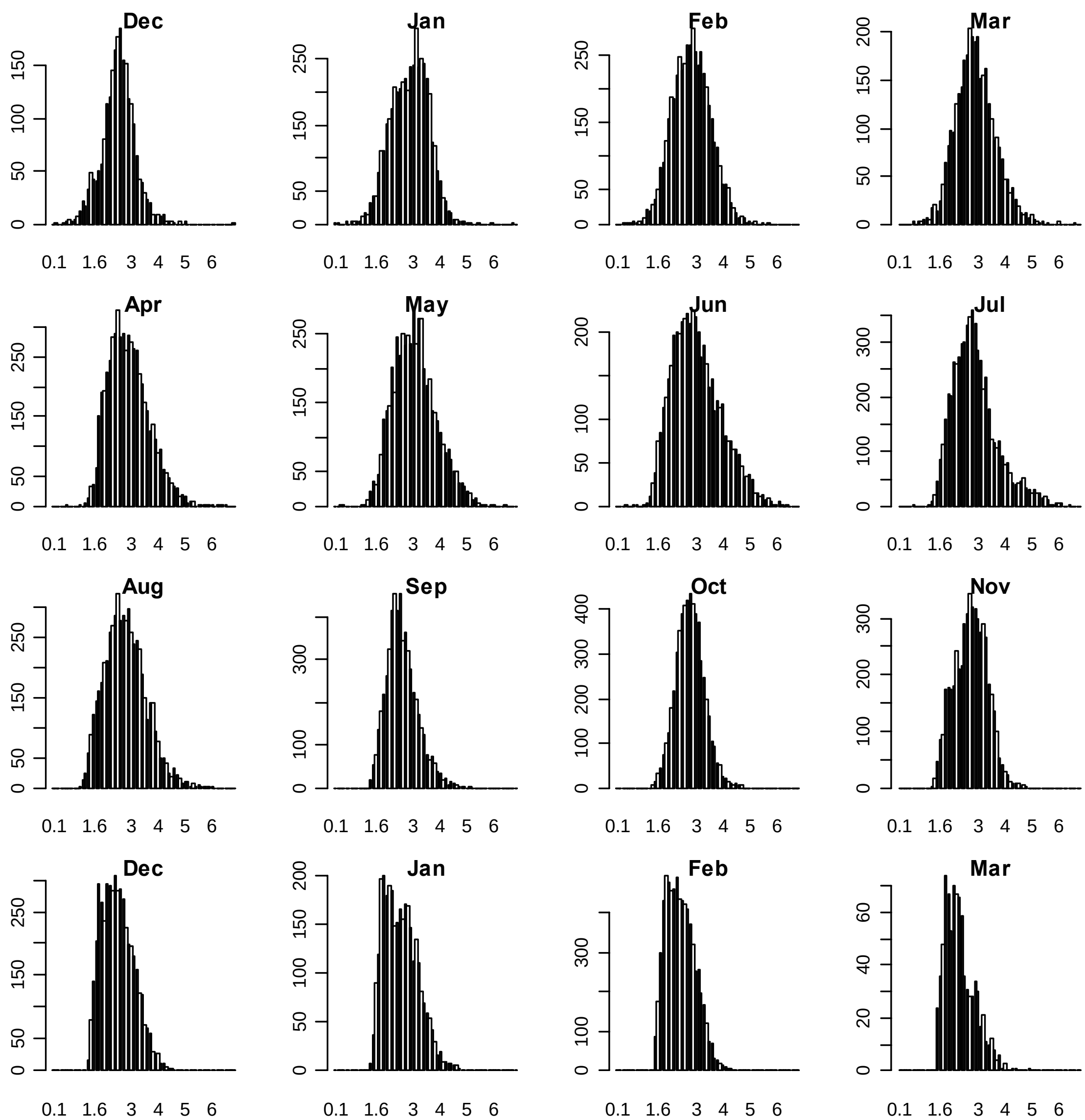


Fig. 18: Suriname male size composition (unpeeled tail weight g) for December 2007 – March 2009 collected from random samples taken in the Guiana Seafoods processing facility.

It is also possible that differences between Suriname and Guyana are due to differences between separate populations in different locations. Excluding juveniles gives comparable sizes for Suriname and Guyana (Fig. 19), but combined sizes reduces the mean weight of Guyana females considerably (Fig. 20). This suggests that juveniles are not generally caught in Suriname either due to different environmental conditions or management controls or a combination of both. If significant concentrations of juveniles cannot be found in Suriname waters, it is likely that adults are migrating from the nursery grounds in Guyana and Brazil as they grow. However on the face of it, the population dynamics in Guyana and Suriname are quite different and there is no evidence that they are shared stocks.

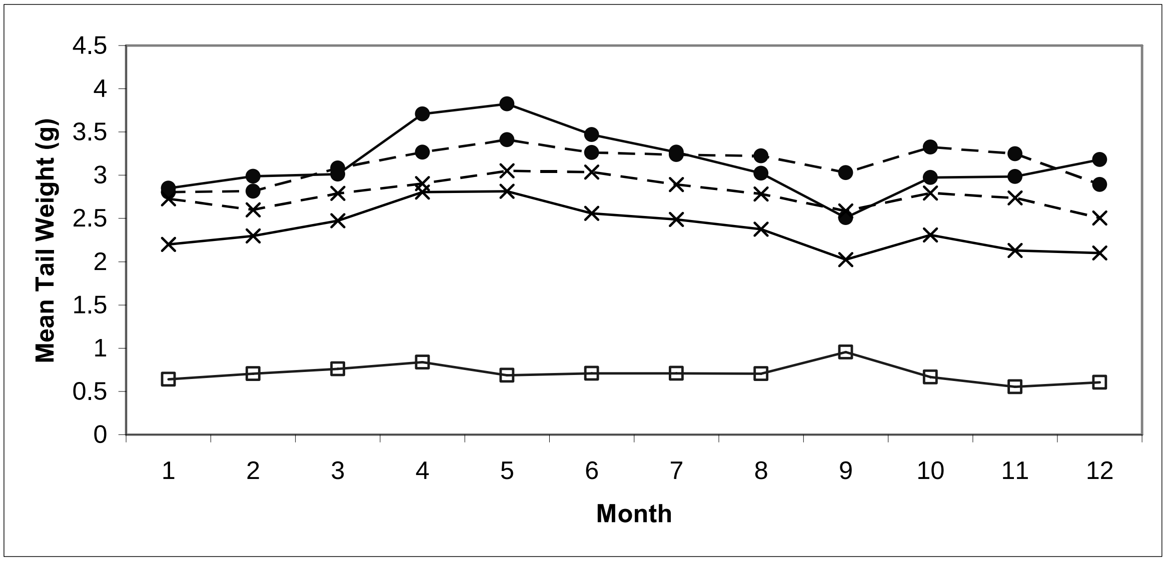


Fig. 19: Mean tail weight by month from random size composition samples for Suriname and Guyana collected during the period December 2007 – April 2008. Mean tail weight (g) of females (●), males (×) and juveniles (□) in Suriname (- - -) and Guyana (——) by month.

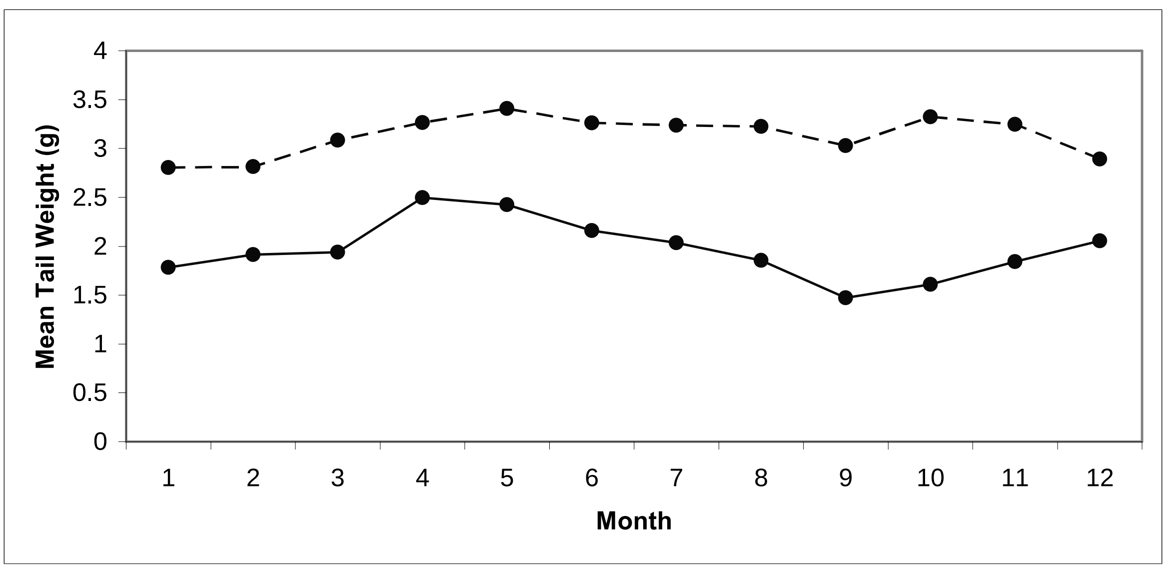


Fig. 20: Combined female and juveniles for Guyana and females for Suriname.

<u>Assessment 4: Stock Assessment Method for Suriname and Guyana</u>

<u>Objective</u>

Complete and check the data necessary for use in a biomass dynamics model and assemble data in a form to which the model can be fitted separately for Suriname and Guyana.

<u>Method/Models/Data</u>

The available data suggests a biomass dynamics model is a suitable assessment method for these data. This was developed in a Bayesian framework to allow greater flexibility and a better evaluation of the assessment uncertainty. One of the requirements for fitting using Bayesian methods is prior probability densities for parameters. Priors are provided before data are used and are either uninformative or formative based on justified belief. The latter approach is used in this case.

The population model requires an initial stock state (B_0), rate of increase (r) and unexploited biomass (B_∞). These parameters each require information to improve the estimation. The catchability parameter (q) prior is assumed uniform (uninformative) on a log scale.

Priors

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. For this reason, the catch time series was extended back using catches loaded down from the FAO FIGIS web site to the start of the fishery (1985 for Guyana and 1989 for Suriname). Although not accurate, these data should allow the initial stock size parameter to be assumed close to zero, decreasing the uncertainty in the results (Fig. 21). Overall, the results should not be affected by small inaccuracies in these early catch data as they occur before the start of the catch and effort time series.

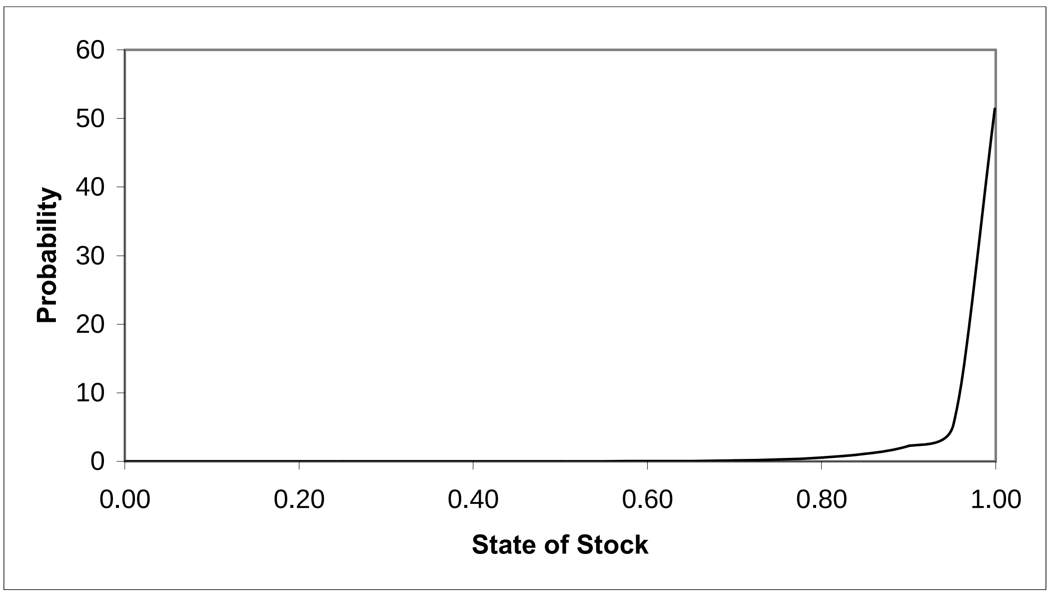


Fig. 21: The beta distribution for the prior of the initial stock state (α=10, β=5.23, μ=0.95). The proposed initial stock state prior was chosen assuming that the stock would only have been very lightly exploited at the beginning of the time series. Some catches are likely to have been taken by artisanal vessels and as by-catch but these should be small.

