ISSN:1995-1434

CRFM Fishery Report - 2007

Volume 2

Report of Third Annual CRFM Scientific Meeting - St.Vincent and the Grenadines, 17-26 July 2007

CRFM Secretariat,
Belize
2007

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Fishery Management Advisory Summaries

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CRFM FISHERY REPORT – 2007. Volume 2 - Fishery Management Advisory Summaries. Report of Third Annual Scientific Meeting –Kingstown, St. Vincent and the Grenadines, 17-26 July 2007

Correct Citation:
CRFM. 2007. Report of Third Annual Scientific Meeting – Kingstown, St. Vincent and the Grenadines, 17-26 July 2007. Fishery Management Advisory Summaries. *CRFM Fishery Report – 2007*, Volume 2. 54 p.

ISSN # 1995-1434
ISBN # 978-976-8165-17-6

Published by the Caribbean Regional Fisheries Mechanism Secretariat,
Belize and St. Vincent and the Grenadines.

Foreword

The 2007 CRFM Annual Scientific Meeting took place during 17-26 July 2007. During this Meeting, CRFM Resource Working Groups examined data from eleven fisheries: the Nassau grouper (*Epinephelus striatus*) fishery of Belize; the queen conch (*Strombus gigas*) fisheries of St. Lucia and the Turks and Caicos Islands; the spiny lobster (*Panulirus argus*) fisheries of Jamaica and the Turks and Caicos Islands; the shrimp (*Farfantepenaeus subtilis* and *Farfantepenaeus brasiliensis*) fishery of Suriname; the Atlantic Seabob (*Xiphopenaeus kroyeri*) fishery of Guyana; the bangamary (*Macrodon ancylodon*) fishery of Guyana; the seatrout (*Cynoscion virescens*) fishery of Guyana; the king mackerel (*Scomberomorus cavalla*) fishery of Trinidad and Tobago; the wahoo (*Acanthocybium solandri*) fishery of the Eastern Caribbean. The Meeting also reviewed and adopted the Report of the Second Meeting of CRFM's Ad Hoc Working Group on Methods. A working draft of a CRFM Data Policy Outline was also reviewed and discussed during the Meeting.

The Report of the 2007 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 2007. National reports, submitted for consideration by the Meeting, are published as Supplement 1 to Volume 1, while the Report of the Second Meeting of the Ad Hoc Working Group on Methods is published as Supplement 2 to Volume 1. Volume 2 contains the fishery management advisory summaries, which are the same as the first 7 sections (sections 1 to 1.7) of each of the fishery reports that are provided in full (sections 1 to 1.8) in Volume 1.

Volume 1 is intended to serve as the primary reference for fishery assessment scientists, while Volume 2 is intended to serve as the main reference for managers and stakeholders.

List of Acronyms and Abbreviations

ANOVA	Analysis of Variance
ARGOS	Advanced Research and Global Observation Satellite
BFD	Belize Fisheries Department
CARICOM	Caribbean Community
CARIFIS	Caribbean Fisheries Information System
CFRAMP	CARICOM Fisheries Resource Assessment and Management Programme
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CL	Carapace Length
CLWG	Conch and Lobster Resource Working Group
CPUE	Catch Per Unit of Effort
CRFM	Caribbean Regional Fisheries Mechanism
DECR	Department of Environment and Coastal Resources
EEZ	Exclusive Economic Zone
FAO	Food and Agricultural 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
LPWG	Large Pelagic Fish Resource Working Group
MEY	Maximum Economic Yield
MSY	Maximum Sustainable Yield
MT	Metric Tonnes
RSWG	Reef and Slope Fish Resource Working Group
SGWG	Shrimp and Groundfish Resource Working Group
SPAG	Spawning Aggregation Working Group
SPR	Spawning Biomass Per Recruit
SPSS	Statistical Package for the Social Sciences
TAC	Total Allowable Catch
TCI	Turks and Caicos Islands
TIP	Trip Interview Programme
USA	United States of America
VMS	Vessel Monitoring Systems
WECAFC	Western Central Atlantic Fisheries Commission

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I. REPORT OF THE CONCH AND LOBSTER RESOURCE WORKING GROUP

Chairman: Patricia Hubert-Medar
Species Rapporteurs: Anginette Murray (Jamaica); Patricia Hubert-Medar (St. Lucia); and Kathy Lockhart (Turks and Caicos Islands)
Consultant: Paul Medley PhD.

A. OVERVIEW

At the Second Annual CRFM Scientific Meeting held in 2006, it was agreed that the Conch and Lobster Working Group (CLWG) continue conducting assessments on the Lobster and Conch fisheries for St. Lucia, Jamaica, Bahamas and Turks and Caicos. The species rapporteur for the Bahamas, Mr. Lester Gittens was selected as Chairman for the Third Annual CRFM Scientific Meeting, but was not able to attend this meeting. As a result a new chairperson was nominated in the person of Patricia Hubert-Medar. Mrs. Anginette Murray replaced Mrs. June Masters as the species rapporteur for the lobster fishery in Jamaica.

One of the recommendations at the Second Annual CRFM Scientific Meeting was for Jamaica to conduct two visual surveys of the conch on Pedro banks. It was reported that one such assessment was conducted in January 2007 and the other is proposed to be conducted in September of the same year. Turks and Caicos Islands was to provide updates for the conch fishery including local consumption.

Dr. Paul Medley was the consultant assigned to the Conch and Lobster Working Group. He worked along with: Mrs. Patricia Hubert-Medar whose assessment was based on the St. Lucia Conch fishery, Mrs. Anginette Murray who worked on the Lobster fishery in Jamaica and Mrs. Kathy Lockhart who updated the conch and lobster assessments for the TCI.

The terms of reference for the Conch and Lobster Working Group were:

- To determine the TAC for the TCI lobster.
- To update the assessment for the TCI conch including local consumption.
- Feasibility to carry out a stock assessment on St. Lucia conch. It was realized that a stock assessment was possible, so it was undertaken.
- Conduct an exploratory analysis of the Jamaica lobster catch and effort data, to develop a strategy to conduct a stock assessment including identifying research priorities for Jamaica

Assessments
No assessment was conducted on the conch and lobster fishery for the Bahamas since the species rapporteur, Mr. Gittens was absent.

Conch
A simple biomass dynamics (Schaefer) model was fitted to a CPUE index using the available catch estimates. The additional "prior" information on the population parameters (rate of increase and unexploited stock size) was included as mathematical probability functions based on assumptions and errors in the estimates from the Caicos Bank and Pedro Bank assessments. The

model was fitted using a Bayesian fitting method that combines the information in the prior and the observations to produce a "posterior" probability for the state of the stock, MSY, replacement yield and other indicators of interest. The model explains the observations well, as indicated by the close fit between the observed and expected CPUE index. However, wide ranges of parameter estimates explain the observations equally well unless additional information on the productivity of this species elsewhere is incorporated. The R^2 statistic indicates that most variation in the CPUE index (i.e. the downward trend) can be explained by the model. However results depend upon the prior information being reasonable. The results were considered sufficiently reliable for adaptive management action.

The Caicos Bank TAC recommendation was updated for the 2007-2008 season based on new data and local consumption data. Including local consumption improved the assessment and this model has now become the standard for management advice.

Lobster

For the TCI, the assessment was based on a recruitment index estimated from the August catch and effort data. The recruitment index is then used to fit the annual catch and effort time series 1974-2006. Once assessed a minimum Total Allowable Catch (TAC) was determined based on the lowest observed recruitment using a standard spawners-per-recruit reference point (SPR40% for 83mm CL; FAO 2006) of approximately 650,000 lbs. A final TAC is then intended to be determined once a recruitment index is made available from the August catch and effort data in November, and the TAC duly topped up with the additional recruits.

Due to insufficient available data for the Jamaica lobster fishery, a stock assessment was not carried out. However, exploratory data sought to identify any seasonal patterns in the CPUE indices as preliminary to developing a recruitment index and monitor trends in mean size. In an attempt to identify and establish a recruitment index, the available catch and effort data submitted for period 1995-2007 were examined. The mean CPUE by month suggests that there may be a decline in catch rate from June to December. This may be the result of recruitment occurring during the closed season increasing the stock size at that time. However, the data are very noisy and sparse so any further attempt to separate out different effects was found to be impossible.

Recommendations

- Rapporteurs should be well advised during the intercessional period of the exact format and type of data requested for assessment prior to the scientific meetings.

- National governments should improve resources such as man power and or finance to collect social economic data and other relevant data pertinent to assessment.

- Advice is needed as to what data can be collected for the purpose of conducting Socio Economic assessments.

- An Economist should be invited to the working group meeting and advise participants with regards to data collection.

- It is recommended that Jamaica data collection be raised as a priority so that better coverage can be conducted.

- The CRFM secretariat needs to incorporate a consultant with economic and social experience to deal with the economic aspect of the assessments at the next scientific meeting.

Stock Assessments for 2008

The working group terms of reference should include in 2008:

- Reassessment of the TCI lobster TAC,
- Reassessment of the St. Lucia conch,
- Jamaica lobster assessment, conditional on the provision of new data,
- Assessment of Bahamas lobster

Other countries conch fisheries will also be checked to see whether several assessments could be conducted based on the method being developed for St. Lucia.

B. FISHERIES REPORTS

1.0 The Spiny Lobster (*Panulirus argus*) Fishery of the Turks and Caicos Islands

1.1 Management Objectives

1. Ensure that the catch in any one year does not exceed the MSY.
2. Improve on net exchange earnings from the lobster fishery.
3. Promote management at the regional level in order to improve the effectiveness in managing the lobster fishery of the Turks and Caicos Islands.
4. Improve our understanding of the spiny lobster stock status in the waters of the TCI.

1.2 Status of Stocks

Lobster landings continued to fluctuate, reaching a peak of 590 MT (1,312,795 lbs.) in 1992/1993 fishing season followed by a steady decline to an all time low of 320 MT (400,375 lbs.) in 2002/2003 fishing season. This decline in catch was attributed to many factors, including low larval retention/recruitment to the TCI fishery during the previous fishing years and/or the harvesting of illegal stock size (Medley & Ninnes, 1997; Bethel *et al.*, 2000).

While the spawning stock biomass can be estimated, a minimum spawning stock size cannot be determined at this time due to the lack of a reliable stock-recruitment relationship for spiny lobster. Instead, a reference point of $SPR_{40\%}$ (a fishing mortality which gives 40% of the unexploited spawning stock under constant recruitment) was used which has been proposed for the region (FAO, 2006). This suggests that overfishing has occurred in the past, and that, overall the stock has been fully exploited since 1977. In 2005 and 2006 overfishing was occurring. The information is sufficient at this time to establish a total allowable catch.

1.3 Management Advice

In order for management to meet the objectives, a suitable control on fishing mortality needs to be established. A total allowable catch (TAC) based on a Maximum Sustainable Yield (MSY) reference point has been identified as the most suitable control. The following is the recommended advice:

- Set a minimum TAC in May, based on the lowest observed recruitment index, at 650,000 lbs whole landed lobster.
- Conduct an annual stock assessment in November updated by the estimated recruitment using the August data. The TAC would then be topped up based on the additional recruits.
- At least two persons in the department need to be able to carry out the annual assessment to allow the TAC top-up.

This harvest rule would allow the fishery to maintain the economic productivity each year for full-time fishers by avoiding extreme fluctuations in catches and reducing the influx of part-time fishers.

1.4 Statistics and Research Recommendations

1.4.1. Data Quality

Catch and effort data are collected from the local processing plants. The data are of good quality, but have a few areas lacking information, such as undocumented August catch for years 1997-2002. Morphometric parameters have been collected from years 1989-1998 and then again collected from 2005-present.

1.4.2. Research

- Conduct an annual recruitment assessment, set a minimum TAC (in May) and as well as allowing the TAC to be topped up (in November), this will guard against changes in the method of fishing which could invalidate the recruitment index.
- Collection of indices such as juvenile abundance in nursery areas, and adult abundance in fishing areas.
- Continue collection of length composition and other biological data of landed lobsters. A regional fishing mortality (F) was determined at the FAO WECAFC Lobster Workshop in Merida. A growth model specific to the Caicos Bank may be used to update this reference point.

1.5 Stock Assessment Summary

The objective of the assessment was to propose a total allowable catch for the stock. This involved updating the current stock assessment with the available data and then identifying a suitable harvest rule for calculating a TAC for this stock.

The previous stock assessment was updated (FAO WECAFC 2006). The assessment is based on a recruitment index estimated from the August catch and effort data. The recruitment index is then used to fit the annual catch and effort time series 1974-2006. The time series of data was extended in this assessment, including the years 1974-1976 and 2006 (Figure 1).