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 exact range of feasible values of r for marine stocks has not been studied. In general, values of r larger than 1.0 must be considered with caution even for very short-lived stocks like shrimp. With more assessments, a meta-analysis may give more guidance. For *Penaeus notialis* in Belize the estimate was 0.87 year^{-1} (Medley 2003) and for mixed Penaeid shrimps in Trinidad the estimate was 0.47 year^{-1} (Medley *et al.* 2006). This suggests values for r in the region 0.4-0.9 are probably consistent with shrimp. A prior based on the beta binomial with probability mass between 0.0 and 1.0 and mode around 0.5 was chosen (Fig. 22), but this should be reviewed in future assessments.

The unexploited abundance prior (Fig. 23) was based on a log-normal with hyper-parameters estimated from reported abundance. The available estimate of the fished area is the continental shelf for Suriname and Guyana (54,550 and 48,655 km^2 respectively), so the productivity per unit area of shelf was used as the basis for a prior on the unexploited biomass. Kapetsky and Lasserre (1984) estimated the mean fishery yield from similar continental shelf to be 5.9 t km^{-2} yr^{-1}. As this would include all caught species as well as shrimp, it is clearly an upper limit and would imply an unrealistically large biomass. A more direct estimate of seabob densities is available from Pezzuto *et al*. (2008) who used trawl data to estimate seabob abundance in a bay in Southern Brazil.

Pezzuto *et al*. (2008) used trawl data to estimate biomass over a 692 km^2 bay using a variety of assumptions as to the trawl catchability. The minimum and maximum 95% confidence interval range for the density was 0.25 and 1.55 t km^{-2}. This was used to define a log-normal prior assuming these values represented the 80% interval for the probability density function (Fig. 23), the wider interval allowing more flexibility.

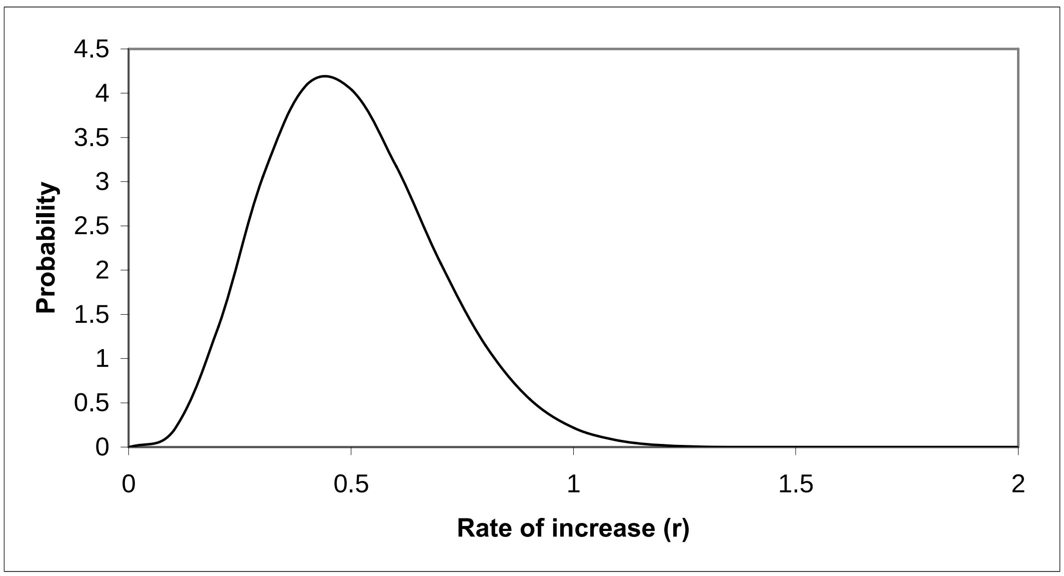


Fig. 22: Beta distribution for the rate of increase (*r*) prior (α=15, β=5, μ=0.25). The value is limited to exist only between 0 and 2 (i.e. the beta value is multiplied by 2 to map from 0-1.0 to 0-2.0), outside this range the model becoming unstable and biologically unrealistic.

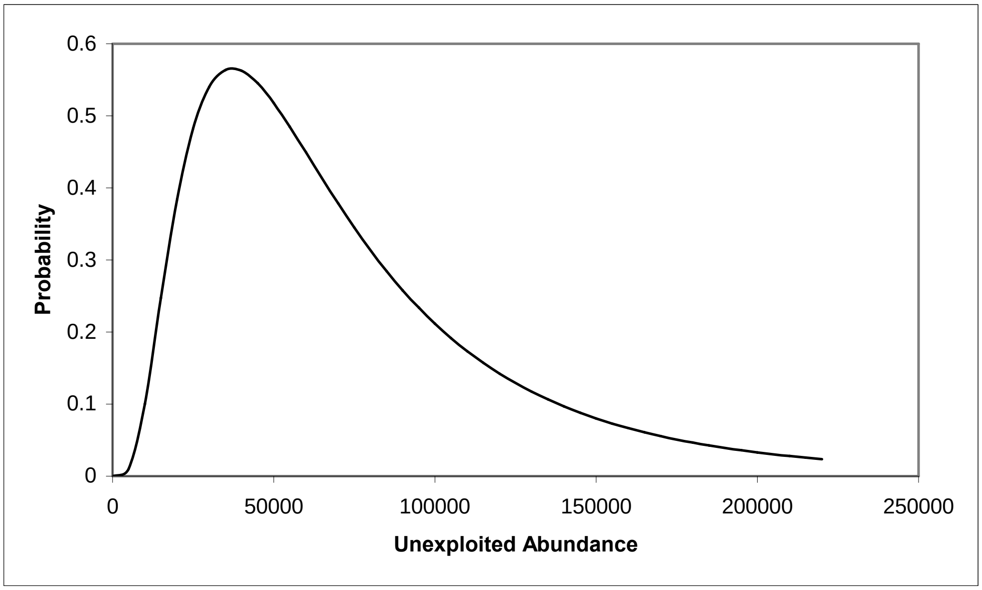


Fig. 23: Log-normal probability density for the unexploited stock size. The prior was designed so that 80% of the probability mass was between the minimum and maximum confidence interval values of tonnes per square kilometre from a Brazilian survey based on artisanal trawl data (Pezzuto, *et al.* 2008) raised to the Suriname continental shelf area.

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 (3 year moving average).

Fitting Method

When fitting models using Bayesian techniques, there are limited options available. Since 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 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 it 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 minimised.

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 re-sampling 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 use for drawing 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 function)/(Approximate function), 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 function – approximate function < 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 kernels) 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 probability 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. (paulahmedley@yahoo.co.uk).

Results

The fitting method worked reasonably well, and the model was able to apply the importance sampling method where the maximum importance was relatively low (a maximum log weight of approximately 2.0). Improvements in the fit will be sought in future assessments. The results are 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 biomass relative to biomass at MSY, the replacement yield, the maximum sustainable yield and current fishing mortality relative to fishing mortality at MSY. The main results of the stock assessment are presented in Section 0. Most importantly the results suggest that it is likely that the stock is not overfished, and overfishing has not occurred in 2008 for either Suriname or Guyana.

Both data sets are likely to need revision. For Suriname, it is expected that revision will not change the qualitative results. However, for Guyana there was some concern that the landings, despite attempts to clean the data, may contain significant inaccuracies. The main concern was the 2004 and 2005 landings, which were three times higher than landings in 2006-2008. To test the impact these two years have on the assessment, a sensitivity analysis was run with these years scaled back to the 2003 value of 16,683 t. This value is still high compared to the remainder of the time series, but appears more realistic.

In terms of the stock status, the sensitivity run implies the stock is broadly in the same state, not overfished and overfishing is not occurring (Table 8). However, the general estimates of productivity are greatly reduced with median MSY reduced from 25,483 t (Table 1) to 16,651 t (Table 8). While it is unlikely that revision of the data will result in the status of the stock changing, these results suggest that the assessment is not reliable enough for setting reference points or a harvest control rule.

Table 8: Results from the sensitivity run where landings in 2004 and 2005 were reduced from 27,193 and 32,356 t respectively to 16,651 t, making the landings time series more consistent with expected values. This table can be compared with Table 1, where the original data were used.

Parameter	Lower Percentile 0.05	Median 0.5	Upper Percentile 0.95
r	0.42	0.60	0.68
B_∞	103795	110481	160698
B_{now}	0.68	0.73	0.78
MSY (t)	14925	16651	18724
Current Yield (t)		10100	
Replacement Yield (t)	12789	13154	13231
B/BMSY	1.36	1.46	1.55
F/FMSY	0.38	0.45	0.53

<u>Discussion</u>

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, but it is necessary that the respective governments agree and then specify reference points and harvest control rules in their Fisheries Management Plans.

Based on the suggested limit, trigger and target reference points, a harvest control rule can be developed for Suriname based either on direct estimate of fishing effort and CPUE (Fig. 24), or on annual stock assessments. The latter are preferred since a full assessment would check that the harvest control rule was giving the desired results. Basing the rule on fishing effort and CPUE would mean that full stock assessments would not be required every year, but could be carried out every two to five years.

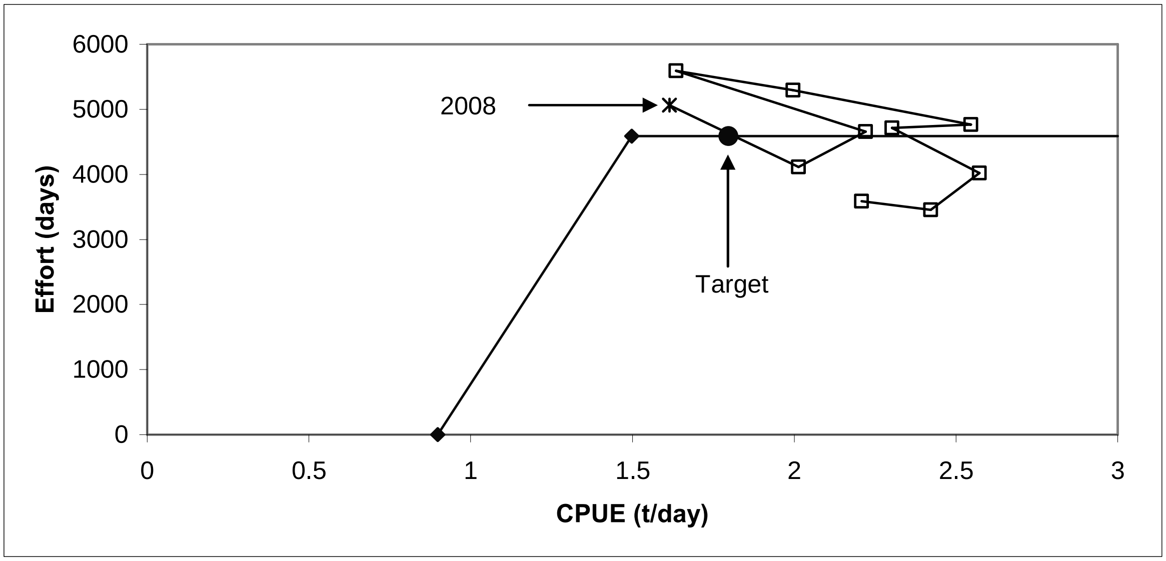


Fig. 24: Possible Suriname harvest control rule for fishing effort as a proxy for fishing mortality, and CPUE as a proxy for biomass. The rule shows what the desired effort would be set to at different levels of CPUE. The target and current levels of effort and CPUE are shown.

<u>Assessment 5: Closed Season Analysis</u>

<u>Objectives</u>

Develop a decision rule to close or open the fishery based on a length composition sample taken from trawl catches.

<u>Method and Data</u>

The data used were the random size composition data described in section Assessment 3: Size Composition Analysis. The method is the same as that used by Medley (2003) and is based on yield-per-recruit. Yield-per-recruit is not the only criteria, but is an important consideration.

The aim is to assess whether a closed season should be implemented based upon a sample taken from trawl catches. The approach is to look at actual size compositions in the catches and decide whether overall it would have been better to leave the animals in the sea longer to grow rather than catch them now. The rule is relatively independent of recruitment, but would reflect current catch composition and would change in relation to these effects. Hence, a strong recruitment could lead to advice closing the fishery for a short period to allow them to grow, for example.

For any particular size composition, the net gain in leaving the animals in the sea can be derived from the growth and mortality models:

$$S_p = \sum_i \left(\int_{t=t_i}^{\infty} W_{it} F e^{-(F+M)(t-t_i)} dt \;-\; \int_{t=t_i+t_p}^{\infty} W_{it} F e^{-(F+M)(t-t_i)} dt \right)$$

where S_p is the difference in the potential yield of the length composition sample between catching now and closing the fishery for t_p months. The weight of the i^{th} shrimp in the catch (sample) is W_{it}, given its age is t_i and natural mortality plus the discount rate is M. The score, S_p, is summed over the sample. A positive number will indicate that overall greater gains would be made by leaving these shrimp in the sea and catching them later.

For the von Bertalanffy growth model (and in the length-weight relationship b=3), the yield equation for each shrimp in the catch composition becomes through integration:

$$\int_{t=t_i}^{\infty} FW_{it} e^{-(F+M)t} dt \quad \left[e^{-M t_p}\right] = \int_{0}^{\infty} FW_{\infty} \left(1 - e^{-K(t+t_i)}\right)^3 e^{-(F+M)t} dt \quad \left[e^{-M t_p}\right]$$

$$= FW_{\infty} \left(\frac{1}{F+M} - \frac{3e^{-K t_i}}{F+M+K} + \frac{3e^{-2K t_i}}{F+M+2K} - \frac{e^{-3K t_i}}{F+M+3K} \right) \quad \left[e^{-M t_p}\right]$$

$$t_i = -\ln\left(1 - \left(\frac{W_i}{W_\infty}\right)^{1/3}\right) \Big/ K + t_0 \left[+ t_p\right]$$

where the t_p term is added to the second yield integral only. Although not done in this model, the method is easily adapted to changes in selectivity with age or length and could be improved with, for example, probabilistic models of growth and mortality to take full account of risks (Medley 1998).

The parameters chosen on this occasion were for exploratory purposes (Table 9), and result in absolute scores which are not necessarily reliable. However, the relative scores between months should still indicate the best months to close if a closure is already decided upon.

Table 9: Population model parameters used in the decision rule. These must be provided and they will clearly influence the result. The growth model refers to asymptotic weight (W_∞), so asymptotic length is not necessary. The natural mortality and discount rate have the same effect. The projection time should be set to the planned closure, in this case 1.5 months. Growth and mortality parameters were obtained from Flores Hernández *et al.* (2003). Fishing mortality is derived from Pezzuto *et al.* (2008) who estimated about 30% of the biomass was removed each month.

W_∞ (g) Males	W_∞ (g) Females	K	t_0
4.5	6.0	0.08333	0
F	**M ($Month^{-1}$)**	**t_p (months for closure)**	**Discount ($Month^{-1}$)**
0.3	0.18333	1.5	0.0042

<u>Results and Discussion</u>

The decision rule is sensitive to choice of parameters. For the parameters available, the yield-per-recruit scores are negative, implying the losses exceed the gains for the size compositions being landed and the parameters (see Fig. 6 and 11). The high natural mortality rate compared to the growth rate (Table 9) implies that a closed season would never be identified as worthwhile using these parameters. Better estimates of mortality and growth may be available for future analyses.

Nevertheless, the lowest score can be used to indicate which particular months may be used to close the fishery. For Guyana, the highest score is in September (the current closed season) and for Suriname, where there is no closed season, the score is more consistent across months, but slightly lower around December and January.

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5.5 Small Coastal Pelagic Fish Resource Working Group (SCPWG)

Chairperson: Maren Headley
Derrick Theophile (Dominica); Paul Phillips (Grenada); John Jeffers (Montserrat); Shawn Isles (St. Kitts and Nevis); Kris Isaacs and Leslie Straker (St. Vincent and the Grenadines); Garth Ottley and Lara Ferreira (Trinidad and Tobago); Kathy Lockhart (Turks and Caicos Islands); Susan Singh-Renton and Maren Headley (CRFM Secretariat); Nancie Cummings and Todd Gedamke (US National Marine Service, Southeast Fisheries Science Center); Paul Medley (Consultant)

A. Overview

Review of Inter-sessional activities

At the Fourth Scientific Meeting in 2008, the SCPWG developed an action plan in view of a one year ban imposed in St. Vincent and the Grenadines, in April 2008, on the sale of small coastal pelagic fish as live bait to foreign-owned longline fishing vessels. Inter-sessional work was conducted in St. Vincent and the Grenadines to determine the trends in the small coastal pelagic fishing operations and the potential demands for these fish from both the food and bait markets. Recommendations were made, taking into account market needs and fishery production levels. The detailed report of this study is included as part of this report and is provided in section B.

Another task identified by the Working Group during the 2008 Scientific Meeting was for each country to 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 lists were required to establish a sampling frame for routine monitoring activities. The meeting was informed that a frame survey for the beach seine fishery was in progress in St. Vincent and the Grenadines, and that these data would be analysed more fully during the next inter-sessional period. Additionally, the representative from Grenada indicated that during the inter-sessional period a census of all beach seines was conducted. In Grenada, the data collected included: the numbers, location and fishing area, information of the mesh sizes, fishing times, influence of the moon and possible distribution of catch (Anon. in prep).

Report on Relevant Activities and Plans of other International Fisheries Organizations and Non CRFM Countries

Eastern Caribbean Flyingfish Assessment

The WECAFC *Ad Hoc* Flyingfish Working Group of the Eastern Caribbean, established in 1997, has held three meetings during 1999-2008 (FAO, 1999; 2001; FAO, in prep). In 2008, the Working Group carried out an assessment of the Eastern Caribbean flyingfish stock (FAO, in prep.). The consultant, responsible for leading the 2008 flyingfish stock assessment conducted by WECAFC, was present at the SCPWG meeting, and was asked to present an overview of the work completed for consideration by the Working Group.

Based on the overview provided, the stock assessment suggested that the stock was not currently overfished and also that overfishing was not occurring. Catch rates have remained stable overall in the time series as catches have increased. The potential yield appeared to be greater than the total catches taken during the fishery's history, since the stock area and stock size were estimated to be relatively large. In consequence, unless a significant increase in catches occurred, no immediate management action was required for stock conservation. The maximum recorded catch so far has been 4700t. In order to avoid overfishing, the establishment of a 5000t catch trigger was suggested by the WECAFC Working Group. The assessment indicated that any fisheries development exceeding 5000t would have unpredictable consequences. In reviewing the assessment results, several of the research recommendations made by the WECAFC Working group were also highlighted.

Following the presentation of the overview, a query was raised regarding the incorporation of environmental data into the assessments. It was noted that attempts were made to do so using environmental data for one country.

In response to another query regarding how countries could move forward with regards to determining whether local depletion was occurring, it was indicated that this would need to be addressed at the national level. However, it was noted that the limitation to this would be the lack of data at the national and regional levels.

Although the SCPWG did not have enough time to conduct a detailed review of the flyingfish assessment completed by the WECAFC Working Group, the SCPWG acknowledged support for the work completed to date and for the initial evaluation undertaken of the findings and recommendations.

Efforts to Improve Sampling in US Caribbean Territories

The following is a summary of the presentations made by Todd Gedamke and Nancie Cummings.

Assessment Needs and Survey Design

Two talks were given which addressed the challenges that are faced in conducting assessments in the relatively data-limited small scale fisheries of the Caribbean. Todd Gedamke and Nancie Cummings began the discussion by reviewing the goals of fisheries stock assessments and, in particular, how the basic concepts surrounding maximum sustainable yield (MSY) form the central point of this process. To highlight that these challenges are faced throughout the Caribbean, an overview of assessment efforts in the US Caribbean was used as a case study and a brief summary of that discussion follows. In recent years, the National Marine Fisheries Service (NMFS) through the Southeast Data, Assessment and Review Process (SEDAR) has attempted to conduct stock assessments in Puerto Rico, and the United States Virgin Islands (USVI) of St. Thomas/St. John, and St. Croix. A team of stock assessment scientists working with data collected over the last 35 years have found that data-limitations preclude valid comprehensive stock assessments for all but a few species. In response to these findings NMFS has organized a data collection working group to review the commercial data collection program and recommend modifications so that future assessments can be conducted.

A brief overview of the data collection working group process was presented. While some specific details of the differences in the fisheries for each island group (i.e. Puerto Rico versus the USVI) were summarized the challenges which should be common to all CRFM participants were highlighted. For example, as in most Caribbean fisheries where a large number of small boats fish from numerous locations, the ability to quantify the landings for the entire island is particularly challenging. In the US Caribbean fishermen are required to report their landings monthly, however, uncertainty due to mis- and non-reporting has resulted in high uncertainty in landings estimates and hampered stock assessments. Another common problem which is faced in the USVI and many Caribbean nations has been a lack of species specific data records. While recording species groups such as 'groupers' or 'snappers' makes data collection easier, extreme differences in life-history parameters within one of these groups results in different vulnerabilities to fishing pressure. While landings of the species group may remain constant, an individual species could be become depleted, or even go extinct, without any ability to detect this in the data.

The second talk focused on how to design a survey and monitoring program to collect the data necessary to conduct stock assessments. While fishery-independent methods (e.g. scientific surveys conducted with an underlying statistical design) provide the most robust source of information, the high costs associated with this approach generally preclude their use in the small scale Caribbean fisheries. As such, the focus of the discussion was on fishery-dependent information and how to sample the commercial landings. The first step in this approach is to determine the 'universe' or the entire sampling frame. In other words, a clear description of the fishery including the number of boats, types of gear being used, species composition of the catch, number of landing sites, and what happens to the fish once they are landed is the first step in designing an effective sampling program. Once these factors are determined, a program can be designed so that sub-samples of the entire landings encompassing all fishing locations results in a representative picture of the overall fishery. The sampling design should account for both spatial and temporal differences in the fishery and will have to account for practical considerations such as the amount of personnel available to conduct the work. The pro's and con's of conducting intensive surveys on an infrequent basis (i.e. comprehensive snapshots) versus longer term monitoring programs were also discussed.

The Working Group appreciated the information shared and agreed that it would be useful for the US scientists to guide a discussion on the development of sampling programmes for selected fisheries in St. Vincent and the Grenadines and TCI. This task was undertaken and is reported under Item 3.0.

Tasks to be addressed during the Meeting

Taking into account the beach seine surveys which were conducted inter-sessionally by Grenada and St. Vincent and the Grenadines in order to develop universe lists (frame surveys) based on recommendations made by the SCPWG at the last Scientific Meeting, and the fact that TCI is in the process of establishing a sampling programme for its fin fish fisheries, the Working Group agreed to review the process of designing statistically based sampling programmes for these types of fisheries, which is currently being utilized for the US Caribbean territories.

This review was led by a staff member of the NMFS SEFSC, Dr. Todd Gedamke, and following were key points raised.

- a quantitative fish stock assessment is an attempt to reflect the 'true' picture of stock status. However, as it is not possible to count every fish in the sea, the best alternatives of obtaining a representative subsample would be via fishery dependent sampling, as well as fishery independent sampling whenever feasible.
- A comprehensive and representative sampling programme would facilitate assessments which are representative of stock situations.

Fisheries dependent sampling

- A frame survey must be conducted to identify all fishing units and landing sites involved both by fishery and by gear. The use of key informants and local knowledge are essential support for a successful frame survey, but there must be some evaluation of the validity of the information so obtained.
- In order to achieve a representative subsample, samples need to be suitably spread across the relevant spatial and temporal strata. If available, data on historical landings, numbers of vessels and/or persons/fishers, could be used to apportion the sampling effort across each of the key spatial and temporal strata. Time/effort required of the samplers would also need to be considered.
- Two approaches are recommended for achieving adequate and representative statistical coverage:
  i) Intensive short term/ "snap-shot" sampling which involved describing the universe, obtaining the variance, and determining sample sizes/strata, and collecting socioeconomic data.
  ii) Monitoring over the long-term.

- The Group was informed that the Intensive short term sampling could be conducted periodically depending on the fishery's complexity whereas monitoring over the long-term should be an ongoing process.
- The Group was also reminded that a sampling frame could be designed based on a Intensive short term sampling alone, whereas monitoring over the long term without conducting Intensive short term sampling would result in a sampling frame which was not representative.

Fisheries independent sampling

- The importance of fishery independent surveys that also take into account spatial and temporal strata (grids/transects stratified by depth or habitat) was discussed. It was indicated that this type of sampling provided data which were more representative than data based on catches and landings and could be used directly by assessment models. The use of incentives for involving commercial fishers in fisheries independent surveys was also highlighted, e.g. reservation of portion of catch quota for involvement in such surveys.

Issues and Recommendations Pertaining to Data, Methods, and/or Training for DMTWG
Following the exercise led by Dr. Gedamke, the Group agreed that the issue of data collection and sampling methodology was very fundamental to all fisheries and that it should be addressed under the DMTWG. One option would be for countries to begin the process of developing universe lists for all key fisheries, and conducting Intensive short term sampling that could then be reviewed during the second meeting of the DMTWG for informing sampling programme improvements.