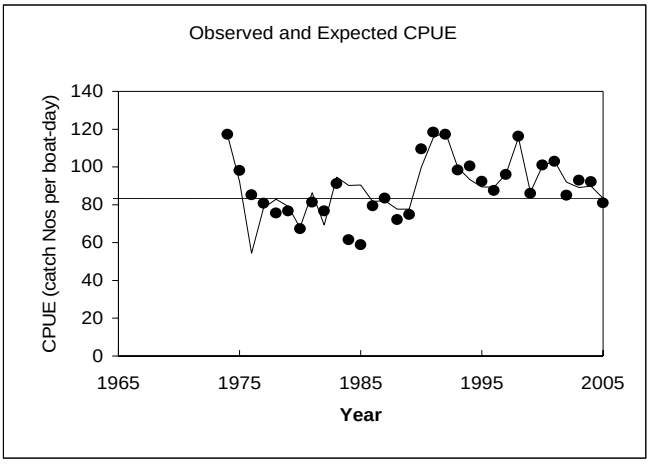


Figure 1: Observed and expected CPUE. The CPUE was used as an index of abundance to fit the population model. The model fits the data well with the exception of years 1976, 1984 and 1985 when catch and effort data recording was poor.

A minimum Total Allowable Catch (TAC) was determined based on the lowest observed recruitment using a standard spawners-per-recruit reference point (SPR40% for 83mm CL; FAO 2006) of approximately 650,000 lbs. A final TAC is then calculated using the new recruits and the mature stock at the beginning of each year based on the SPR 40% fishing mortality, which has been proposed for the region (at the FAO WECAF Workshop in Merida; FAO 2006).

As can be observed over the years, if this type of management was in place the economic returns to fulltime fishers would have been more consistently achieved, while reducing the number of part-time fishers. The annual assessment allows for the minimum TAC to be surpassed based on the recruits for that year and therefore is precautionary (Figure 2).

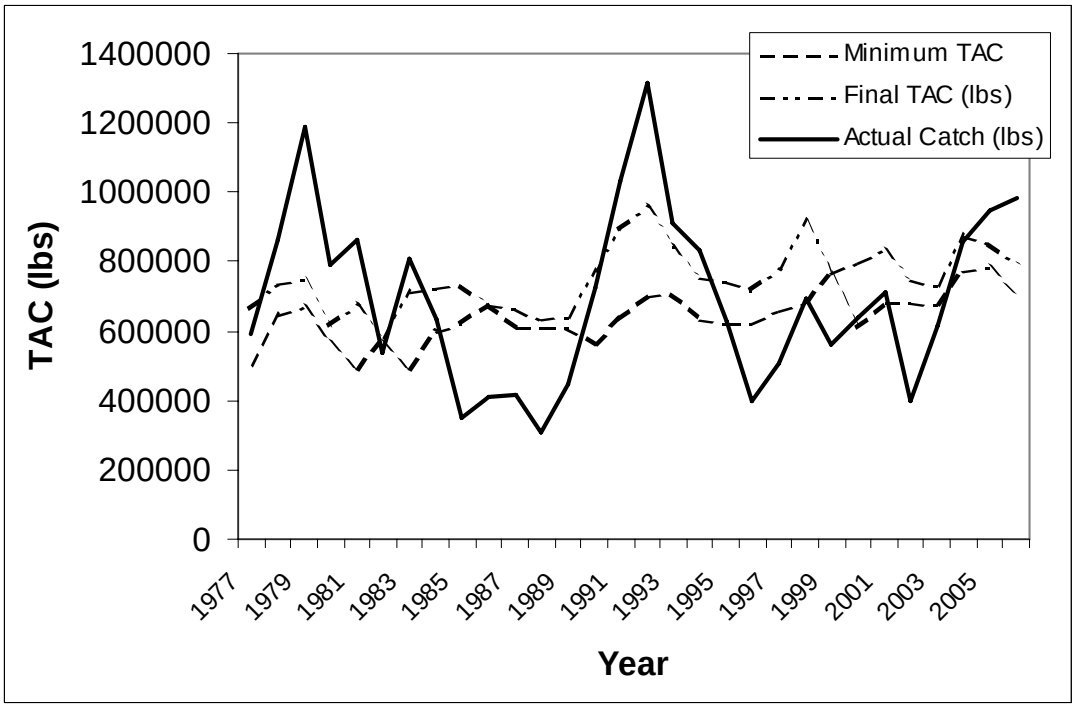


Figure 2: If the harvest rule described had been used to set the TAC in each year, the high levels of harvest observed in the past would have been capped. It might be expected that more stock would have carried over between years smoothing out the landings and possibly enhancing recruitment through the years.

1.6 Special Comments

None.

1.7 Policy Summary

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

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

Inclusive to the policy is the current functioning stock assessment to determine a MSY for the Queen Conch. With this effective harvest strategy, it seems apparent that determining a TAC for the spiny lobster population could also be just as effective. Often times it is suggested that effort controls such as restriction of the fishery be the management control. However, it is socially unacceptable to place effort restrictions, so harvest strategy such as TAC would again be the most effective management tool for the TCI government.

1.8 References

Bethel, G., Cruz, R., Deleveaux, V., Harper, D., Luckhurst, B., Joseph, W., Medley, P. and Muller, R. (2001). Lobster assessment report. Region 4: Bahamas, Bermuda, North Cuba, St. Lucia, Turks and Caicos Islands and the United States of America. *FAO Fisheries Report* No. **619**:91-114.

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

2.0 The Queen Conch (*Strombus gigas*) Fishery of the Turks and Caicos Islands

2.1 Management Objectives

- To ensure that the catch does not exceed sustainable levels or a predetermined reference point (e.g. MSY).
- To maintain effort levels in the queen conch fishery at or below the corresponding level required to obtain the target reference point.

2.2 Status of Stocks

According to the assessment conducted at the Second and Third Scientific Meetings of CRFM, catch rates are operating at a constant level, which imply that the stocks are operating at optimum levels, with a biomass at 56% of the unexploited biomass.

2.3 Management Advice

Advice for management to meet the management objectives are as follows:

- Continue to assess the conch stock yearly, based on catch, effort and local consumption data to determine current status of the conch population relative to the biomass and fishing effort that produce maximum sustainable yield (MSY)
- Total Allowable Catch is effectively working with the closed season and effort controls.

2.4 Statistics and Research Recommendations

2.4.1. Data Quality

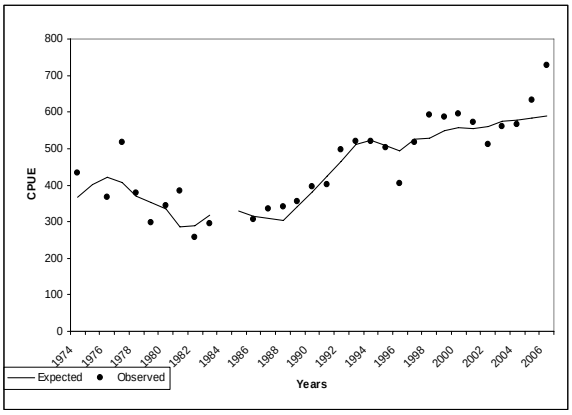
Catch and effort data are collected from the local processing plants. The data are of good quality, but have a few areas lacking information, such as illegal harvest. The DECR completed a local consumption survey of Queen conch in 2005 and has updated the assessment. However, there was an increase in estimated population based on immigrant migration and it was therefore suggested that the assessment be conducted to include local consumption.

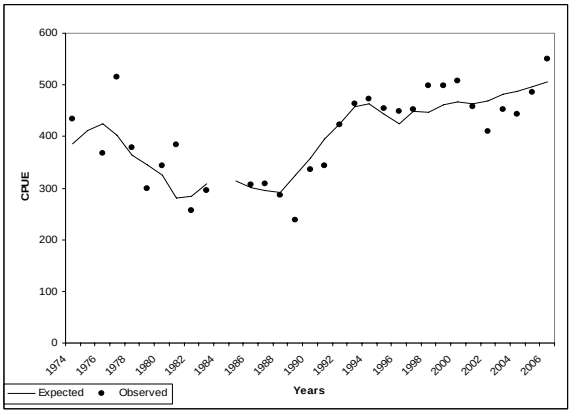
2.4.2. Research

- Conduct a visual survey to determine the abundance of conch.
- Work with the Department of Economics and Planning to study economic aspects of the fishery before the end of 2008.
- Examine possibilities of hiring an economist to provide understanding of the economic pros and cons for the conch fishery.
- Provide additional funding for research to add parameters to the current stock assessment model (i.e. conch shell length versus shell lip thickness, additional visual surveys, local consumption survey, population census, fisher information)

2.5 Stock Assessment Summary

The assessment used available catch and effort data to determine the Maximum Sustainable Yield (MSY), the effort necessary to obtain MSY, the virgin (unfished) biomass level, and the status of the fishery relative to conditions generating MSY (i.e., current effort and current biomass relative to the levels producing MSY). A Schaefer model was re-produced that showed a high correlation of more than 60% between observed and expected catch rates (CPUE).





Stock Assessment Utilizing Local Consumption Data
p = 0.3486645
r = 0.432024217
K = 19050655
q = 0.00006
Sum of Squares = 9.10E+11

Stock Assessment Utilizing ONLY Catch and Effort Data
p = 0.450038232
r = 0.387940512
K = 17806838
q = 0.00005
Sum of Squares = 1.369E+12

Diagram A. Observed vs. Expected CPUE for two models fitted using Excel's Solver.

Sensitivity analysis demonstrates the following:

Assessment with recorded catch & effort only	1,726,998 lbs. 4032.25 boat-days 60% 67.6%	MSY f_{MSY} $B/B_{Unexploited}$ Effort as % of f_{MSY}	* Quota for 2007-2008 1,416,139 lbs. (precautionary approach for local consumption 82%)
Assessment with local consumption included in the catch	2,057,586 lbs. 3922.74 boat-days 56% 69.5%	MSY f_{MSY} $B/B_{Unexploited}$ Effort as % of f_{MSY}	* Quota for 2007-2008(-600,000 lbs. local consumption) 1,457,586 lbs.

*Quota for 2007-2008 is based on local consumption of conch on the current estimated population of more than 34,000 individuals.

Sensitivity analysis indicates that the local consumption information does increase the MSY, but it does not greatly influence the effort necessary to achieve MSY. If the TCI was to set a quota for the fishery based on the MSY from catch and effort data only, it would be operating within 1.9% of the most conservative MSY. However, if the assessment is based on the addition of local consumption, the TCI government must remember that approximately 600,000 lbs. of conch would be consumed locally and must be removed from the total MSY before the quota allocation for export.

2.6 Special Comments

This year's assessment was an update of the 2006 CRFM assessment. The analysis was to re-evaluate the local consumption because of an estimated increase in local population. The method of analysis remains the same as the last assessment. However, the impact of local consumption is expected to increase because of the increase in human population.

2.7 Policy Summary

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

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

Inclusive within the policy is the functioning stock assessment that determines a MSY for the Queen Conch. With this effective harvest strategy in place, the TCI has an effective management tool. With socially unacceptable management controls such as effort control, setting a TAC based on the MSY is an effective management tool.

In order to make sure that the TCI is continually allowed to freely trade the queen conch species, it must take necessary steps to become a signatory to the CITES Convention (i.e. complete the draft Endangered Species Bill and provide permanent legislation for mandated Scientific and Management Authorities).

3.0 The Queen Conch (*Strombus gigas*) Fishery of St. Lucia

3.1 Management Objectives

The management objective for this fishery is to ensure sustainable use of the stocks and to rebuild the stocks, particularly in the nearshore area.

3.2 Status of the Stock

The stock assessment indicated that the St. Lucia conch stock is overfished, but that overfishing is probably not occurring (Table 1).

This study is consistent with the conclusion based on a study of the biological data collected during 1996-1998, which indicated that the nearshore fishery was over exploited. However, the assessment also provides a target, to increase the catch rate to be above the MSY level.

Table 1: Estimated current yield together with the median and 95% confidence interval for three indicators of interest. As B/BMSY is below 1.0 (MSY reference point), the stock should be designated as overfished. Catches are currently likely to be below the replacement yield, so that the stock size should increase, albeit slowly. Reduction in catch should speed recovery and reduce the risk of further overfishing. Since the current catch is likely to be below MSY, once the stock starts to recover, it should rise above the MSY level.

Current Yield (t)		35	
	5%	**Median**	**95%**
B/BMSY	0.60	0.74	0.88
Replacement Yield (t)	34	45	54
MSY (t)	37	48	58

3.3 Management Advice

It is essential that measures are put in place to contain the level of effort to ensure the sustainability of the fishery. It is therefore recommended that the current catch remains at the same levels (35 tons per year) or lower. This is necessary to ensure rebuilding of the current stock. If no recovery is detected in future years, catches will need to be decreased. Management could:

- seek to control effort through a licensing system where only traditional conch fishers are allowed into that fishery, and/or
- introduce a closed season to limit effort. The Fisheries Regulations make provisions for a closed season but, to date, this management measure has not been implemented.
- fully enforce regulatory actions enacted in the law.