In order for countries to conduct, the tasks which should be undertaken during the inter-sessional period include:

- Development of data collection/interview forms
- Completion of universe lists
- Compilation of habitat maps, and fishing area maps

Inter-sessional Work Plan
Based on the reviews and discussions held by the Working Group this year, it is recommended that.

1) The universe lists for the small coastal pelagic fisheries should be completed and should include: a list of all fishers, fishing areas, the number of boats, gear types, species composition of the catch, number of landing sites, and distribution of the fish after landing to the various sectors e.g. fish vendors, trading vessels, processing plants restaurants, and the public. These data would facilitate the establishment of a sampling frame.
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.
3) 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.
4) 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.
5) Inter-sessionally the Group should also review the analysis of ecosystem impacts caused by fluctuations in the abundance of small coastal pelagic resources, and consider options for advancing this analysis in the future. This would serve as a good starting point for

consideration by the Working Group of the application of ecosystem models for fishery assessment purposes.

Adjournment
The Meeting was adjourned at 5:25 pm on June 16, 2009.

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B. Fishery Reports

5.5.1 Analysis of supply and demand for small coastal pelagic fish species, mackerel scad (*Decapterus macarellus*) and bigeye scad (*Selar crumenopthalmus*), in St. Vincent and the Grenadines

5.5.1.1 Study Objectives

The study was part of a larger activity that had three aims.

(i) For the purpose of developing a field sampling programme, data were gathered on the nature and extent of seine fishing operations throughout the state of St. Vincent and the Grenadines.

(ii) Data were also gathered to identify, and to improve understanding of, the key components comprising the beach seine industry.

(iii) In St. Vincent and the Grenadines, the government imposed a 1-year ban on the sale of live bait to foreign-owned longline vessels in April 2008. To facilitate an informed review of the government's need to continue the ban, trends in small coastal pelagic beach seine fishing operations were examined, and production/supply was compared with market demands.

The present report provides the results of the analysis undertaken in respect of aim (iii).

5.5.1.2 Methods

Interviews with local consumers

Interviews were conducted with 150 local consumers to determine consumption patterns of these fish by local households (Appendix 1). Consumers were interviewed during visits to 6 major points of sale on St. Vincent: Kingstown, Campden Park; Clare Valley and Questelles; Layou; Barrouallie; Chateau Belair.

Interviews with captains/owners of foreign-flagged longline fishing vessels

At the time the ban was imposed in April 2008, the Fisheries Division estimated that 8-9 foreign-owned longline vessels were purchasing live bait from local seine fishers. Of this total, 5 fishing vessel operators were interviewed (3 vessel owners, 1 captain and 1 company director) to determine the nature and extent of their demands for live bait. The questionnaire developed for these interviews is shown in Appendix 2.

Interviews with beach seine fishers

A total of 32 seine fishing units were identified to be active throughout the state of St. Vincent and the Grenadines. Of this total, 21 seine unit leaders were interviewed about their fishing operations and their opinions about market demands. The questionnaire used for these interviews is shown in Appendix 3.

Analysis of historical landings data

Landings data gathered during routine fishery monitoring for the period 1979-2008 were examined. It was noted that:

(i) for the period 1979-1992, available landings data reflected activity at the Kingstown fish market only;

(ii) from 1993, though the data collection programme began to capture landings taken throughout the country, there were an initial problem of double-counting, and:

(iii) dramatic annual fluctuations in landings were observed during the past 3 years.

In view of this, we decided to use landings for the most recent 10-year period, 1999-2008 to examine both annual and monthly trends in production.

5.5.1.3 Results and Discussion

Food demand

Over 80% of the consumers interviewed identified robin as their preferred species of small pelagic food fish. Of the 309 species preference identifications by consumers, 39% were for robin, while 28% of the identifications were jack. Consumers confirmed that price and availability were the most important factors influencing their purchase of small pelagic fish. Based on purchase data provided by the 150 households interviewed, we estimated an average consumption of 4.8 lbs per person per month. From this, we estimated a total maximum potential consumption demand of 214,493 lbs per month for the population of Kingstown and the west coast of St. Vincent which had the most regular access to supplies of small pelagic species. This figure assumes that the sample is representative of the small fish consumption patterns of households not interviewed in the areas concerned.

Bait demand

At the time of the study, 4 vessels were flagged with Trinidad and Tobago and one was flagged with the USA. These vessels were 15-22 m in total length. Fishing trips ranged from 14 to 21 days, with each vessel able to set its longline gear to fish 600-900 hooks at a time. All interviewees indicated that the most preferred bait species was the jack, because this species kept in good condition longer than any other small fish species caught in St. Vincent and the Grenadines. Notwithstanding, availability of bait and time of year were the most crucial factors influencing bait purchases. Both jack and robin were purchased in live condition directly from fishers at a price of US$1-1.20 per lb.

All interviewees indicated that they would like to purchase bait from April to December, while 3 vessels indicated that they would like to purchase bait every month of the year.

To estimate live bait demand, the actual fishing days per trip were assumed to be 12-19 days, with 600-900 hooks deployed once per day. Based on the recommended size of small fish, 5 fish typically weigh 1 lb. These data gave an estimated bait demand of 1440-3420 lbs of bait for each fishing trip. *It should be noted that this maximum figure of 3420 lbs per vessel per trip agrees with a maximum estimate of 4000 lbs per vessel per trip, provided by 1 fisher who regularly sold bait fish to the vessels before the ban*. Assuming each vessel conducts 1-1½ trips per month, the estimated potential monthly demand for bait per vessel was estimated to range between 1,440 lbs and 5,130 lbs per month. For the 5 vessels interviewed, this would give a combined total monthly demand for live bait of 7200-25,650 lbs.

Analysis of supply level (fish landings) and comparison with demand

Production/supply trends - The main species comprising the landings have been mackerel scad (*Decapterus macarellus*, local name 'robin'), and bigeye scad (*Selar crumenopthalmus,* local name 'jack"). During the period 1999-2008, the landings of robin and jack showed relative stability until 2006-2008 during which time dramatic yearly fluctuations were observed. While it is possible that the observed fluctuations may reflect a real change in stock conditions, as well as the instability of these conditions, whether caused by the ongoing impacts of climate change impacts, natural shifts in stock abundance, or movement patterns from year to year, it is also possible that during 2006-2008, that some of the live catch that was being sold directly to the foreign longliners at sea was not being fully captured by the land-based sampling programme (fig. 1).

While robin was generally most abundant in the early part of the year and landings of jack typically peaked around the middle of the year, the observed seasonal peaks were not tightly fixed from year to year. The variability is apparent when the mean monthly landings and 95% confidence interval range were estimated for the preferred bait, jack (fig. 2), and for the two main small pelagic species, jack and robin, combined (fig. 3).

Comparison with food and live bait demand levels - For the 5 vessels interviewed, the combined monthly demand for live bait was estimated to range from 7200 lbs to 25,650 lbs per month. In figures 2 and 3, these estimated levels are shown for reference. It should be noted that larger vessels that fish more than 900 hooks per day would have an even higher demand. Fig. 4 and 5 show the mean landings of jack, and of jack and robin combined, left after both the minimum and maximum bait demand amounts are subtracted from each monthly mean landing value. The monthly food demands for jack, and for jack and robin combined, of the Kingstown and west coast populations, were calculated by using preference data and apportionment of the total estimated food demand. These amounts are also shown in figs. 4 and 5. In each instance, the remaining supply was insufficient to satisfy the total food demand.

Economic considerations

Consumers usually paid EC$2-4/lb for jack and robin, depending on size of fish and availability. The longline operators indicated that they paid EC$2.68-3.22 per pound of live bait. The differences in gross profit made by fishers were calculated for 4 different pricing scenarios, using the upper and lower price limits for each market group (Table 1). The higher price per pound paid by the bait market in 3 of the 4 pricing scenarios resulted in notably better profits for fishers, ranging from EC$0.68 to as much as EC$1.22 on every pound obtained from the bait market.

Opinions on improving market services and management

Fishers - The fishers ranked the travelling vendors (48%) and the local consumers (47%) as their most important buyers. Of 18 opinions submitted with regard to the ban and supplying both the bait and food markets, 5 opinions noted the need to regulate the size of bait sold. While 5 opinions indicated that only the local food market should be retained, 3 opinions felt that there was enough resource to supply both the food and bait markets. One opinion reflected the possibility for increasing fishing effort to address increasing market demands.

Consumers – Of 64 opinions expressed, 29 suggested an increase in fishing effort in order to increase the supply of fish, while 29 recognized the need for improved management and enforcement, including the need for using more environmentally-friendly fishing methods and resolving sectoral conflicts.

Longline operators – Of the 13 opinions expressed, 3 recommended that the longline vessels be allocated bait quotas, 3 recognized that a minimum bait size limit should be effectively enforced, and 3 noted the importance of regulating sales. Two opinions recommended that the size of longline vessels purchasing bait should be restricted, as larger vessels would have a higher demand for bait and would be more inclined to purchase all bait sizes. Another 2 opinions noted the need for active enforcement of the management rules.

5.5.1.4 Conclusions

1. Of the 6 small coastal pelagic species fished in St. Vincent and the Grenadines, only robin and jack were landed in substantial commercial quantities. Landings of these species usually varied with month, and this monthly pattern varied from year to year.
2. The jack was the most preferred bait species by the longliners, as it keeps in good condition for a longer period compared to other potential bait species.
3. Robin was the species most preferred by the average consumer.
4. For the given vessel size range (15-22 m), with hook setting capacity of 600-900 hooks per day, a trip length of 14-21 days and averaging 1-1½ trips per month, the estimated maximum potential monthly demand for bait was 5,130 lbs per vessel or 25,650 lbs of bait for a total of 5 vessels of the size and fishing capacity examined.

5. For the population of Kingstown and the west coast of St. Vincent, the estimated total small fish food market demand was 214,493 lbs per month. A few consumers from other parts of the country indicated a similar demand per person per month of 4.8 lbs of jack and robin.
6. The combined monthly landings of jacks and robins exceeded the monthly consumption demand noted at (5) only once since 1999.
7. The overseas bait market is more lucrative for fishers when local food market price for these small fish remains below EC$3.00 per lb.
8. Economic benefits from live bait market was enjoyed by only 4 fishers

5.5.1.5 Recommendations

Research and Resource assessment

The status of the jack and robin stocks is unknown.
(I) Given recent observed dramatic annual fluctuations with an overall downward trend in landings since 2003, urgently review and improve fishery monitoring system to facilitate assessment of the resource, including improved understanding of the biology and ecology of the fishes concerned.
(ii) Consideration should be given to the collection of additional social and economic data and information to facilitate a more comprehensive evaluation of the socio-economic aspects necessary for informing management decisions pertaining to this fishery.

Food market

This is a large market with demand exceeding production/supply.
(i) Improve distribution of jack and robin by road and market services to increase local food security (health benefits), and to guarantee quicker and greater sales for the fishers (economic benefits).

Live bait market

If live bait market is to be retained:
(i) Establish a limit on the number of vessels purchasing live bait;
(ii) Consider sale of the jack only as live bait, given consumers' preference for robin
(iii) Consider options for ensuring equitability of the economic benefits derived.

Management Control

(i) Establish minimum size limits for both the jack and robin, to guarantee continued resource productivity
(ii) Invest in improved Monitoring Control Surveillance to ensure management controls are effective.

Table 1. Prices of jack and robin paid by the live bait and food markets, and the gross profit difference (live bait price-food market price) per pound and per 1000 pounds.