3.4 Statistics and Research Recommendations

3.4.1. Data Quality

The annual catches need to be re-estimated using the raising factors from the original data, and more catch and effort data might be available to extend the time series back to earlier years. In earlier years, it was thought that the shell weight was included in the reported catch weight of the trip, so an adjustment was made. This adjustment was later found to be incorrect. The adjustment was reversed both in the catches and CPUE data at this meeting. It was unclear whether this correction was necessary for all years in the catch time series. In particular, the 1996 catch appears too high.

With the exception of the problem noted above, the catch and effort data is believed to be very reliable. From 2000 to the present, all catch and effort data have been subjected to integrity checks both before and following data entry. Before data entry, data sheets are checked for errors and omissions with the data collectors, whilst subsequent to data entry into the Trip Interview Program (TIP) database, data are also validated and verified for errors and omissions.

3.4.2. Research

The following are suitable data for providing advice necessary for meeting management objectives:

- Catch and effort: The catch and effort data are monitored well, although past raising to total catch will need to be reassessed.
- Abundance survey: A survey has not been conducted but could be useful in helping to determine stock status.
- Habitat mapping: Area of conch habitat and fishing grounds would be useful in helping to identify realistic harvest from this species.
- Mapping of the fishing grounds and conch habitats should be carried out as soon as possible. This would make the stock assessment more reliable and would enable the management authority to manage the resource more effectively through for example zoning and declaring closed areas if necessary.
- An abundance survey would give an accurate estimate of the current biomass as well as identify juvenile and breeding areas. This would improve the accuracy of the assessment and give more options for appropriate management and control of this fishery.

3.5 Stock Assessment Summary

A stock assessment was carried out using the catch and effort data collected since 1993. The data were insufficient to estimate the stock size and production, therefore additional information on the biology of the stock was added from assessments in the Turks and Caicos Islands and Jamaica. Together with the catch and effort data from St. Lucia, this information was sufficient to determine the state of the stock and maximum sustainable yield for this fishery.

A simple biomass dynamics (Schaefer) model was fitted to a CPUE index (Fig. 3) using the catch estimates. The additional “prior” information on the population parameters (rate of increase and unexploited stock size) was included as mathematical probability functions based on assumptions and errors in the estimates from the Caicos Bank and Pedro Bank assessments. Including uncertainty is a marked improvement on previous assessments where fixed values had to be assumed, producing unreliable results. The model is fitted using a Bayesian fitting method that combines the information in the prior and the observations to produce a “posterior” probability for the state of the stock, MSY, replacement yield and other indicators of interest. The model fitted the data well (Fig. 4), but results depend upon the prior information being reasonable. The results were considered sufficiently reliable for adaptive management action.

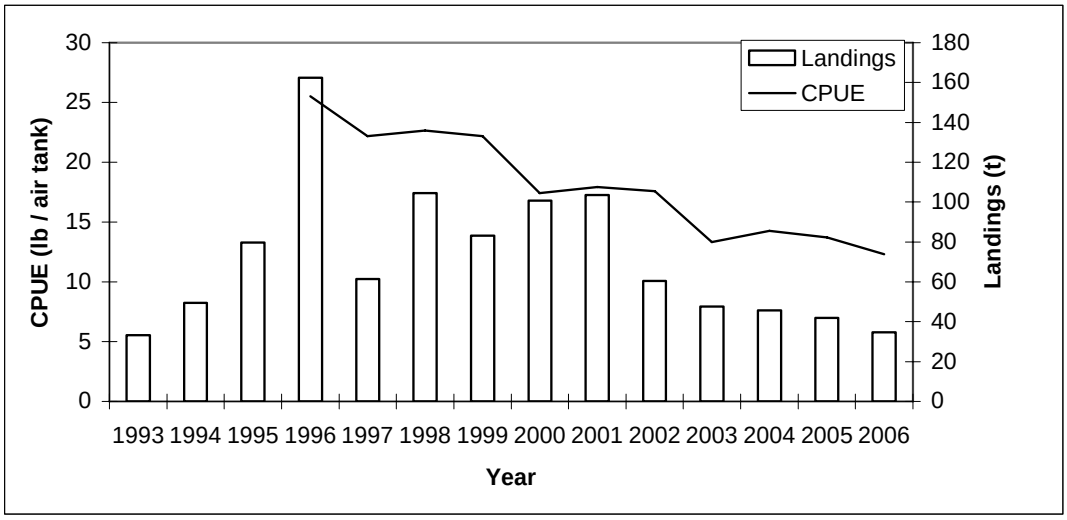


Figure 3: The available total catch and CPUE data used for the stock assessment. The CPUE abundance index shows a continuous decline since 1996, suggesting that the stock has declined over this period. The catch time series 1993-2001 has some uncertainty as to the recorded data (see data quality).

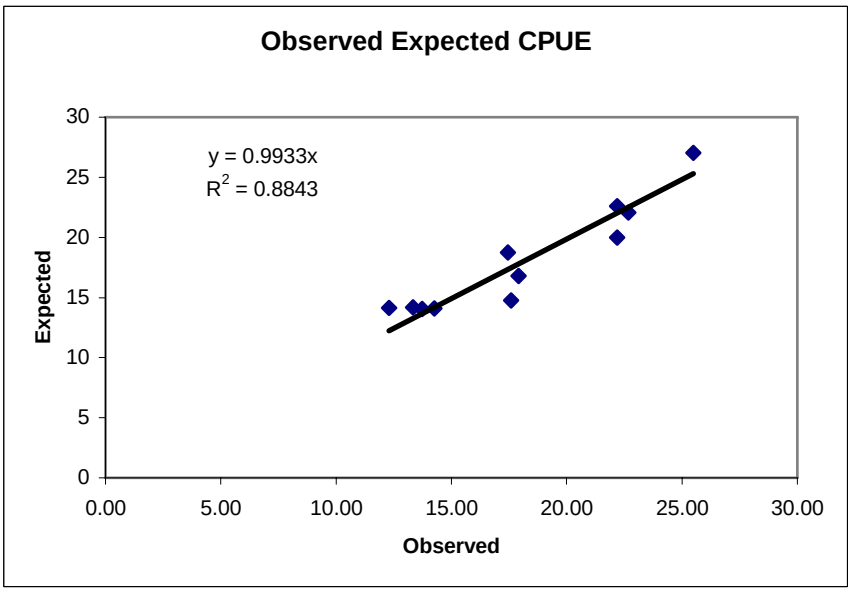


Figure 4: The model explains the observations well, as indicated by the close fit between the observed and expected CPUE index. The R^2 statistic indicates that most variation in the CPUE index (i.e. the downward trend) can be explained by the model. However, wide ranges of parameter estimates explain the observations equally well unless additional information on the productivity of this species elsewhere is incorporated.

3.6 Special Comments

The priors for the unexploited stock size and rate of increase are probably both biased upwards. Both the Pedro Bank and Caicos Bank are likely to have more appropriate conch across the shelf than St. Lucia. St. Lucia is a volcanic island resulting in much of the shelf area being significantly deeper than 50m compared to these other banks, and probably makes the stock smaller (lower B_∞)

and possibly less productive (lower *r*). Representing the prior information as probabilities has allowed the observed catch and CPUE series to correct this, since with higher population size and productivities the decline in CPUE would not have been observed. Nevertheless improved prior information based on actual conch habitat areas in St. Lucia would improve the accuracy of the assessment.

3.7 Policy Summary

- 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.

4.0 The Spiny lobster (*Panulirus argus*) Fishery of Jamaica

4.1 Management Objectives

The management objective for the spiny lobster fishery of the Government of Jamaica is "Biological sustainable use of the fishery resources in order to ensure present and future economic earnings from the fishery" (CFRAMP, 2000). There is no fishery management plan specific to lobster available to this meeting.

4.2 Status of Stock

During the present assessment of the spiny lobster the status of the stock could not be determined based on the available data at the Fisheries Division. The catch and effort data were too sparse across gears, months and fishing areas to allow any stock assessment. However, previous studies have been carried out by other researchers that indicate the possible status of the stock.

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

4.3 Management Advice

Although the state of the stock could not be determined from available data of the Fisheries Division, Jamaica has regulations which are not being enforced. Evidence from the catch and effort data collection programme indicates landings of lobster continue throughout the closed season. It is highly recommended that the Government of Jamaica pay special attention in ensuring that the current closed season is enforced. Possible considerations to enhance the effectiveness of the closed season are to prohibit the sale, processing and importation of lobster during this time. These measures would probably not only reduce the harvest of small lobsters, but increase the chance of detecting recruitment from the catch-effort data necessary for stock assessment.

It is also recommended that the Government of Jamaica pay more attention to this fishery and put in place the data collection activities that are required so that the current status of the stocks can be determined.

4.4 Statistics and Research Recommendations

4.4.1 Data Quality

Catch and effort data are gathered from various landing sites along mainland Jamaica (where lobsters are fished from northern and southern shelf, as well as fishing grounds in close proximity to the south island shelf) and the Pedro Bank for the period 1995 to 2007. Where they are collected, the data are reliable and accurate, but suffer from low sampling levels and gaps in the collection periods. Length frequency data were also available from various landing sites along the southern coast but few from the major fishing ground of Pedro Bank.

In an attempt to apply various assessments to the available data, significant gaps were identified. In some cases landings were reported with no effort. This could be as a result of data collectors omitting to ask that question or the providers of the data were reluctant. Consequently, some data from an already sparse data set had to be discarded. While the data are probably adequate for

estimating statistics such as total catch, they are inadequate for determining catch rates by gear, month and location which are required for stock assessment.

4.4.2 Research

The sparse data collection resulting from the attempt to cover both the mainland and Pedro bank, suggests that more intense specific monitoring should be carried out on a single lobster fishery to determine the details necessary for a full assessment, as well as the seasonal patterns in landings, estimates of current fishing mortality and so on. 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.

The Fisheries Division has problems monitoring the wide range of fisheries undertaken in Jamaica. Any monitoring that can be undertaken by the fishing industry itself, notably the processing sector, would greatly enhance the ability to manage this fishery. One aim of such monitoring would be to establish a conversion factor from carapace length to tail length, so that a minimum tail length could be established which is consistent with the minimum carapace length.

The Fisheries Division is in the initial stage of carrying out a Lobster Casita Project which seeks to investigate a more efficient and sustainable system for the lobster fisheries. On a cautionary note, the Division should consider exerting its energy and resources into the enforcement of the regulations already in place for lobsters (especially minimum size and closed season) which will improve the status of the resources and also establish a more accurate recruitment index.

4.5 Stock Assessment Summary

No stock assessment was carried out as the available data were insufficient. However, exploratory data sought to identify any seasonal patterns in the CPUE indices as a preliminary to developing a recruitment index and monitoring trends in mean size. This assessment has resulted in the same results and conclusions of the work conducted at the WECAFC Spiny Lobster meeting in 2006 (FAO 2007), with additional corrections and verifications.

Recruitment Index

In an attempt to identify and establish a recruitment index, the available catch and effort data submitted for period 1995-2007 were examined. The total monthly CPUE was calculated by summing the catch and effort separately across the years and then dividing the summed catch by the summed effort. The mean CPUE by month (Figure 1) suggests that there may be a decline in catch rate from June to December. This may be the result of recruitment occurring during the closed season increasing the stock size at that time. However, the data are very noisy and sparse so any further attempt to separate out different effects was found to be impossible.

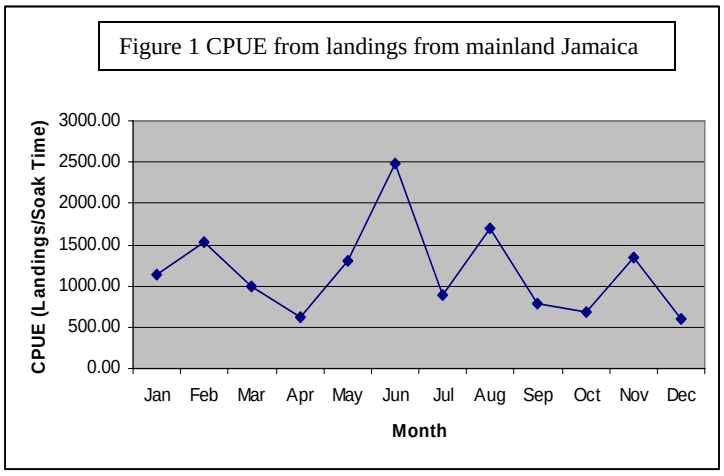


Figure 1: Monthly catch per unit effort (CPUE) for mainland Jamaica. The highest CPUE seems to occur in the middle of the year during and after the closed season.

Trends in mean Carapace Length (CL)

The length frequency data were used to examine changes in length and gear selectivity.

The lowest mean carapace length was observed in August which lies at the margins of the present closed season (Figure 2). The results are consistent with, but cannot confirm, recruitment during the closed season. The sizes confounded with location and gear type. The hookah gear landed the largest lobsters while skin divers landed lobsters often below the minimum size (Figure 3). However, separation of the data simultaneously by gear and month or location significantly increased errors in the estimated means (Figure 4) or prevented estimation.

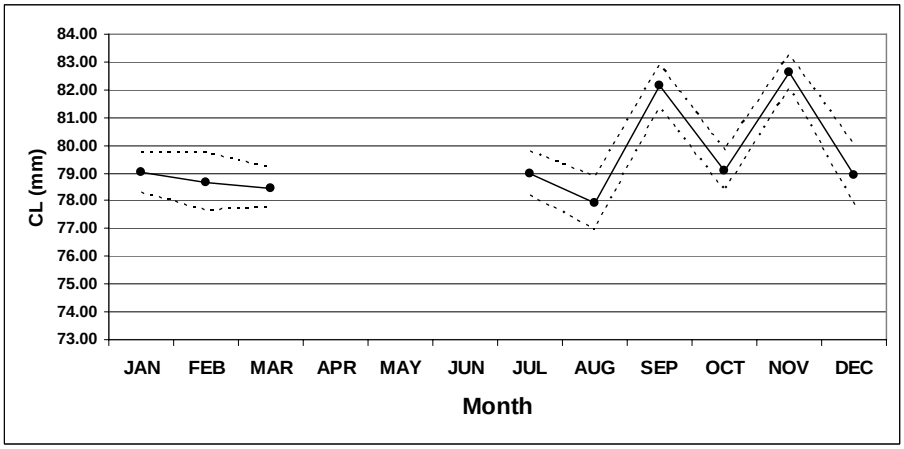


Figure 2: Seasonal differences in mean carapace length together with 95% confidence intervals for south Jamaica.

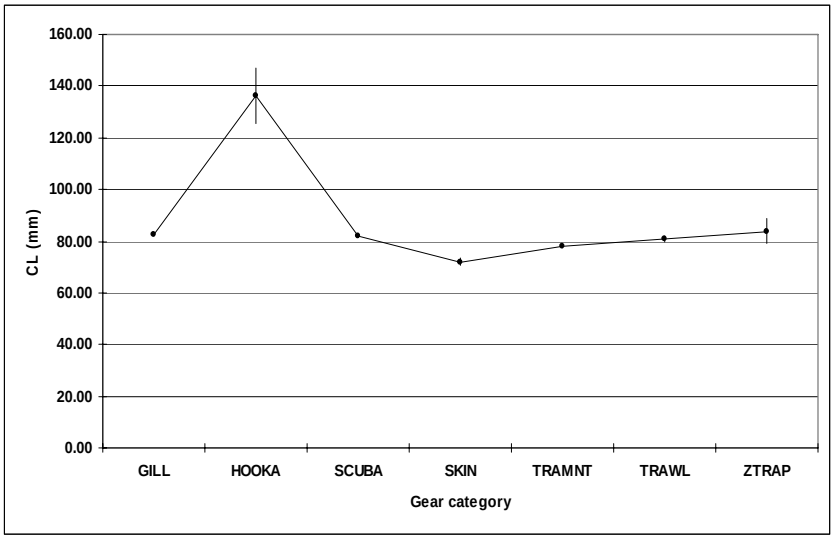


Figure 3: Mean carapace by gear for the Southern shelf and Pedro Bank combined, with 95% confidence intervals. Hookah, presumably operating in deeper water, landed the largest animals. Skin divers landed the smallest lobster, often below the minimum size (76mm CL).

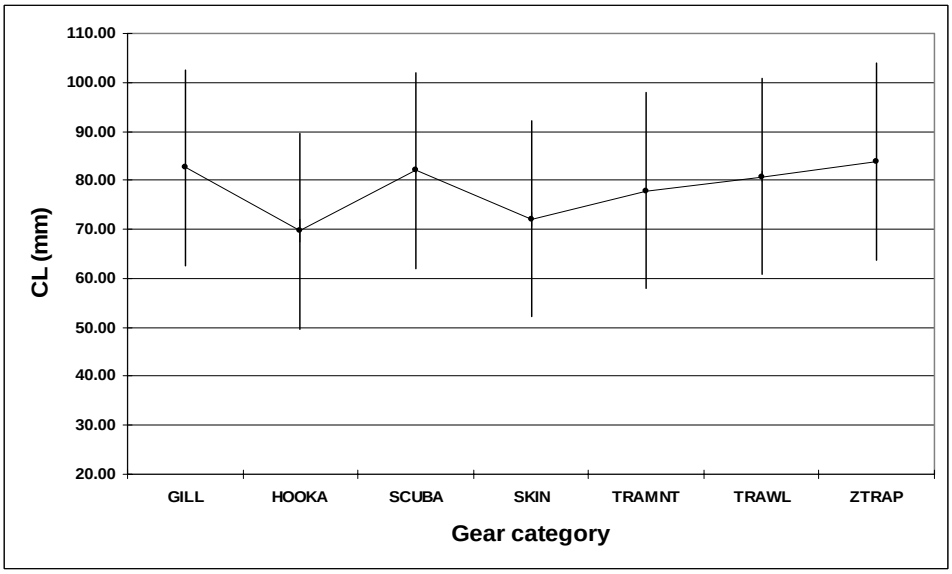


Figure 4: Mean carapace length by gear for the Southern shelf only, with 95% confidence intervals. The much smaller number of data makes it impossible to determine differences between gear types.

4.6 Special Comments

None.

4.7 Policy Summary

The goal to be achieved from proper management of the marine fisheries of Jamaica is the sustainable use of fisheries resources for the maximum benefit of the people of Jamaica. The

objective for lobster is to restore/rehabilitate the fishery through protection of lobsters and protection and enhancement of their habitat.

There is need for gear restrictions, effort reduction, and enforced closed season and co-management arrangements. There is already legislation in place to prevent the taking of berried lobsters, and which prohibits the landing of lobsters during the close season. However, monitoring data suggest that these regulations are not enforced.

4.8 References

CFRAMP. (2000). Jamaica National Marine Fisheries Atlas. *CARICOM Fishery Report.* No. **4**.

FAO. (1993). Marine fishery resources of the Antilles. *FAO Fishery Technical. Paper.* No. **326**. Rome.

FAO. (2007). Report of the fifth regional workshop on the assessment and management of Caribbean spiny lobster, Merida, Yucatan, Mexico, 19-29 September, 2006. *FAO Fisheries Report.* No. **826**.

Kelly, R. (2003). Report on the spiny lobster fishery in Jamaica. In Report of the Second Workshop on the management of Caribbean spiny lobster fisheries in the WECAFC Area, p 100-106, *FAO Fisheries Report* No.**715**.

II. REPORT OF THE SHRIMP AND GROUNDFISH RESOURCE WORKING GROUP

Chairperson: Suzuette Soomai, Trinidad and Tobago
Rapporteurs: Yolanda Babb, Suriname (Shrimp)
Colletta Derrell, Guyana (Shrimp)
Pamila Ramotar, Guyana (Groundfish)
Consultants: John Hoenig (Virginia Marine Institute of Science)
Clay Porch, Todd Gedamke (US National Marine Service, Miami Laboratory)
Lynn Waterhouse (Virginia Marine Institute of Science)
Absent: Ms Lara Ferreira (Trinidad and Tobago) who was invited by the CRFM to assist in a technical capacity with the shrimp assessments.

A. OVERVIEW

1.0 Review of Inter-sessional activities

1.1 Shrimp

At the Second CRFM Scientific Meeting in 2006, Guyana conducted an assessment for the seabob (*Xiphopenaeus kroyeri*) and it was recommended that during the inter-sessional period a biological sampling programme be initiated to collect additional information to validate the 2006 assessment. It was also recommended that additional computerization of available sampling trip data should be completed. These activities were not completed due to insufficient data entry and field data collection staff.

It was recommended that at the Third CRFM Scientific Meeting in 2007, that Guyana and Suriname could conduct a joint assessment for *Farfantepenaeus subtilis* and *F. brasiliensis* similar to the assessment that was completed for Trinidad and Tobago and Venezuela at the Second CRFM Scientific Meeting. The inter-sessional meetings that were recommended to prepare for this were not scheduled. It was discussed at this meeting that Guyana's seabob (*Xiphopenaeus kroyeri*) is being considered a priority fishery for assessment since it now contributes significantly to the total annual landings and exports of marine products.

1.2 Groundfish

At the Second CRFM Scientific Meeting, it was recommended that the whitemouth croaker, *Micropogonias furnieri*, be added to the list of species for future assessment. The data preparation for this species was not completed by Trinidad and Tobago during the inter-sessional period due to time constraints in filling data gaps and data for the species were not available for the meeting for assessment.

1.3 Management Developments

In Guyana, a Fisheries Advisory Committee (FAC) was formed in 2007.

In Suriname, the Ministry of Agriculture, Animal Husbandry and Fisheries has prepared an Agricultural Sector Plan for 2006 – 2010 that includes projects for the fisheries sector namely updating of legislation, establishment of a Fisheries Inspection Institute. In January 2007, Suriname implemented a vessel monitoring system (VMS) using the ARGOS system in an

attempt to enforce the fishing zone regulations for fish trawlers. A designated landing site is currently being constructed for the artisanal fisheries in Paramaribo.

In Trinidad and Tobago, a new Marine Fisheries Policy was completed in 2007 and a new Fisheries Management Act to repeal the Fisheries Act of 1916 has been prepared in 2006 and is awaiting Cabinet approval.

2.0 General Review of Fisheries Trends throughout the Region

Suriname, Guyana and Trinidad and Tobago have substantial fisheries for the shrimp and groundfish resources of the Brazil-Guianas Continental Shelf. These resources are considered to be shared by all the countries on the continental shelf. In addition to these countries, Jamaica has a small shrimp fishery in the Kingston Harbour. Assessments have been conducted in the past under the FAO/WECAFC ad hoc Working Group on Shrimp and Groundfish Resources of the Brazil-Guianas Shelf and the CRFM. Species that have been assessed were the five shrimp species (*Farfantepenaeus notialis, F. subtilis, F. brasiliensis, Litopenaeus schmitti, X. kroyeri,*) and the main groundfish species (*Macrodon ancylodon, Cynoscion virescens,Cynoscion jamaicensis, Micropogonias furnieri*, *Lutjanus synagris, Nebris microps*). Results of assessments show that many of these species are fully to over-fished.

3.0 Review of Fisheries to be Assessed

3.1 Species and data available

Shrimp

Five species, *Farfantepenaeus notialis, F. subtilis, F. brasiliensis, X. kroyeri, Litopenaeus schmitti* were listed for assessment (CSM 2007: Document 1-A).

Guyana: *Xiphopenaeus kroyeri* (seabob), *Farfantepenaeus notialis* (pink shrimp), *F. brasiliensis* (pink spotted shrimp). Available data are monthly catch weight per size category collected at processing plants over the period 1998 – 2005.

Suriname: *Farfantepenaeus brasiliensis, F. subtilis* (brown shrimp). Available data are monthly catch in numbers and catch in weight (heads on and heads off), recorded by market category over the period 2000 – 2005.

Groundfish

Four species, *Lutjanus synagris*, *Macrodon ancylodon Cynoscion virescens, Micropogonias furnieri* were listed for assessment (CSM 2007: Document 1-A). Data for *L. synagris* and *M. furnieri* were not available at this meeting.

Guyana: *Cynoscion virescens* (sea trout)*, Macrodon ancylodon* (bangamary)**,** *Nebris microps* (butterfish).

Cynoscion virescens - catch and effort data were available from the industrial trawlers and artisanal gillnets for the period 1996 to 2006. Length data were collected for gillnets, seines (Chinese, pin) and cadell lines from 1996 to 2006 and from trawlers for 1998 to 2006.

Macrodon ancylodon - catch and effort and length frequencies for the period 1995 to 2006 from industrial trawlers and artisanal gillnets and Chinese seine.

Nebris microps - This species was not previously included in the list of species to be assessed. However, catch and effort and length frequencies for the period 1995 to 2006 were available at this meeting from industrial trawlers, artisanal gillnets and Chinese seine.

4.0 Review of Management Objectives and Management Strategies

Management objectives have been outlined in the national policy documents of the respective countries. Overall management objectives are to:

- Sustainably manage the resources,
- Maximise the long-term production of shrimp and groundfish by achieving MSY
- Contribute to employment, generation of foreign currency; maximisation of exports.

5.0 Fishery Data Analyses and Assessments

5.1 Groundfish

The sea trout fishery in Guyana

An assessment was completed to determine changes in the stock status based on three types of analyses: (a) estimation of total mortality rate using information on mean length (Gedamke and Hoenig 2006); (b) estimation of total mortality using length-converted catch-curve analyses and (c) estimation of trends in abundance based on standardized CPUE information.

The bangamary fishery in Guyana

A preliminary assessment was conducted to determine trends in the fishery from standardized CPUE indices generated using the general linear model (GLM).

The butterfish fishery in Guyana

A preliminary review of the available data was initiated to determine trends in the fishery from standardized CPUE indices from GLM. A report was not written for presentation.