Bait market	Food market	Difference per lb and per 1000 lbs
2.68	2.00	$0.68 per lb, $680 per 1000 lbs
2.68	3.00	-$0.32 per lb, -$320 per 1000 lbs
3.22	2.00	$1.22 per lb, $1220 per 1000 lbs
3.22	3.00	$0.22 per lb, $220 per 1000 lbs

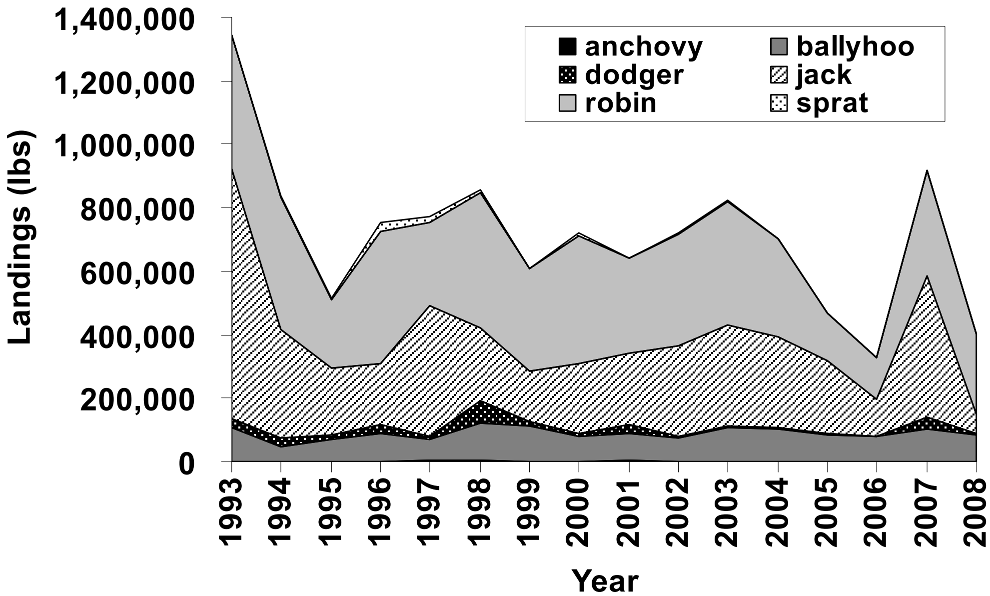

Fig. 1: Annual total landings (lbs) of 6 small coastal pelagic fish species during the period 1993-2008.

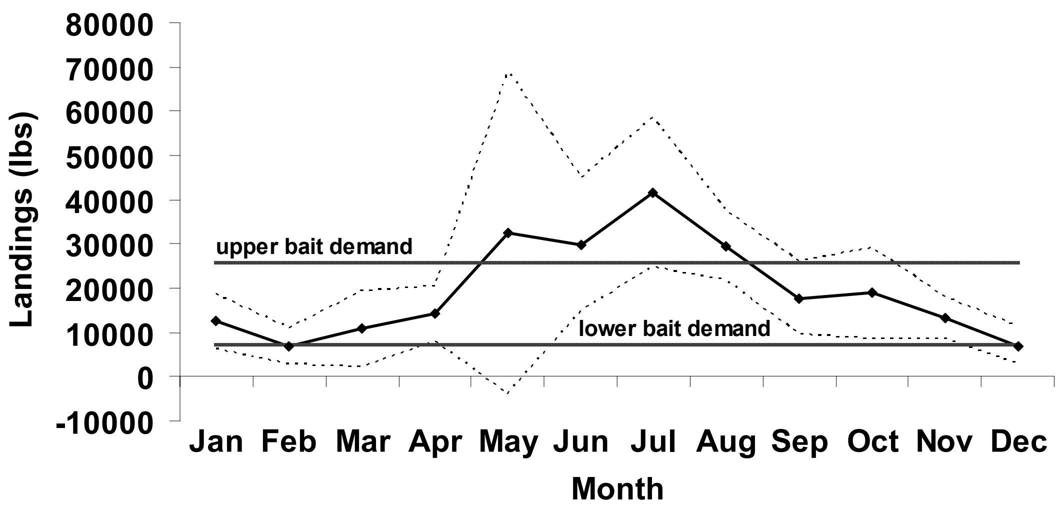

Fig. 2: Monthly average landings of jack for period 1999-2008, showing 95% confidence interval. The lower and upper limits of the estimated monthly live bait demand range for 5 longline vessels [7,200 - 25,650 lb/mth] are shown for reference.

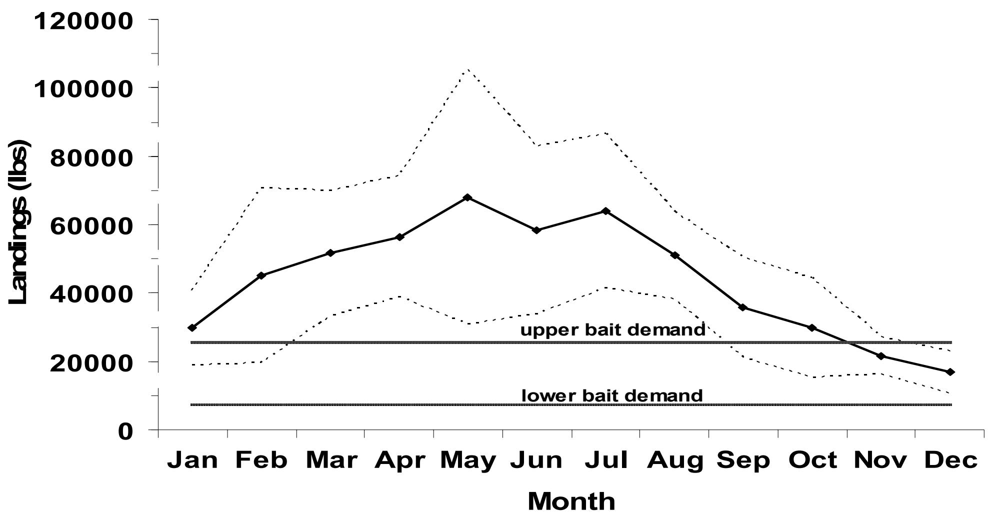

Fig. 3: Average monthly landings of jack and robin (combined) for 1999-2008, with 95% confidence interval. The lower and upper limits of the estimated monthly demand range for 5 longline vessels [7,200 - 25,650 lb/mth] are shown for reference.

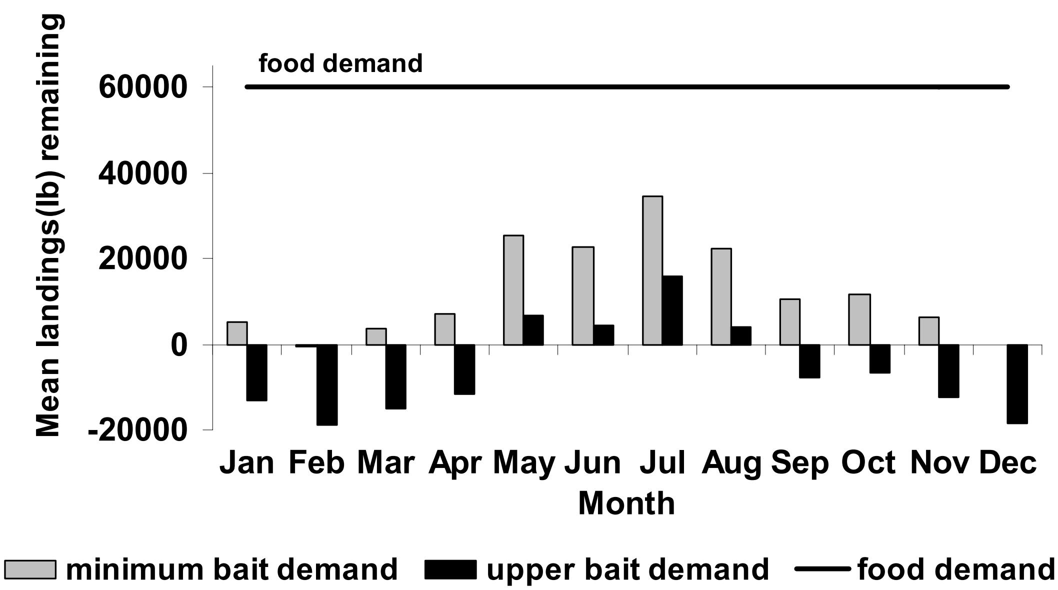

Fig. 4: Minimum and maximum live bait demands subtracted from the mean monthly production of jack, with food demand amount for jack (60,058 lbs) shown for reference.

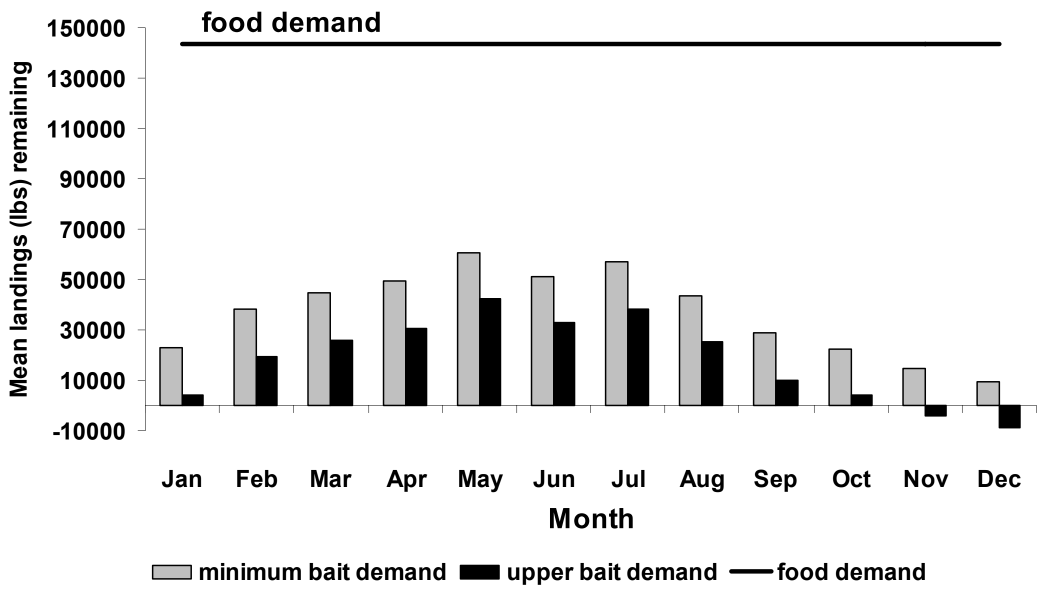

Fig. 5: Minimum and maximum live bait demand amounts subtracted from mean landings (jack and robin combined) for each month, with food demand line for jacks and robin combined (143,710 lbs), shown for reference.

6. Meeting of the Working Group on Data, Methods and Training (DMTWG)

The Scientific Meeting was advised that as the DMTWG was not yet formally established by the CFF, the present meeting of the Working Group would be an informal meeting for planning purposes only.

Given that the elected Chairperson, Mr. Lester Gittens, was absent, Mrs. June Masters agreed to serve as Chairperson for the informal meeting.

The agenda for the informal meeting was adopted without modification (Appendix 3).

6.1 Data – issues and recommendations

The following issues were identified, and the Working Group considered options for addressing these issues, particularly the role of the DMTWG.

6.1.1 Quality control

This issue was identified as certain datasets submitted for analysis during the 2009 working group session contained inconsistencies and needed to be verified. The meeting recalled that data quality control had been reviewed during the second meeting of the Ad Hoc Working Group on Methods. The meeting was also reminded that data management and computerization were key components of quality control, especially after data programmes become established.

Suggested options for resolution

Noting that the review provided during the second meeting of the Ad Hoc Working Group on Methods has been documented in a written report, it was recommended that working group members should be informed of the availability of such documentation and should have easy access to it. The meeting was reminded that the review in question had been published as part of a previous scientific meeting report and was available for download from the CRFM website. It was suggested that one section of the CRFM website (addition of special access tabs) could be devoted to facilitating access and communication exchanges concerning scientific meetings issues in general.

Consideration should be given to the improvement of data management and computerization skills. For successful implementation of this recommendation, Fisheries Divisions/ Departments had to be committed as a first step.

The meeting considered the option of developing a manual of data forms that would facilitate standardization of forms and data collected. However, it was argued that such a manual could be too general, and there was already a wealth of such documentation available from FAO. It was then suggested and agreed that the DMTWG should consider compilation of a CRFM notebook/casebook. Material prepared for dealing with specific country requests and situations could then be included in such a notebook/casebook for future reference by other countries faced with similar challenges.

6.1.2 Completeness of data

The meeting noted that available datasets were often incomplete.

Suggested options for resolution

Prior to the commencement of the annual scientific meetings, fisheries officers should conduct a data search and should ensure that all data are retrieved.

Additionally, fisheries officers should work to develop historical data series, by individual species at least for commercially important fisheries. Additionally, documentation of developments and events throughout the history of a fishery should be prepared and made available to the Working Groups. Moreover such an information base should be managed and maintained.

In the case of fisheries data obtained from processing plant, data recording and reporting should be standardized, to avoid gaps and to facilitate use of all the available data.

6.1.3 Availability of data to officers

This was identified as an issue, given that there have been instances in which officers attending the scientific meetings did not have access to all available data held by their divisions/departments.

Suggested options for resolution

Prior to the commencement of the annual scientific meetings, officers should conduct a data search and should ensure that all data are retrieved.

Working groups should adopt a structured approach for inter-sessional activities that would ensure identification of key developments with regard to data and hence more complete preparations and datasets.

6.1.4 Existence of data

This issue was identified because in many instances, continuing lack of data prevented analyses from being carried out for determining management advice. The meeting noted that some training may be needed to assist some countries with improving their fisheries monitoring programmes. The importance of determining existence of and access to data from non-CRFM countries was also highlighted, but not discussed.