5.2 Shrimp

The seabob fishery in Guyana

Trends in recruitment were observed by analyzing the CPUE by numbers of shrimp for the commercial classes for each month over the period 1998 – 2001. This was used to determine growth and to determine an appropriate closed season to protect recruitment of *X. kroyeri*.

The penaeid shrimp fishery in Suriname

Monthly catch in number per unit of effort for both species were used to establish patterns of yearly recruitment and to determine an approximate growth curve. Knowledge of recruitment and growth was used to recommend a closed season to protect recruitment of *P. subtilis.*

6.0 Recommendations

6.1 General recommendations (all items are considered high priority)

1. Co-operation among countries
   - The species being assessed under this Working Group are shared by the countries on the Brazil-Guianas Continental Shelf. Future assessments should include data from other countries that are not members of the CRFM (Venezuela, French Guiana and Brazil). Venezuela was invited to attend the meeting but was unable to attend. The Working Group aims to conduct joint analyses for shrimp and groundfish between countries on the

Brazil-Guianas continental shelf. It is recommended that CRFM enter into arrangements with these other states to facilitate their participation and exchange of data at future Scientific Meetings. It is also recommended that consideration be given to networking with the FAO/WECAFC ad hoc Working Group on Shrimp and Groundfish Resources of the Brazil-Guianas Continental Shelf.

2. Computerization of data
   - Both Suriname and Guyana indicated that there is a considerable amount of biological and catch and effort data which have been collected and are still to be computerized. It is recommended that the CRFM can assist countries with this activity through the provision of resources in the respective fisheries departments to complete these activities in the inter-sessional period.

3. Availability of data
   - Participants at CRFM Scientific Meetings need to bring all available information that may assist with the completion of assessments. In some cases national data were available within the Fisheries Department but the country participants were not allowed access to the information prior to the meeting.

4. Observer Programmes
   - The observer programmes for the offshore trawl fleets need to be reinstated/established in the region to obtain information on fishing operations and total catches, including discards of commercial species, onboard vessels.

5. Data Collection
   - On the respective national levels, all attempts must be made to obtain more representative statistical coverage of gear. Current sampling programmes are generally subject to severe staff constraints which negatively impact the data collection programmes both in terms of the volume of data and the continuity over time.

6. Data Documentation
   - Considerable time was still spent trying to understand the data at this meeting and it is recommended that improving the data sets should be addressed in the inter-sessional period. There is still the need to have more communication between the consultants and the species rapporteurs in the inter-sessional period. A standard format for data files must be decided on to facilitate easy interpretation of data at the meeting and documentation needs to be improved.

6.2 Specific Recommendations

Groundfish

1. Species to be Assessed
   - The list of groundfish species for assessment should be expanded to include additional species that are common to the countries exploiting the resources of the Brazil-Guianas Continental Shelf. Specifically, it is recommended that *Cynoscion acoupa, Nebris microps* and *Micropogonais furnieri* should be included in the list of species to be assessed at next year's meeting. A preliminary analysis of *N. microps* was initiated at this meeting and should be finalized at next year's meeting.

2. Collection of Otoliths

- Collection of age data from otoliths is recommended to supplement length data and to provide more reliable growth parameters for fish species for use in analyses. This activity should be given high priority within countries of the Working Group.

Shrimp

1. Species to be Assessed

- A joint analysis for the seabob fishery should be conducted by Suriname and Guyana at the next Scientific Meeting.

2. Effort Data

- For the seabob fishery in Guyana, effort data need to be extracted from logbooks kept at the shrimp processing plants.

3. Biological Data

- For shrimp in Guyana and Suriname, length frequency data need to be collected.

4. Economic Data

- For Guyana and Suriname, economic data such as price per pound for the various market categories should be documented over the course of a year in the first instance.

B. FISHERIES REPORTS

1.0 Guyana Seatrout (*Cynoscion virescens*) Fishery

1.1 Management Objectives

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

- To maintain the stock at all times above 50% of its mean unexploited level.
- To maintain and improve the net income per fisher at a level above the national minimum desired income.
- To include as many of the existing participants in the fishery as is possible given the biological, ecological and economic objectives listed above.

1.2 Status of Stocks

The catch per day of trawlers has fluctuated with little trend since 1996, suggesting that the recruitment of young seatrout to the fishery has generally remained constant during the time (figure 1). Results of the assessment suggest a high fishing mortality rate, particularly on younger fish, which may exceed the level that maximizes the yield per recruit (figure 2). The catch per day from gillnet vessels has declined in recent years, which suggests that too many young fish are being caught by the trawl and other inshore fisheries to sustain the adult population of seatrout. This condition, if allowed to continue, may lead to a decline in recruitment.

1.3 Management Advice

The adult seatrout population appears to have been reduced to levels well below 50% of the unexploited level, indicating that the first management objective above has not been met. There were data gaps and other uncertainties with regards to the growth parameters for seatrout that influenced the ability of the assessment to give good results. In view of this, more specific management advice cannot be given at this time. It is therefore recommended that the precautionary approach be adopted and the harvesting of seatrout should be reduced.

1.4 Statistics and Research Recommendations

1.4.1 Data Quality

- Catch and effort data quality needs to be improved. The on-going collection of catch, effort, and size frequency data should be expanded to cover all months, gear types and areas where fishing is occurring (this information is necessary to develop total catch and CPUE series).
- This assessment used catch and effort data from 1996 – 2006. However catch and effort data were collected prior to 1996. These data records from the earlier surveys need to be reviewed and computerized, so that longer time series may be examined which will result in more informative assessments.

1.4.2 Research

- Ototliths (ear bones) and scales should be collected from a sample of fish for a feasibility study on determining age. Assuming that this is successful, it will be possible to better characterize what ages are being exploited and to develop a more suitable growth curve.

- The observer programme for the trawl fleet needs to be reinstated to obtain information on fishing operations and total catches, including discards of commercial species, onboard vessels.

- There should be collaboration with countries such as Suriname, Venezuela and Brazil for stock assessments since seatrout is considered a shared stock.

1.5 Stock Assessment Summary

The analysis utilized recent (1996-2006) length and catch per unit effort (CPUE) levels for artisanal gillnet, Chinese seine and trawl fleets operating in Guyana. Biological parameters were obtained from a previous unpublished assessment in 2003 for the species and from Charlier *et al*. (2000). The assessment was based on three types of analyses: (a) a mean size model that observed growth using the length frequency information (Gedamke and Hoenig 2006); (b) length-converted catch-curve analyses and (c) standardized CPUE information.

(a) Mean size Model:
Mean lengths from the trawl samples suggested that selection of fish from as early as age 1 was common. The truncated length composition data used in this model suggest a highly exploited population. However, the exploitation rate may be somewhat over-estimated because larger fish may be able to evade the trawls and also migrate further offshore than most trawls operate. They are also somewhat uncertain owing to the lack of definitive growth parameters.

(b) Length-converted catch-curve Model:
The length frequency data from the trawl samples were converted to relative age by use of the two sets of growth parameters: those from the previous assessment (CRFM 2004) (K=0.3, Linf=90) and those from (Charlier *et al*. 2000) (K=0.39, Linf=95.8).

The results indicated mortality rates that were similar to the values estimated by the mean length method using the same data and growth parameter estimates.

(c) Standardised catch per day.
Catch per day was standardized to account for unbalanced and incomplete sampling across months, regions and years by use of the general linear model (GLM). The standardized trawl and gillnet catch per day series are shown in Figure 1. The results suggest that the availability of younger fish to the trawls has remained fairly constant since 1998 except for a spike in 2005. However, the availability of larger fish (estimated at age 5 and older) to the gillnets appears to have decreased after 1999. This suggests that growth overfishing is occurring (where too many sea trout are caught before they have had a chance to grow to an optimal size), but not necessarily recruitment overfishing (since there is no evidence that the abundance of young animals has declined despite the declining availability of larger fish).

1.6 Special Comments

Alternative data sources for monitoring gillnets need to be developed. Either samples need to be aged using hard parts, such as scales or otoliths, or more detailed catch and effort monitoring needs to be conducted.

Trawl length frequency provides useful information on the stock and therefore length frequency sampling from trawl should be increased.

1.7 Policy Summary

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

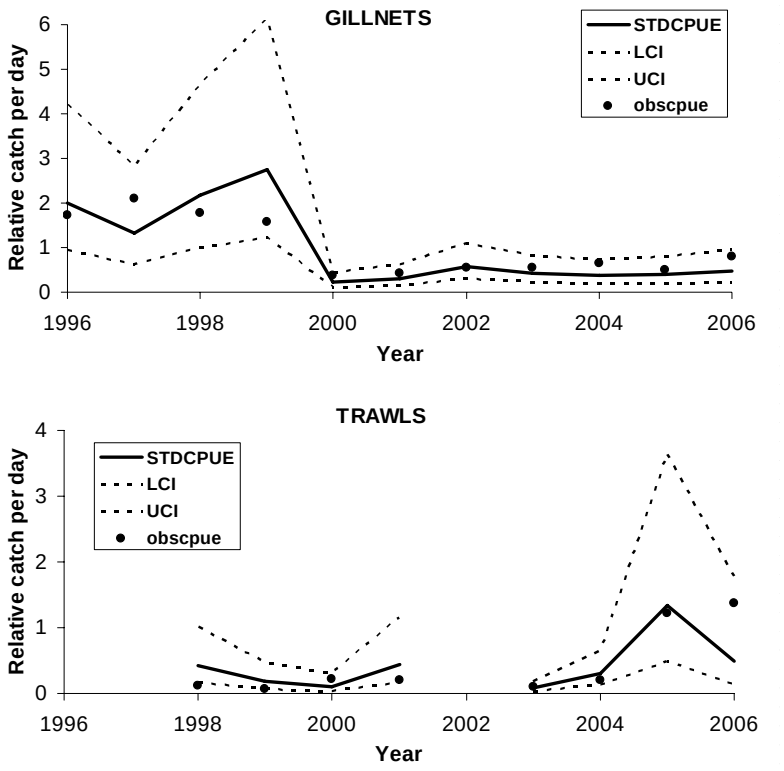


Figure 1: Standardized catch per day for gillnets (top) and trawls (bottom). The two series were normalized to have the same scale by dividing the annual values for each series by the average for that series. STD CPUE = standardized catch per unit effort; dashed lines indicate 95% confidence intervals; obscpue = observed catch per unit effort.

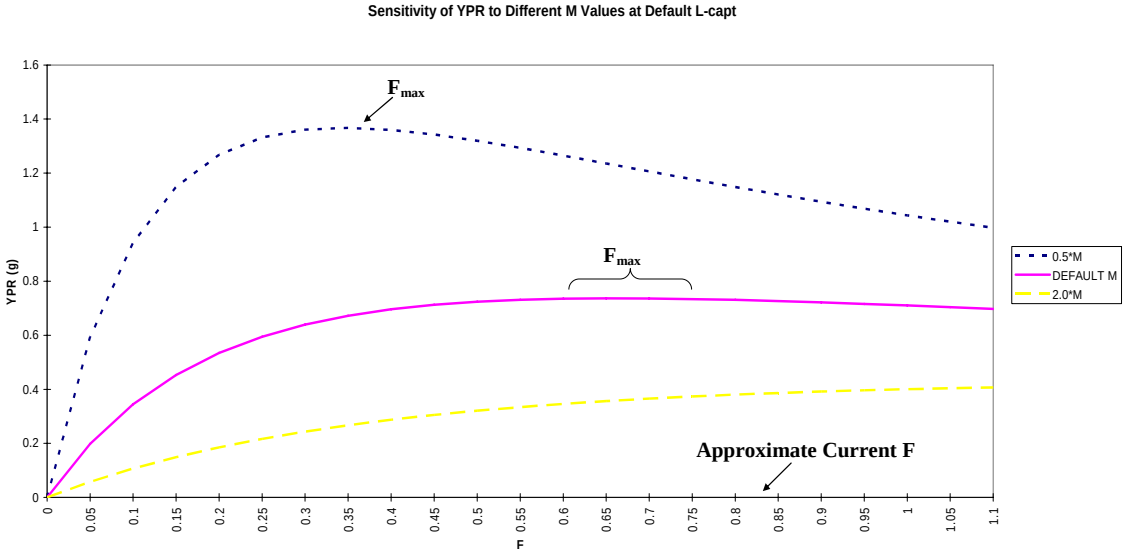


Figure 2: Yield per recruit analysis for sea trout in Guyana using parameters used from the current analysis (K= 0.3938, L_{inf} = 95.8, M= 0.59 yr^{-1}, a = 0.0000118, b= 3.0, Z = 1.42). M was varied by multiplying by 0.5 or 2.0.

1.8 References

Charlier *et al*. (2000). Report of the National Workshop on Shrimp and Groundfish on the Brazil-Guianas Shelf, Belem, 24 May – 10 June 1999. *FAO Fisheries Report* No. **628**. Rome, FAO 2000. 206 p.

CRFM (Caribbean Regional Fisheries Mechanism). (2004). Report on the Shrimp and Groundfish Workshops Conducted in Guyana (November 2003), Belize (December 2003) and Trinidad and Tobago (2004). 93 p.

Gedamke, T., and Hoenig, J. M. (2006). Estimating Mortality from Mean Length Data in Non-equilibrium Situations, with Application to the Assessment of Goosefish (*Lophius americanus*). *Transactions of the American Fisheries Society*. **135**:476-487.

2.0 Guyana Bangamary (*Macrodon ancylodon*) Fishery

2.1 Management Objectives

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

- To maintain the stock at all times above 50% of its mean unexploited level.
- To maintain and improve the net income per fisher at a level above the national minimum desired income.
- To include as many of the existing participants in the fishery as is possible given the biological, ecological and economic objectives listed above.

2.2 Status of Stocks

The recent reductions in the standardized abundance indices for gillnet in 2004 and Chinese seine in 2006 are cause for concern. However, it is unclear whether these trends continue. The data were insufficient to clearly determine the status of the stock but the recent decline in gillnet catches is cause for concern.

2.3 Management Advice

It is recommended that reductions in trawling be considered to maintain higher yields of bangamary**.** There were data gaps and other uncertainties that influenced the ability of the assessment to give good results. In view of this, more specific management advice cannot be given at this time. Data collection needs to be improved and, pending this, the precautionary approach needs to be adopted.

2.4 Statistics and Research Recommendations

2.4.1 Data Quality

- Catch and effort data quality needs to be improved. The on-going collection of catch, effort, and size frequency data should be expanded to cover all months, gear types and areas where fishing is occurring (this information is necessary to develop total catch and CPUE series).
- This assessment used catch and effort data from 1995 to present however catch and effort data were collected prior to 1995. These data records from the earlier surveys need to be reviewed and computerized, so that longer time series may be examined which will result in more informative assessments.

2.4.2 Research

- Ototliths (ear bones) and scales should be collected from a sample of fish for a feasibility study on determining age. Assuming that this is successful, it will be possible to better characterize what ages are being exploited and to develop a more suitable growth curve.

- The observer programme for the trawl fleet needs to be reinstated to obtain information on fishing operations and total catches, including discards of commercial species, onboard vessels.

- Collaborate with countries such as Suriname, Venezuela and Brazil for stock assessments since bangamary is considered a shared stock.

2.5 Stock Assessment Summary

The analysis utilized recent (1996-2006) length and catch per unit effort (CPUE) levels for artisanal gillnet, Chinese seine and trawl fleets operating in Guyana. Catch per day was standardized to account for unbalanced and incomplete sampling across months, regions and years by use of the general linear model (GLM). The standardized trawl Chinese seine and gillnet catch per day series are shown in Figure 1.

The results suggest that the availability of younger fish to Chinese seines and slightly older fish to the trawls has fluctuated with little trend since 1996. In both gears the highest catch per day on record occurred in 2005, but these estimates were based on few samples and are not significantly different from the values in some of the earlier years. A similar trend was noticed for seatrout, suggesting the upswing may be related to mutually favourable environmental conditions. The availability of larger fish to gillnets appears to have also fluctuated over the time series; however a substantial decrease was estimated for 2004.

Data for later years are needed to confirm whether the results represent a trend or simply an anomalous year. There may be some concern that growth overfishing is occurring (too many bangamary are caught before they have had a chance to grow to an optimal size), but not necessarily recruitment overfishing (there is no evidence that the abundance of young animals has declined despite the 2004 reduction in the availability of larger fish). It was noted, that the time series does not extend back to the inception of the fishery and therefore it is impossible to tell whether recruitment has been reduced relative to unfished levels.

2.6 Special Comments

Alternative data sources for monitoring the gillnet fishery need to be developed. Either samples need to be aged using hard parts, such as scales or otoliths, or catch and effort monitoring needs to be conducted.

Trawl length frequency data provide useful information on the stock. Length frequency sampling from the trawl fishery should be increased.

2.7 Policy Summary

To manage, regulate and promote the sustainable development of Guyana’s fishery resources for the benefit of the stakeholders in the sector and the nation as a whole.

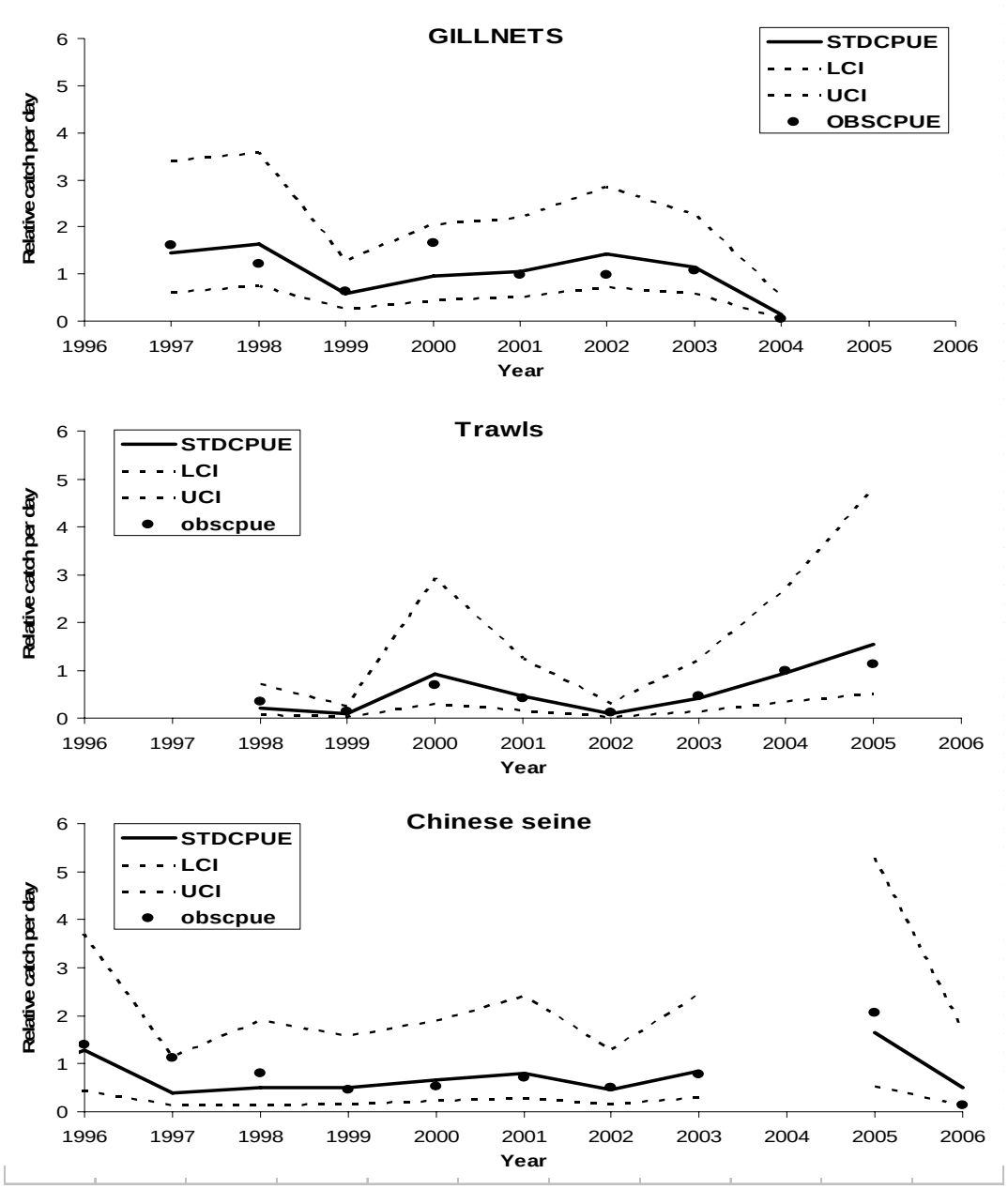


Figure 2: Standardized catch per day for gillnets (top), trawls (middle) and chinese seine. The three series were normalized to have the same scale by dividing the annual values for each series by the average for that series. STD CPUE = standardized catch per unit effort; dashed lines indicate 95% confidence intervals; obscpue = observed catch per unit effort.

3.0 Guyana Seabob (*Xiphopenaeus kroyeri*) Fishery

3.1 Management Objectives

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

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

3.2 Status of Stocks

The current data are not sufficient to fully determine the status of the stock. However, there is continuing concern that the seabob fishery is fully- to over- exploited. In last year's assessment, it was noted that the mean size of animals has decreased over the years suggesting increasing fishing mortality (Figure 1).

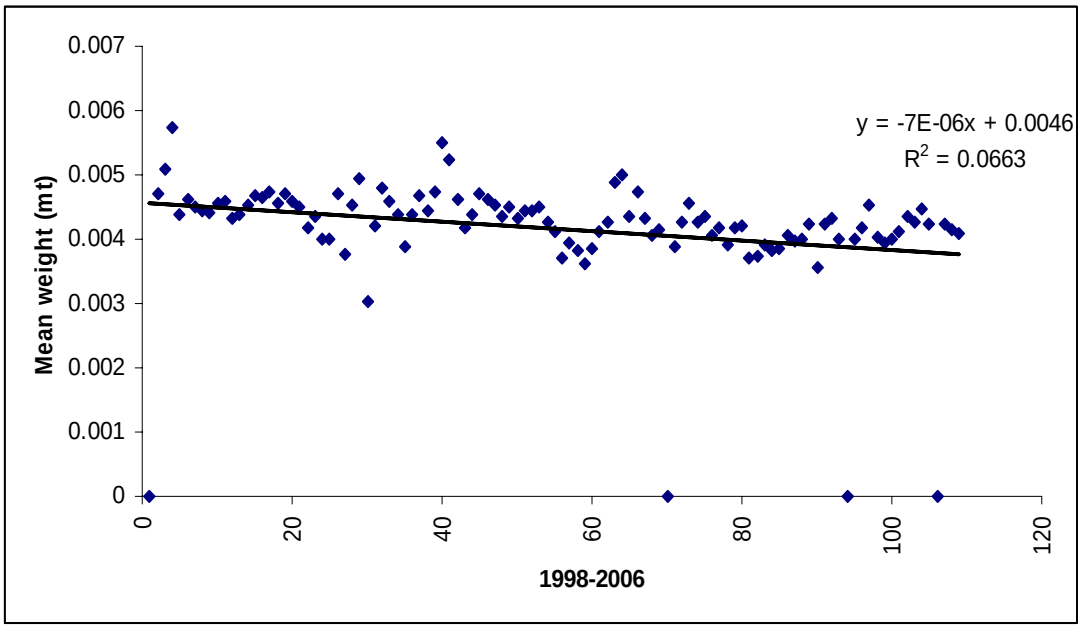


Figure 1: Plot of mean weight of the shrimp landed in each month versus month, from 1998 to 2006. A declining trend over years in mean weight is consistent with increasing fishing mortality leading to fewer shrimp reaching large size. Data for 2006 appear rather flat but at a low mean body size.

3.3 Management Advice

Studies need to be conducted to determine the effectiveness of the current closed season from September – October which has been decided on by members of the trawler association since 2003. This current study indicates that the current closed season occurs at the least effective time for reducing fishing mortality and for protecting recruitment. It is recommended that the closed season be placed in May to protect the pulse of recruitment until it reaches the next market category in June.

3.4 Statistics and Research Recommendations

3.4.1 Data Quality

1. Data on length frequencies need to be collected to be able to determine seasonal changes in size, sex and maturity compositions, and to determine growth rates. The landings by market category are too broad to enable determination of growth, recruitment patterns and appropriate placement of the closed season.

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

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

3.4.2 Research

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

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

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

3.4.3 Management

Further scientific studies on the seabob fishery need to be conducted to determine the most appropriate period in which to implement a closed season. The results of these studies will be incorporated into national regulations and should be included in the granting of licenses.

3.5 Stock Assessment Summary

Because a closed season was enacted beginning with 2002, only the data from January 1998 to December 2001 was used in this analysis to prevent a bias from the effects of the closed season. Trends in recruitment were looked for by analyzing the CPUE by numbers of shrimp for the commercial classes for each month averaged over the time span. The CPUE was then used to create an average $US per unit of effort (1 unit of effort = 1 boat-day) for all the months. The total landings and market values for the commercial classes were used to establish the monetary value of the fishery each month.

The value of the landings peaks in June (Figure 2). September has the lowest value of the landings and October is the fourth lowest month. The maximum value of the catch per vessel per day peaks in April (Figure 3) and the lowest CPUE occurs in October with September having the third lowest value.