Suggested options for resolution

Rigorous sampling is necessary to acquire good data. Fisheries monitoring programmes also need to determine options for collection of social and economic data, and also data required for implementing ecosystem approaches.

6.1.5 Submission of data

It was pointed out that data submission and review were tasks that should be carried out prior to the start of the annual scientific meetings. This would allow time for identification of gaps, correction of data errors, and identification of the need to locate additional datasets.

Suggested options for resolution

Working groups should adopt a structured approach for inter-sessional activities, and establish deadlines for submission of data proposed for analysis during the annual scientific meetings.

6.1.6 Generation of age and growth parameters

The meeting recalled that several recommendations for generating age and growth data were made during the annual scientific meetings since they began in 2004. Acting on these recommendations, the CRFM agreed to resume the regional age and growth laboratory at the IMA, and IMA had also prepared a proposal that included a proposed schedule for dealing with the scientific meeting requests.

It was proposed and agreed that the Secretariat would compile a list of all the age and growth requests made during the scientific meetings to date. This list, together with the proposal prepared by the IMA, would then be put forward to the CFF at its next meeting for consideration alongside the identification of assessment priorities for 2010.

6.1.7 Summary of recommendations with agreed actions

(a) Datasets, proposed for analysis during the annual scientific meeting, should be prepared and cleaned and submitted to the Secretariat 6 weeks prior to the start of the meeting, together with explanatory notes.

(b) National reports should be submitted to the Secretariat 6 weeks prior to the start of the annual scientific meetings.

(c) During the inter-sessional period, the DMTWG should commence work on the establishment of a CRFM notebook/casebook. The specific contents of the CRFM notebook/ casebook will evolve in response to data needs, but is initially envisaged to contain a compilation of approved data collection forms used by countries and any training material reviewed during the activities of the various CRFM Working Groups and the annual scientific meetings. The meeting further recommended that the proposed inter-sessional activity be coordinated by the elected DMTWG Chairperson, who would be supported by the Secretariat.

(d) The Secretariat should compile a list of all the age and growth requests made during the scientific meetings to date. This list, together with the species list included in the proposal prepared by the IMA, should be considered at the next meeting of the CFF, alongside the identification of assessment priorities for 2010.

<u>6.2 Methods –issues and recommendations</u>

The following issues were identified and options for resolution were discussed.

6.2.1 Testing of PARFISH

A presentation was made to update the meeting of inter-sessional and ongoing efforts by Trinidad and Tobago to test the application of the PARFISH method to assessment of the shrimp stocks fishery of Trinidad and Tobago and Venezuela.

ParFish Case Study: Trinidad and Tobago Shrimp Trawl Fishery

Lara Ferreira, Fisheries Division, Ministry of Agriculture, Land & Marine Resources, Trinidad &Tobago; Paul Medley, Fisheries Consultant, UK

Background

Under the CRFM Ad hoc Working Group on Methods, the ParFish (Participatory Fisheries Stock Assessment) methodology was one of the methods identified for consideration. ParFish is an approach to stock assessment that is rapid, involves fishers and other stakeholders, and is considered to be suitable for small-scale fisheries and appropriate for data-poor situations. Trinidad and Tobago volunteered to test the methodology and identified the shrimp trawl fishery as the case study.

Objectives

- To test the ParFish methodology to determine its appropriateness for assessing similar fisheries in the region.
- To involve the Trinidad shrimp trawl industry stakeholders in making decisions that affect their livelihoods by getting their views on the state of the shrimp stocks and how the fishery should be managed, and in particular their preference for a closed season.
- To obtain a quantitative assessment of the effect fishers believe pollution is having on the fishery and shrimp stock.

- Incorporate the results of the ParFish interviews with the available scientific data to re-assess the state of the stock and propose recommendations for management of the fisheries

Description of the Fishery

Shrimp resources in the Orinoco Delta-Gulf of Paria region are exploited by fleets from both Trinidad and Tobago and Venezuela. In the case of Trinidad and Tobago the shrimp is exploited mainly by the trawl fleet which comprises some 113 artisanal, ten (10) semi-industrial and 27 industrial trawlers. The artisanal vessels are pirogues 6.7-10.4 m in length with either an inboard diesel engine (Type II) or outboard engines (Type 1). These vessels manually deploy one stern trawl. The semi-industrial trawlers (Type III) are 9.3-13.1m in length with 165-174hp inboard diesel engines. These use a single net operated by a hydraulic winch. The industrial vessels (Type IV) use two nets attached to twin outriggers. The nets are set and retrieved using a hydraulic (double-drum) winch. The vessels are 18.7-24.3 m in length and usually have 365 hp inboard diesel engines.

All trawlers operate in the Gulf of Paria on the west coast of Trinidad. The industrial trawlers, and to a much lesser extent the semi-industrial trawlers, also operate west of Saut D'eau on the north coast and in the Columbus Channel on the south coast. Figure 1 shows the trawling areas around Trinidad and the associated landing sites. The trawl fleet targets five shrimp species as well as associated groundfish. Estimated landings for the entire trawl fleet in 2007 were 774t of shrimp valued at TT$24.9 million and 887t bycatch (groundfish) valued at TT$6.7 million.

Die *et al.* 2004 reported that the Venezuela trawl fishery comprised two fleets: an industrial fleet of 88 vessels (mostly metal vessels 24 to 30 m in length); and an artisanal fleet of 28 wooden vessels (8 m in length with outboard engines). The industrial operated in the southern Gulf of Paria and in front of the Orinoco river delta while the artisanal fleet operated in the northern area of the Orinoco river delta. In March 2008, a new law was introduced which banned industrial trawling in Venezuelan waters. The trawlers were however allowed to operate for one year from the date of issue of the law. The estimated shrimp landings for Venezuela in 2007 were 177.7t (INSOPESCA 2008 and 2009).

Status of Stocks

An assessment of shrimp (five species) was conducted using data from Trinidad and Tobago and Venezuelan trawl fleets operating in the Orinoco Delta-Gulf of Paria region for 1988 to 2004 in a biomass dynamics model (the logistic or Schaefer model) (Ferreira and Medley 2006). The results indicate that the stock is overfished. The biomass appears to have consistently declined since 1988. The maximum sustainable yield is in the region of 1700 t and catches higher than this will not be sustainable. The assessment recommended that new fishing controls be introduced in both Trinidad and Tobago and Venezuela to decrease the total number of vessels and/or days at sea permanently. In the case of Trinidad, one of the options recommended was a closed season ranging from one month (January) to four months (November to February) when the greatest percentage of small shrimp is landed.

While the fishing industry stakeholders at an April 2005 meeting (which was held under the auspices of the FAO/WECAFC) agreed that the stocks of shrimp and fish have been declining and that fishing effort should be controlled, they noted that, from their observations, pollution was also a major cause for the decline of the stocks. The stakeholders recommended that pollution in the Gulf of Paria be monitored for its impact on fisheries and that it be controlled by the relevant government authorities, including the industry (Medley *et al*, 2006). The Fisheries Division in collaboration with the Food and Agriculture Organization of the United Nations (FAO) commissioned a study entitled "Review of the Effects of Pollution and Coastal Development on Fisheries in the Gulf of

Paria and Columbus Channel". This study was conducted by a team from the University of the West Indies, (Seepersad *et al*, 2007).

Methodology

The Government of Trinidad and Tobago contracted Dr. Paul Medley, one of the developers of the ParFish methodology for a two-week period in April/May 2008 to brief Fisheries Division staff on the methodology and to conduct training in carrying out the ParFish interviews. The interviews were conducted with the aid of a questionnaire which comprised two components: the Stock Assessment component to obtain the views of the fisher on the state of the stock and its productivity both for the current situation (with pollution) as well as for the hypothetical situation (without pollution); and the Preference component to obtain the fisher's preferences with respect to various scenarios representing the effort applied and catch obtained, as well as months for a closed season.

Over the period April to October 2008, four meetings were held with shrimp trawl industry stakeholders in four communities, namely Orange Valley, Otaheite, San Fernando, and the south west peninsula (Icacos, Fullerton, Bonasse). At these meetings, a Powerpoint presentation was given to the stakeholders, which briefed them on the ParFish methodology and the purpose of the study, and the current state of the stock based on the best available scientific information. A handout was provided which summarized the findings of the Review of the Effects of Pollution and Coastal Development on Fisheries in the Gulf of Paria and Columbus Channel (Seepersad *et al*, 2007). The interviews were then conducted by teams from the Fisheries Division with stakeholders willing to participate. Follow-up visits to the communities were made where necessary to conduct additional interviews. In the case of Port of Spain, one of the two major landing sites of the industrial fleet (the other being Orange Valley), the fisherfolk were briefed and interviewed on an individual basis rather than through a group meeting. A total of 43 stock assessment interviews and 35 preference interviews were conducted with fisherfolk. The numbers of interviews conducted by landing site and trawler type are given in Table 1.

Fig. 1: Trawling areas around Trinidad (Chan A Shing 2002).

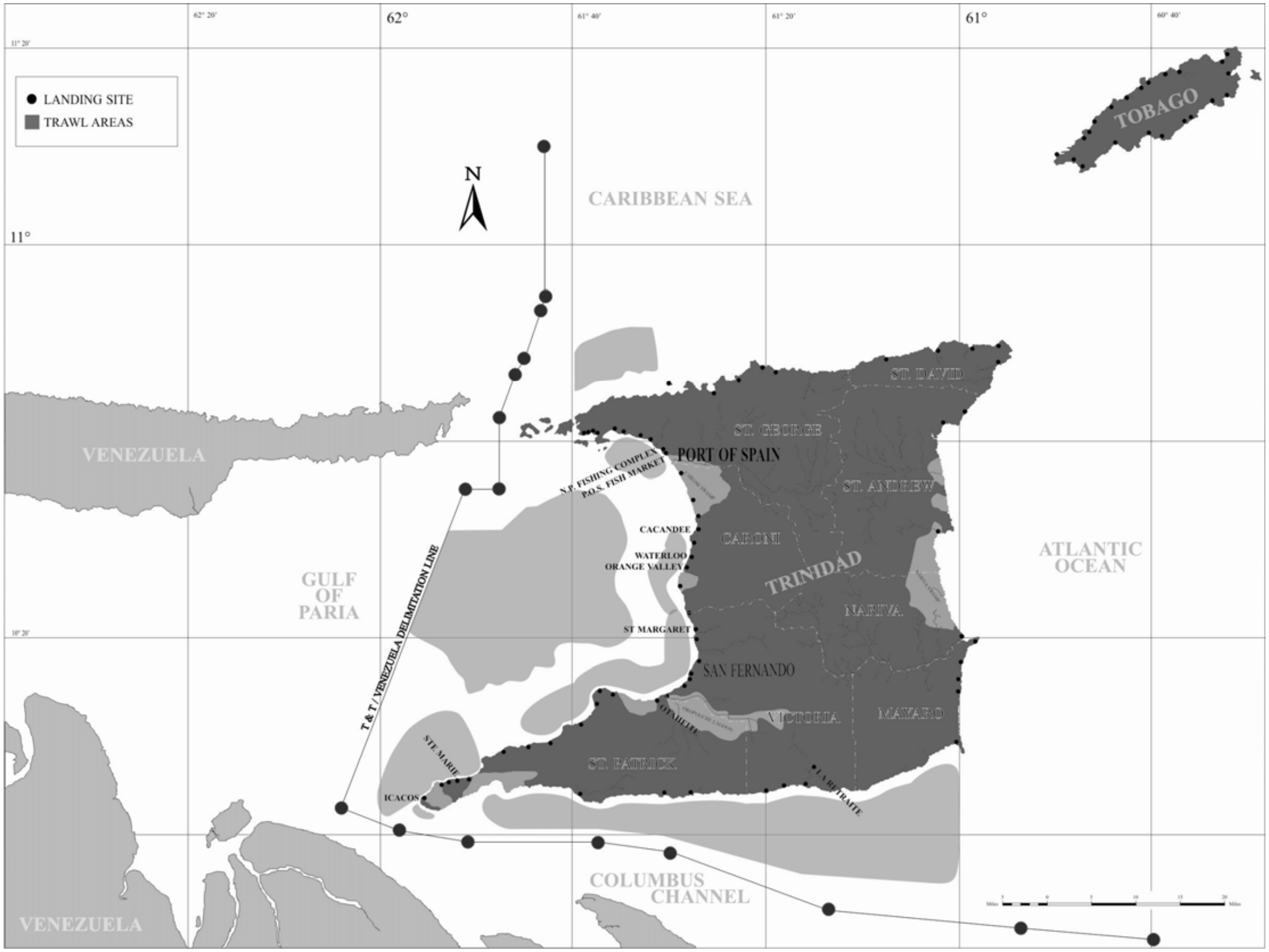

Table 1: Number of ParFish interviews (S-Stock assessment; P-Preference) conducted by landing site and trawler type.