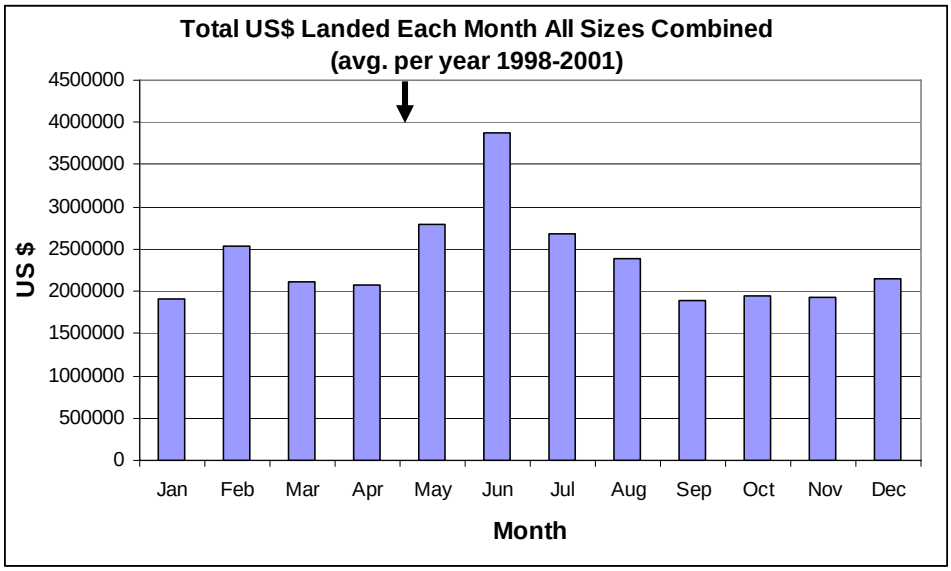


Figure 2: The total US$ landed each month (all sizes combined). The data from January 1998 to December 2001 were combined and averaged. The arrow over the month of June indicates this month has the highest sales value.

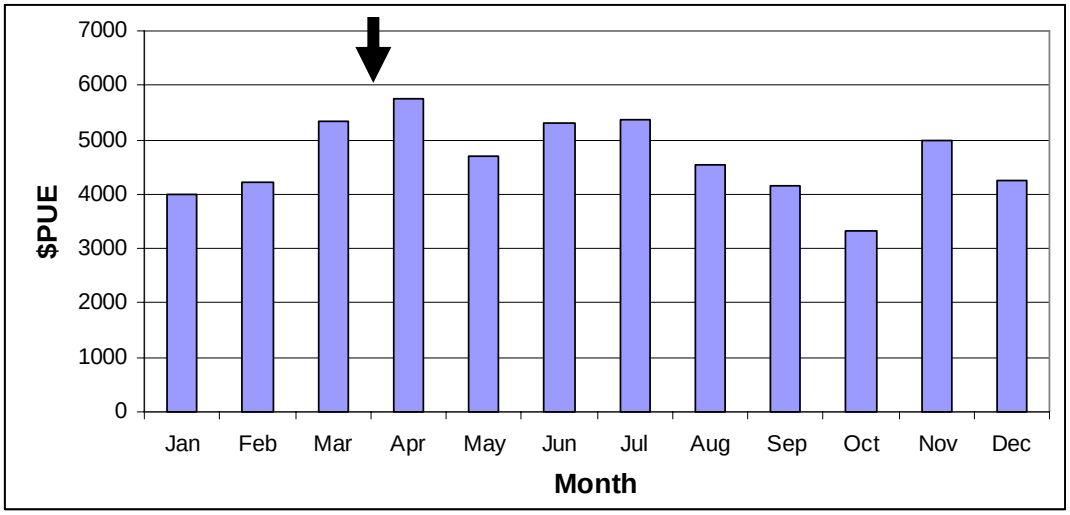


Figure 3: Average US$ per boat day earned each month in the years 1998 to 2001.

The CPUE for the commercial landings shows a peak of recruitment in the smallest size category (300/500 tails/lb) in May (Figure 4). This recruitment can be followed into the next market category (200-300 tails/lb) in June (Figure 5).

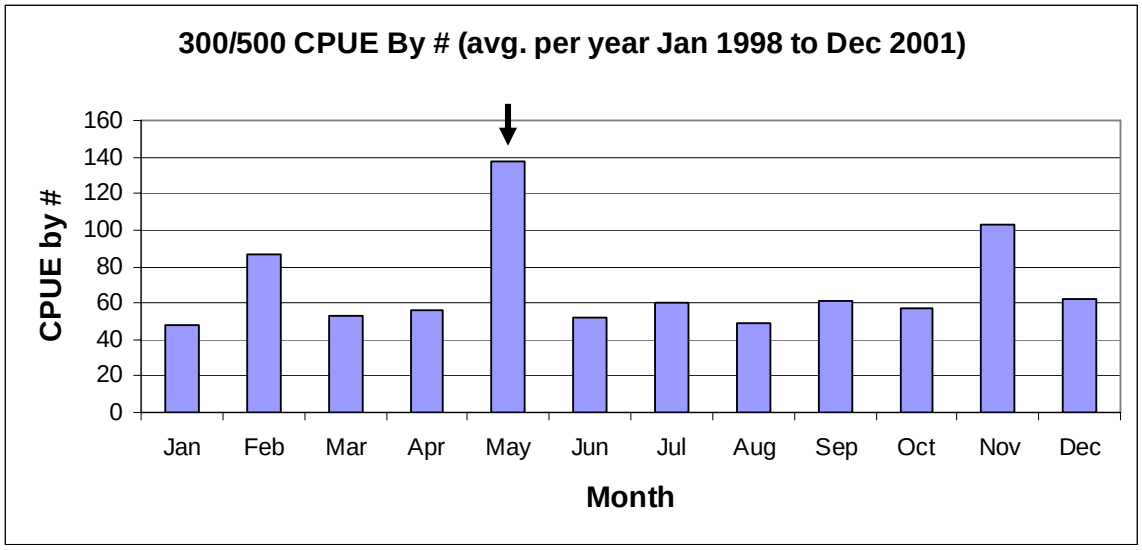


Figure 4: Trends in CPUE by number for commercial size 300-500 tails/lb by month of the year.

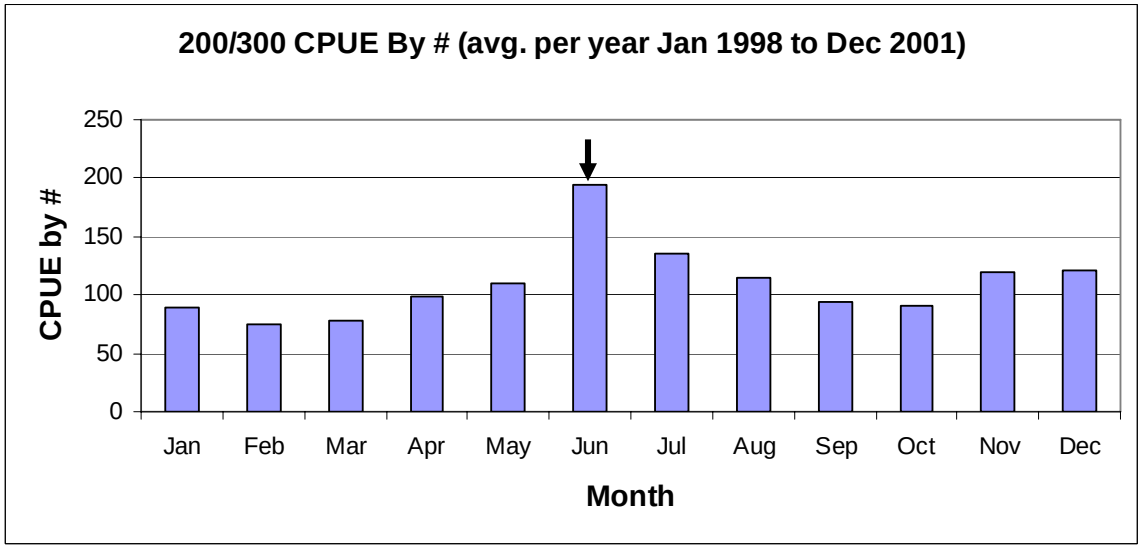


Figure 5: Trends in CPUE by number for commercial size 200-300 tails/lb by month of the year.

Thus, it appears that a seasonal closure in September-October is the least effective way to reduce fishing mortality and does little to protect against recruitment overfishing because recruitment is low during the closure. In contrast, a closure in May would protect a large pulse of recruitment and allow it to reach the next highest market category with a higher price per pound in June.

3.6 Special Comments

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

3.7 Policy Summary

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

4.0 The Shrimp (*Farfantepenaeus subtilis* and *Farfantepenaeus brasiliensis*) Fishery of Suriname

4.1 Management Objectives

- Long term conservation of the resources.
- Maximisation of the long-term production of shrimp by achieving MSY (Maximum Sustainable Yield)
- Contribution to the trade balance; generation of foreign currency; maximisation of exports.

These objectives may coincide with MSY or MEY.

4.2 Status of the Stock

In the previous assessment of these stocks by WECAFC (FAO 2000 & 2001), it was concluded that the shrimp stocks are fully exploited and the fishing mortality was high and rising. It was estimated that the fishing mortality was several times higher than F_{MSY}. Licensing data show that the fishing effort (number of vessels) has declined by 40% (Figure 1). Because of the high fishing mortality, the possibility of implementing a closed season to improve the yield was considered in this current assessment.

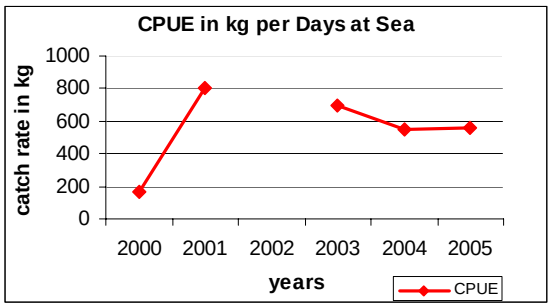


Figure 1a: Catch rate values for both penaeid species. Cpue is declining from 2001.

Figure 1b: Effort in days at sea, showing a decline since 2000 but not since 2001.

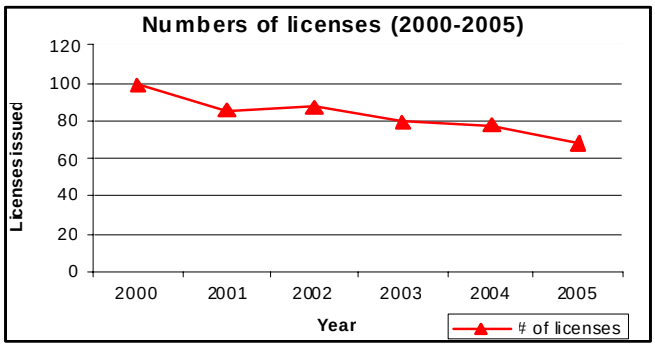


Figure 1c: The effort expressed in the number of licenses issued each year is showing a gradual decline.

4.3 Management advice

It is recommended that management measures should be taken to rebuild the stock and improve yields. One option is to initiate a closed season. There is a clear peak in recruitment of *Farfantepenaeus subtilis* in July-August and a broader peak for *Farfantepenaeus brasiliensis*

around November (Figure 2). However, because recruitment of *F. subtilis* does not coincide with that of *F. brasiliensis*, action taken to prevent fishing on the recruits in the beginning of the recruitment season of *F. subtilis* will not protect *F. brasiliensis* recruits because they are not present on the fishing grounds at that time.

It appears that the best time for a closed season is July and August to protect *F. subtilis* recruitment although it was felt that *F. brasiliensis* recruitment would be little affected. Another option is to increase the minimum mesh size of the cod-end during July and August. This mesh size regulation is more difficult to achieve.

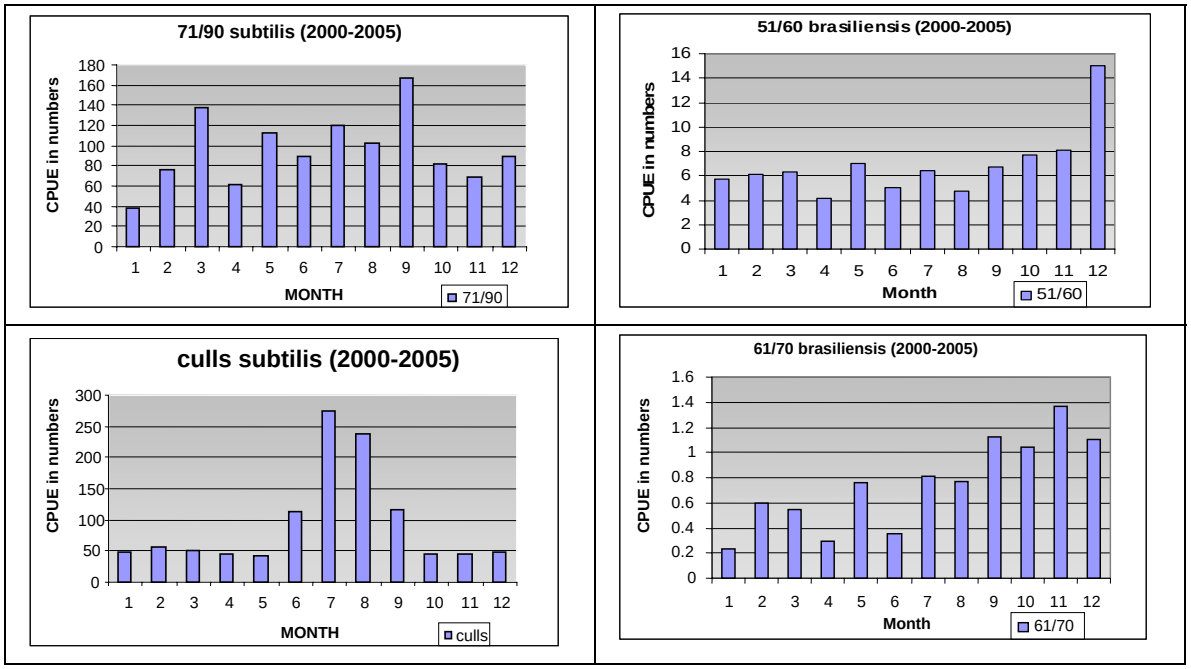


Figure 2: Catch rate in numbers for the smallest sizes of *F. subtilis* (left) and *F. brasiliensis* (right).