Trawler Type	Number of Interviews Conducted												No. of vessels in Fleet
	Port of Spain		Orange Valley		San Fernando		Otaheite		SW Peninsula		Total		
	S	P	S	P	S	P	S	P	S	P	S	P	
Artisanal (outboard engines)			1	1					7	4	8	5	113
Artisanal (inboard engines)			6	6	6	3	8	6			20	15	
Semi-Industrial			6	6							6	6	10
Industrial	4	4	5	5							9	9	27
Total	4	4	18	18	6	3	8	6	7	4	43	35	150

Some Preliminary Results

Fishers attribute the worse state of the stock predominantly to pollution rather than fishing (Fig. 2). Similarly, recovery times (an indicator of the rate of increase) were thought by fishermen to be longer with current levels of pollution, although this change is small compared to the relative wide range of answers given by fishers (Fig. 3). Comparing individual fishers' estimates of MSY with and without pollution gives a similar picture, implying that most fishers believe productivity of the resource has been significantly reduced due to the effects of pollution (Fig. 4). However, a few respondents gave answers indicating the contrary (Log(w/o pollution : w pollution) < 0), but whether this was due to misunderstanding the questions or a genuine belief in increases in productivity (due to increased eutrophication for example) is not clear and will need to be verified.

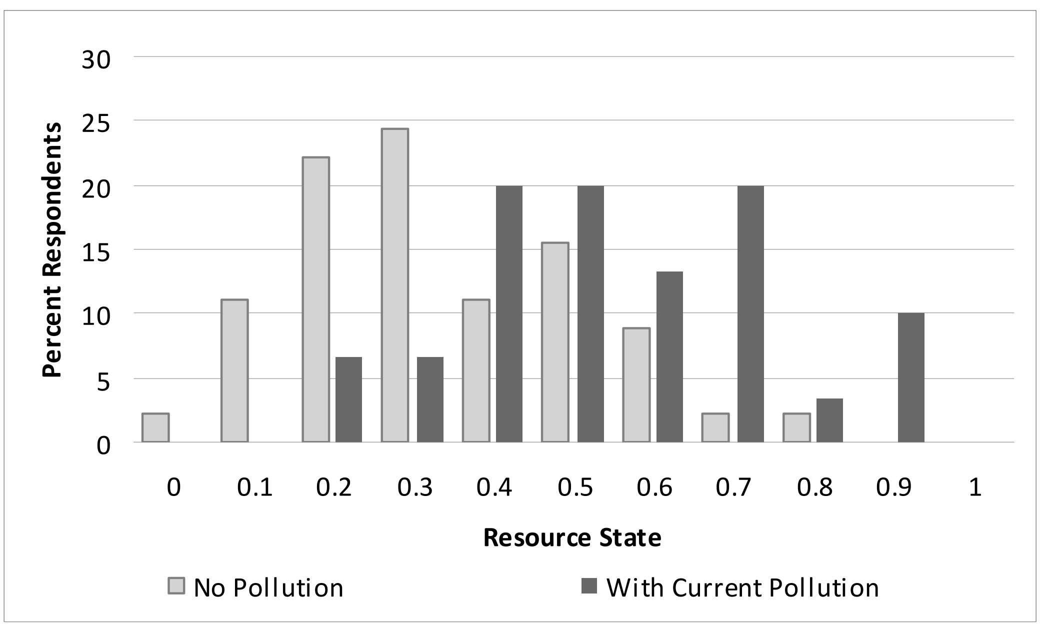

Fig. 2: Resource state, measured as the proportion of unexploited biomass, with and without pollution. 45 respondents gave valid responses to the without pollution questions and 30 to the with pollution questions.

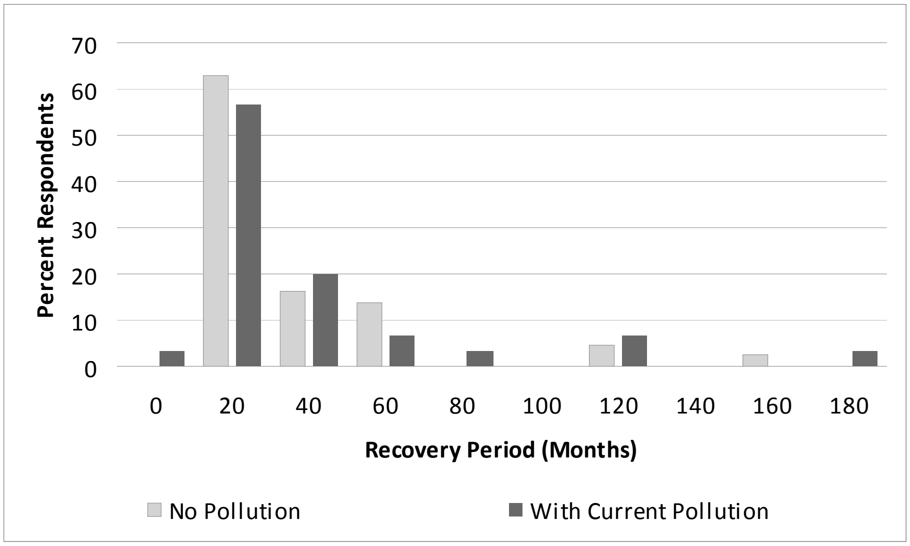

Fig. 3: The recovery period is the time that the stock would take to recover from the current state to the unexploited state with no fishing. There is a small shift, with fishers generally believing that it will take longer for the stock to recover with pollution obscured by the overall differences among fishers. 43 respondents gave valid responses to the without pollution questions and 30 to the with pollution questions.

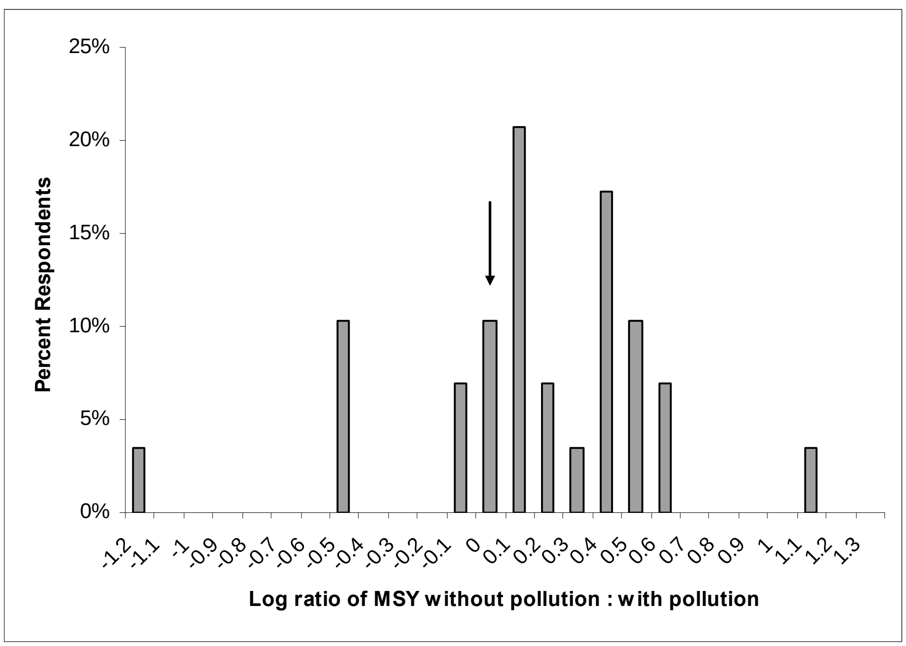

Fig. 4: Pairwise comparison of the effect of pollution on the MSY estimate for 30 respondents who gave valid answers for both sets of questions with and without pollution. The MSY was estimated from the answers to the questions given by the fishermen. Each fisherman who was able to give answers to the questions with and without pollution gave two contrasting MSY estimates. These were logged to reduce the dispersion among respondents. The higher log ratio (> 0.0) between these two estimates indicate that fishermen believe pollution decreases productivity, and conversely the lower ratio (< 0.0) suggests that they believe it increases productivity.

Follow-Up Activities

- Continued analysis of the ParFish interviews

- Incorporation of the data into an updated and modified biomass dynamics model for Trinidad and Tobago and Venezuela using a Bayesian framework. This model will be a modification of the biomass dynamics model developed for Trinidad and Tobago-Venezuela at the 2006 CRFM Scientific Meeting (Ferreira and Medley, 2006), and the 2005 bilateral Trinidad and Tobago-Venezuela meeting held under the auspices of the FAO/WECAFC Ad Hoc Working Group on the Shrimp and Groundfish Resources of the Guianas-Brazil Continental Shelf (Medley et al, 2006). This should be completed during the inter-sessional period. This activity will require the technical assistance of Dr. Paul Medley, for which funding will be requested from the CRFM.

- Presentation of the results of the ParFish interviews and assessment to the fishing communities.

- Analysis of the usefulness and appropriateness of the ParFish methodology.

The meeting acknowledged the significant work completed inter-sessionally by the Trinidad and Tobago fisheries staff in preparing for and carrying out the PARFISH interviews, and also the progress in analyses completed during this year's meeting of the SGWG. For completion of the exercise, it was recommended that the investigators consider options for simplifying the graph titles, captions and text explanations where relevant, and also consider options for weighting the analyses based on data that measure key informant quality and experience, e.g. years of active experience in the fishery. A full report of the PARFISH method test of this fishery was requested to be presented at the next meeting of the DMTWG.

6.2.2 ECOPATH

The meeting was reminded about the need to give further consideration to the use of ECOPATH as one of the analysis tools for addressing ecosystem approaches. It was agreed that the ECOPATH model should be explored further by the CRFM Working Groups, and some training would be needed to facilitate this. It was pointed out that Ms. Elizabeth Mohammed of the Trinidad and Tobago Fisheries Division had expertise and experience using the ECOPATH model and could assist with the proposed training.

6.2.3 Visual surveys to inform Bayesian Methods

The meeting noted that in the absence of routine monitoring programmes, visual surveys were valuable for gaining some insight into present stock abundance. Moreover, such surveys usually facilitated the collection of ancillary data on habitat and stock conditions that could be used to inform the development of priors for Bayesian analyses.

6.2.4 CRFM Toolbox

As in previous meetings of the Ad Hoc Working Group on Methods, the issue of establishing a CRFM toolbox was raised. Such a toolbox would provide a central location for placement of the relevant text descriptions/literature and worked example spreadsheets for each method, including special applications of these methods. It was agreed to explore usage of CRFM website space, if available. It was agreed that the consultants, who supervised the use of particular methods and finalized the prepared datasets, would be responsible for contributions to the CRFM toolbox.

6.2.5 Summary of recommendations with agreed actions

(a) A full report of the PARFISH method test being conducted by Trinidad and Tobago for its shrimp fishery would be presented at the next meeting of the DMTWG.

(b) The use of ECOPATH as a tool for addressing ecosystem management issues should be explored during future meetings of the Resource Working Groups, whose members would need to pursue some initial training.

(c) A CRFM toolbox should be established as a central reference repository for text descriptions and worked example spreadsheets for each method used during the annual scientific meetings, and attending consultants would be responsible for preparing contributions to the CRFM toolbox.

6.3 Training – issues and recommendations

To improve data quality and availability, the following training needs were identified:

(i) Collection of fish hard parts for age and growth analysis;

(ii) Training in data management, including management and maintenance of field sampling programmes, as well as of computerized databases;

(iii) Training in data manipulation.

The representative from IMA indicated that she would investigate options for using the internet to provide training in the collection of fish hard parts. It was also proposed that countries could receive assistance during the annual scientific meetings to establish, or review and improve, their field sampling programmes. Training in *Excel*, including the use of pivot tables, was proposed to improve data manipulation skills. The meeting also noted the relevance of the Secretariat's ongoing programme of assistance to countries to improve management and maintenance of national CARIFIS databases.

With regard to methods of data analysis, the following training needs were identified:

(i) ECOPATH, required to advance the work progress achieved under the FAO LAPE project in promoting ecosystem-based approaches, and to introduce this method for other areas within the CRFM region.

(ii) Noting the open and free online access to the statistical software *R*, as well as *R*'s growing capabilities including its interface with *Excel*, it was recommended that fisheries staff participating in the annual scientific meetings be trained in the use of *R*.

Summary of recommendations with agreed actions

(a) Internet options for training fisheries staff in sampling of fish hard parts would be explored by staff of the regional fish age and growth laboratory at the IMA.

(b) For countries wishing to establish or improve national field sampling programmes, these requests could be dealt with during the annual scientific meetings, particularly during the meetings of the DMTWG.

(c) A 2-day training session should be conducted at the start of the next annual scientific meeting, prior to commencement of the individual Working Group sessions: half-day should be reserved for training in data manipulation using *Excel* and pivot tables, while 1½ days should be reserved for training in the use of the *R* statistical software.

Generally, the meeting was also apprised of various projects, e.g. ACP FISH II, that had just begun or were about to commence in the region, and which could provide training opportunities or funding for such. Countries were urged to keep informed and to be openly supportive of these project developments and the possible opportunities, to guarantee access to funds both at the national and regional levels.

6.4 Inter-sessional work plan

(a) Datasets, proposed for analysis during the 2010 annual scientific meeting, should be prepared and cleaned and submitted to the Secretariat 6 weeks prior to the start of the 2010 meeting, together with explanatory notes.

(b) National reports should be submitted to the Secretariat 6 weeks prior to the start of the 2010 annual scientific meeting.

(c) During the inter-sessional period, the DMTWG should commence work on the establishment of a CRFM notebook/casebook, as outlined in section 6.1.7.

(d) The Secretariat should compile a list of the species for which age and growth parameters have been requested by the annual scientific meetings to date. This list, together with the species list included in the proposal prepared by the IMA, should be considered at the next meeting of the CFF, alongside the identification of assessment priorities for 2010.

(e) The PARFISH method test being conducted by Trinidad and Tobago for its shrimp fishery should be completed.

(f) Working Groups should begin to investigate options for using ECOPATH to promote ecosystem-based approaches.

(g) Work should commence on establishing the CRFM toolbox, as outlined in section 6.2.5.

(h) Internet options for training fisheries staff in sampling of fish hard parts should be explored by staff of the regional fish age and growth laboratory at the IMA.

(i) A 2-day training session should be conducted at the start of the next annual scientific meeting, prior to commencement of the individual Working Group sessions: half-day should be reserved for training in data manipulation using *Excel* and pivot tables, while 1½ days should be reserved for training in the use of the *R* statistical software.

6.5 Any other business

There was no additional business discussed.

6.6 Adjournment

The meeting was adjourned at 11.35 a.m.

6.7 References

Chan A Shing, C. (2002). Atlas: Marine fisheries of Trinidad and Tobago. Part 1. Trinidad inshore fisheries. Fish. Info. Ser. No. 10. Fisheries Division, Ministry of Agriculture, Land and Marine Resources; Port of Spain (Trinidad and Tobago). 76 p.

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

Ferreira, L. and P. Medley. (2006). The shrimp fisheries shared by Trinidad & Tobago and Venezuela. In: Report of Second Annual Scientific Meeting – Port of Spain, Trinidad and Tobago, 13-22 March 2006. *CRFM Fishery Report* – 2006, Volume 1. pp. 93-111.

Medley, P., J. Alió, L. Ferreira and L. Marcano. (2006). Assessment of shrimp stocks shared by Trinidad and Tobago and Venezuela. FAO/Western Central Atlantic Fishery Commission. Report of Workshop on the Assessment of Shrimp and Groundfish Fisheries on the Brazil-Guianas Shelf . Port of Spain, Trinidad and Tobago, 11-22 April, 2005. Rome: FAO. (In press).

Seepersad, G., P. Antoine, and R. Stewart (2007). Review of the Effects of Pollution and Coastal Development on Fisheries in the Gulf of Paria and Columbus Channel. Fisheries Division, Ministry of Agriculture, Land and Marine Resources (MALMR), Trinidad and Tobago, and Food and Agriculture Organization of the United Nations (FAO). (In press).

7. Proposal to establish a CRFM Scientific Committee

The CRFM Secretariat presented a draft of this proposal for review by the Meeting (Appendix 4). There were no additions or revisions to the proposal in its present form.

8. Any other business

The FAO representative provided an update on the progress being made on the Magdelesa project proposal. The FAO representative reiterated the importance of the project proposal, and urged countries to respond to updated requests for informing finalization of the proposal before August of this year, as available implementation funding would no longer be available after that time.

9. Review and adoption of meeting report

It was agreed to adopt the report by email. To facilitate this, Working Groups agreed to submit their final full reports to the Secretariat by 26 June 2009.

10. Adjournment

The Chairman opened the floor for remarks prior to formal adjournment.

On behalf of the CRFM Secretariat, Dr. Singh-Renton thanked the Chairman for his efforts in guiding the meeting through the course of the 2 days of plenary deliberations. She also thanked the Working Group Chairpersons, Rapporteurs and Consultants for their time and persistence to produce quality outputs.

In closing, the Chairperson expressed his gratitude to the Secretariat staff for their efforts in ensuring a successful meeting. The Chair also took the opportunity to acknowledge the dedication of the Working Group members, their Chairpersons, Rapporteurs and Consultants, who worked very hard to complete the tasks that were assigned to them this year.

The meeting was adjourned at 3.50. p.m. on 18 June 2009.

Appendices

Appendix 1: Agenda

FIFTH ANNUAL SCIENTIFIC MEETING
(Kingstown, St. Vincent and the Grenadines)

<u>I. Individual Resource Working Group Sessions: 9– 16 June 2009 (0830-1700h)</u>

(See document 2 (c) for Working Group session agenda)

<u>II. Formal plenary sessions: 17 – 18 June 2009 (0900-1700h)</u>

1. Opening of the meeting.
2. Adoption of meeting agenda and meeting arrangements.
3. Introduction of participants.
4. Presentation of national (country) reports.
5. 2009 reports of the CRFM Fishery Resource Working Groups (listed in alphabetical order):
    - 5.1 Conch and Lobster Resource Working Group (CLWG);
    - 5.2 Large Pelagic Fish Resource Working Group (LPWG);
    - 5.3 Reef and Slope Fish Resource Working Group (RSWG);
    - 5.4 Shrimp and Groundfish Resource Working Group (SGWG);
    - 5.5 Small Coastal Pelagic Fish Resource Working Group (SCPWG).
6. Meeting of the Working Group on Data Methods and Training (DMTWG)
7. Proposal to establish a CRFM Scientific Committee.
8. Any other business:
    - 8.1 Update from FAO on the Magadalesa (Moored Fish Aggregating Devices in the Lesser Antilles) Project Proposal.
9. Review and adoption of meeting report.
10. Adjournment.

FIFTH ANNUAL SCIENTIFIC MEETING
ANNOTATED AGENDA
(Kingstown, St. Vincent and the Grenadines)

I. Individual Resource Working Group Sessions: 9– 16 June 2009 (0830-1700h)

(See document 2 (c) for Working Group session agenda)

II. Formal plenary sessions: 17 – 18 June 2009 (0900-1700h)

1. Opening of the meeting.
- The plenary meeting sessions 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 17 June 2009.

2. Adoption of meeting agenda and meeting arrangements.
- The Chairperson will review the agenda and request that it be adopted by the Meeting. The Chairperson will also confirm general meeting arrangements.

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

4. Presentation of national (country) reports.
- The Secretariat will be asked to list those national reports that have been submitted for consideration by the 2009 Meeting.

5. 2009 reports of the CRFM Fishery Resource Working Groups (listed in alphabetical order):
   5.1 Conch and Lobster Resource Working Group (CLWG);
   5.2 Large Pelagic Fish Resource Working Group (LPWG);
   5.3 Reef and Slope Fish Resource Working Group (RSWG);
   5.4 Shrimp and Groundfish Resource Working Group (SGWG);
   5.5 Small Coastal Pelagic Fish Resource Working Group (SCPWG).
- Each Working Group Chairperson will present an overall report of the Working Group's 2009 meeting, including overall findings, recommendations and conclusions.
- Each species rapporteur will also present his/her fishery assessment report for 2009.
- Other technical documents prepared by working groups will also be presented.
- Following each presentation, the Meeting will be invited to review, discuss, and endorse each report's findings and recommendations.

6. Meeting of the Working Group on Data Methods and Training (DMTWG)
- The Chairperson of this Working Group will conduct this meeting, guided by prepared agenda given in document 2(d).

7. Proposal to establish a CRFM Scientific Committee.
- The Chairperson will request the Secretariat to present this proposal for review and discussion.

8. Any other business
- The Chairperson will address any items identified to be addressed under this agenda item.

9. 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.

10. Adjournment.
- The Chairperson will make any necessary closing remarks, and move to adjourn the Meeting.

Resource Working Group Meeting Agenda
(CLWG; LPWG; RSWG; SGWG; SCPWG)

1. Report of work progress since last meeting.
2. Report on relevant activities and plans of other international fisheries organizations.
3. Tasks to be addressed during meeting.
4. For fishery analysis/ assessment tasks identified at (3), review relevant policy and management objectives, fishery characteristics and trends, and available data.
5. Conduct statistical and assessment analyses of the fisheries concerned, and document findings and recommendations.
6. For other tasks identified, conduct literature review, research and/or data analysis, and document findings and recommendations.
7. Review and adoption of fishery analysis reports and any other technical documentation prepared.
8. Issues and recommendations pertaining to data, methods, and/or training for DMTWG.
9. Inter-sessional work plan.
10. Any other business.
11. Review and adoption of Working Group report.
12. Adjournment.

Appendix 2: List of Participants

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Appendix 3: Agenda DMTWG Meeting

1. Data – issues and recommendations
2. Methods – issues and recommendations
3. Training – issues and recommendations
4. Inter-sessional work plan
5. Any other business
6. Adjournment.

Appendix 4: Proposal to establish a CRFM Scientific Committee

Terms of Reference of CRFM Scientific Committee

Rationale

The CRFM's structure and mandate recognize the need for science-based fisheries management. The CRFM Structure includes a decision-making body, the CRFM Ministerial Council, and a technical advisory body, the Caribbean Fisheries Forum (CFF), supported by a Secretariat. The CFF meets at least once per year to review the progress of technical activities coordinated by the CRFM Secretariat, including the outputs of CRFM annual scientific meetings, and to prepare recommendations for consideration by the CRFM Ministerial Council. The CFF also has the authority to direct the scientific meetings to address scientific and other technical questions related to fisheries management.

At the scientific/ technical implementation level, five fishery resource working groups have been established by the CFF to coordinate research and assessment of five major resource categories (reef and slope, conch and lobster, shrimp and groundfish, small coastal pelagic fish, large pelagic fish). CRFM holds an annual scientific meeting that is a joint meeting of these five fishery resource working groups, and is intended to allow sharing of knowledge and expertise, as well as to facilitate wider review and consultation concerning the interpretation of assessment results and suitable fishery management recommendations. By this means, the CRFM scientific meetings ensure that fishery assessments and management recommendations are updated and presented to the CFF and the Ministerial Council annually.

Acknowledging the need to establish a formal scientific implementation body of the CRFM that would assume responsibility for overseeing the work of CRFM fishery resource working groups and for reporting on these activities to the CFF, the CFF agrees to establish a CRFM Scientific Committee (CSC) for this purpose. It is expected that the status and recognition of the CSC will also enable formal scientific networking and partnerships with the international scientific community and ensure that CRFM scientific inputs are given their due acknowledgement.

Terms of Reference

The terms of reference for the CRFM Scientific Committee (CSC) follow.

(i) Is the formal scientific implementation body to oversee all activities of CRFM fishery resource working groups and of other CRFM technical working groups established to support completion of tasks associated with research, resource assessment, and the formulation of management advice.

(ii) Is the formal scientific implementation body to report directly to the Caribbean Fisheries Forum.

(iii) For investigations pertaining to shared fishery resources, nurture the necessary collaboration, between CRFM fisheries scientists and fisheries scientists from non-CRFM States and the wider international scientific community, through the development of appropriate networking and partnerships arrangements.

(iv) Carry out specific scientific and other technical tasks, and develop and implement proposals for scientific projects, as directed by the CFF.

(v) Prepare reports of the activities of the CSC.

Mode of Operation

The CSC is responsible for overseeing the activities of CRFM fishery resource working groups, and of other CRFM technical working groups established to support completion of tasks associated with research, resource assessment, and the formulation of management advice.
To facilitate sharing of data, knowledge and expertise, the CSC is expected to collaborate with scientists working on similar issues from non-CRFM States and the wider international scientific community. This is especially important for the management of shared fishery resources.
A Chairperson and Vice-Chairperson of the CSC should be elected.

Membership & Participation

CRFM Member States are members of the CSC and are expected to participate actively in the work of this Committee. Non-CRFM fisheries scientists and scientific representatives with overlapping work interests will be invited to contribute to the work of the CSC and participate in CSC meetings.

Meetings

The CRFM Scientific Committee will hold an on-site scientific meeting once a year.


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