F. subtilis appears to recruit in July and August (lower left panel) and appears to reach the next market category by September (upper left panel). *F. brasiliensis* appears to recruit in November (lower right panel) and reaches the next largest market size by December (upper right panel).

4.4 Statistics and Research Recommendations

4.4.1 Data Quality

Only catch and effort data was available from 2000 – 2005 for *F. subtilis* and *F. brasiliensis*. Data of head-on size categories was not used, which represent only larger shrimp and not the total catch. The year 2002 was not included, because the data showed some errors.

More detailed information and data should be obtained on life history of these species; length measurements of the different size categories, growth rate estimates, factors affecting productivity and price data.

4.4.2 Research recommendations

An observer program must be implemented to collect biological data on carapace length for the various size categories of the species under study to improve assessment and clarify the best optimal period and length of a closed season.
Growth parameters must be estimated to improve assessment on these species. Growth parameters can be derived from length frequencies obtained by observers. Length data is the basis for construction of many population assessment models.

Fishing locations are also needed. These could be extracted from the Vessel Monitoring System (VMS) records. Price data of the various size categories are also needed to evaluate the consequences (benefits) of management actions.

4.5 Stock Assessment Summary

The total landings were converted in total numbers for the two penaeid species, using sampling data collected at SAIL. Catch per unit of effort (CPUE) series were calculated from 2000 – 2005 combined for each month of both species.

Graphs of catch in number per unit of effort (Figure 2) established patterns of recruitment over the year. The graphs were also used to determine an approximate growth curve (Figure 3). Knowledge of recruitment and growth was used to justify the recommendation of a closed season to protect recruitment of *F. subtilis*. The data were not sufficient to construct a growth curve for *F. brasiliensis*; more detailed length-frequency distributions for both species would enhance the ability to determine growth.

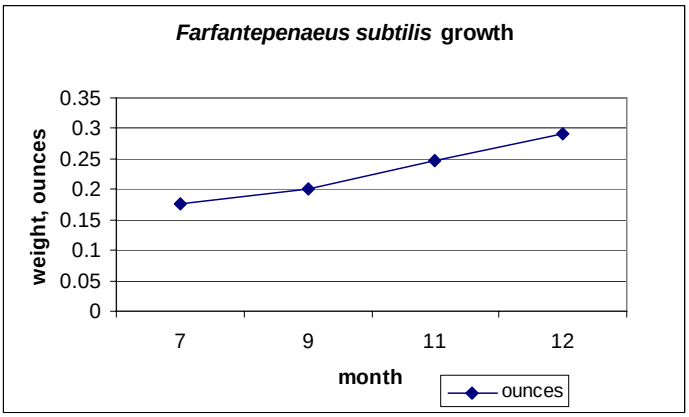


Figure 3: Estimated growth of *F. subtilis* in ounces from July to December based on following a peak in the landings data from one market category to the next over time.

4.6 Special Comments

Shrimp stocks, especially *F. brasiliensis,* are shared stocks. Therefore, joint assessment should be conducted within the Guiana – Brazil region. This was done in the past (last time, 2000) in the ad hoc working group on Shrimp and Groundfish of WECAFC. This effort should be continued through the CRFM or FAO, or both, to urge the other countries to be part of these assessments. *Xiphopenaeus kroyeri* (seabob) was introduced as a major fishery, but the impact it might have on the penaeid shrimps was not assessed yet at the regional level. This might be important, since in some countries vessels harvesting penaeid shrimp have switched to the *X. kroyeri* fishery.

4.7 Policy Summary

The role of the fisheries sector could be expressed as follows:

- Provides jobs (primary and secondary level)

  Create more qualitative job opportunities and reasonable incomes. Diversity of the sector is also important.
- Creates a balance of payment through export of fish and shrimp products
- Contribute to the GDP of the country
- Contribute to the national budget through fees and income tax.

The main policy is to manage the fish and shrimp resources in a sustainable way to generate revenues in the long term.

4.8 References

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III. REPORT OF THE REEF AND SLOPE FISH RESOURCE WORKING GROUP

Chairman: Ramon A. Carcamo (Belize)
Consultant: David Die PhD.
Maren Headley (CRFM Secretariat)

A. OVERVIEW

At the First Annual CRFM Scientific Meeting held in St. Vincent and the Grenadines in 2004, the Reef and Slope Fish Resource Working Group (RSWG) conducted some analysis on the data from the Red hind (*Epinephelus guttatus*) fishery. The data were submitted by St. Vincent and the Grenadines and the working group was composed of Yolanda Babb, Sophia Punnett, Paul Medley and Susan Singh-Renton. However, it was noted that a quantitative assessment of the fishery was not possible because of time and data constraints. Nevertheless, trends in landings and size frequency of catch were examined which provided some preliminary results.

During the Second Annual CRFM Scientific Meeting held in Trinidad & Tobago the Red hind fishery was submitted again for consideration by the Third Annual CRFM Scientific Meeting. In addition other fisheries were submitted for consideration in the analysis process *viz* the Nassau grouper (*Epinephelus striatus*) and Mutton snapper (*Lutjanus analis*) fisheries of Belize.

In this Third Annual CRFM Scientific Meeting the RSWG was then responsible to conduct analyses on data from Nassau grouper, Mutton snapper, Red hind and Lane snapper (*Lutjanus synagris*). The RSWG for the third annual meeting was composed of Dr. David Die, Ramon Carcamo and Ms. Maren Headley.

Data assessment:

1. At the beginning of the session for the RSWG the species rapporteur questioned the availability of data for the Lane snapper. It was noted that it was not clear which country expressed a desire for the Lane snapper fishery to be assessed. Therefore, due to the absence of data it was removed for analysis during the sessions.

2. The data for the Nassau grouper fishery and Mutton snapper fishery of Belize were then reviewed by the RSWG.

3. The Nassau grouper data were gathered by conducting underwater visual surveys at several spawning aggregation sites in Belize. However, due to the nature of the data set and the time series it was not possible to conduct a quantitative stock assessment. Therefore, the data were used to conduct a Multi-factor ANOVA analysis to determine any trends or variations with respect to different factors such as site, quarter, management and moon phase. Also other basic statistical descriptive analyses were possible.

4. Preliminary results were obtained that could explain some activities that occur at the spawning aggregation which will assist in better monitoring the spawning aggregation sites.

5. It was then possible to propose management and policy recommendations for the Belize Nassau grouper fishery.

6. While the Mutton snapper dataset was also analyzed it was not possible to formalize any significant recommendations due to the time limitations which the RSWG had, since the responsibilities of the Chairperson and species rapporteur were conducted by one person.

7. The recommendations coming out of the analyses presented in the species report will be submitted to the country for consideration.

B. FISHERIES REPORTS

1.0 The Nassau Grouper (*Epinephelus striatus*) Fishery of Belize

1.1 Management Objectives

The Nassau grouper fishery of Belize is the most important target species in the Deep Slope Fishes category. Belize Fisheries Department (BFD, 2004) noted the following management objectives for this fishery:

- Control fishing effort at or less than present levels;
- Maximize catches for domestic and export markets, while aiming to achieve sustainability through conservation;
- Limit fishing effort on spawning aggregations and protect areas where these species normally inhabit during the early life stages of their development;
- Promote mariculture development, particularly for the groupers and to integrate traditional fishermen into this field.

Due to the heavy commercial exploitation of the Nassau grouper, the Belize Fisheries Department in 2002, declared 11 aggregation sites as protected areas, these sites were also previously considered as multi-species aggregation sites (Paz and Grimshaw, 2001). In addition, a Belize Spawning Aggregation Working Group (SPAG) was established for the specific task of monitoring these 11 spawning sites.

1.2 Status of Stocks

The Nassau Grouper (*Epinephelus striatus*) is the second most commonly caught, but and the most valuable finfish in Belize. However the catches have dropped considerably (BFD, 2004). Caye Glory was once Belize's most productive grouper bank, where catches reached 2 tons per day in the late 1960's. Production significantly declined over the last few decades as a result of continuous and intensive fishing at the site (Craig, 1969; Paz and Grimshaw, 2001; Sala *et. al.*, 2001). Fishers have observed that spawning females have been increasingly getting smaller. Additionally, catches of groupers have decreased from 45 MT (approximately) to less than 14 MT (approximately) during the 1990s (BFD, 2004).

In 2007, spawning aggregation data collected by SPAG was analysed. The results indicate that the protection provided to the spawning sites has had a detectable positive effect on the abundance of Nassau grouper. It is not known, however, whether the Nassau grouper stock which occurs within Belizean waters is overfished.

1.3 Management Advice

Although the protection of selected spawning aggregation sites seemed to have had a positive impact on stocks of Nassau grouper, the impact on other species could not be determined. Continued monitoring of these sites by SPAG, although costly, has proven to be a useful tool for the evaluation of these effects. Thus it is essential that such monitoring continues.

To enforce the protection of the spawning sites it is necessary for the Fisheries Department to increase its presence at these sites especially during spawning seasons. The Fisheries Department needs to continue to work with its partners and stakeholders to be able to efficiently manage these spawning aggregation sites. It is also recommended that the Fisheries Department should embark on a national campaign to sensitize and educate the general public especially the fishing

communities about the status of the spawning sites in Belize. It is also recommended that all known multi-species spawning aggregation sites in Belize remain closed to fishing.

The lack of comprehensive information on stock status for Nassau grouper and other important species requires a precautionary approach to management. Although current management protects part of the spawning stock, there are still some spawning sites that continue to be open to fishing. Additionally, fish outside spawning sites are not protected. If the Government was to consider it necessary to implement additional precautionary measures to improve the stock status of these species, it should evaluate the benefits and costs of imposing a size limit and/or seasonal closures for Nassau grouper and other associated species.

1.4 Statistics and Research Recommendations

1.4.1 Data Quality

The coordination provided by SPAG has been valuable in providing the data used in the 2007 analysis of Nassau grouper, and is a reflection of the success of the program in standardizing the methods of counting and measuring fish. Examination of these data however, shows that the number of samples obtained in certain sites is inadequate for evaluating the effects of management on such sites. Further examination of the database could provide guidance on how to make the current sampling effort a more effective tool for monitoring the effects of management and for the evaluation of stock status.

1.4.2 Research

Analyses of the SPAG database should be conducted for other species of fish that also aggregate at the spawning sites to evaluate the effect of protection on their stocks. Additionally, biological data on snappers and groupers, collected at the landing sites, should be used in future evaluations of stock status.

1.5 Stock Assessment Summary

The effect of management (protection of spawning sites) on the abundance of Nassau grouper was evaluated by analyzing the SPAG database. Analyses were conducted on the estimated size (maximum number of fish observed, and biomass of such fish) of Nassau grouper aggregations and on the presence/absence of Nassau grouper in the aggregation sites.
Analysis of variance tests showed that:

a. Nassau grouper aggregation size (biomass and number of fish) varied significantly between sites and quarter of the year, but not between moon phases or between the pre-management period (before 2002) and the post management period (2002 and after).
b. In the case of presence/absence of Nassau grouper, quarter, site, and management period were significant factors in explaining the observed variability.

It is possible that the analyses examining aggregation size did not detect the effect of management because of the high variability in the data. The size of the aggregations varied considerably, even at the peak spawning times, thus making comparison of the pre-management and post-management size of aggregations difficult. On the other hand the presence/absence data had less variability and, in this case, management period was found to have a significant effect. It should be noted that this is a common result in data sets where the probability of having observations with a zero count is large, as it is the case with underwater visual censuses.

The Nassau groupers from Belize are thought to be migratory species, but they exhibit high site-fidelity, spawning at exactly the same location and on the same days of the lunar calendar year

after year. Assuming the Belizean Nassau grouper is shared with neighbouring countries, a complete assessment would require data from all fisheries operating throughout the entire range of the stock.

1.6 Special Comments

The data for red hind were reviewed during the meeting but were not analysed because of the low number of observations present in the SPAG database.

1.7 Policy Summary

The Government of Belize and the Belize Fisheries Department is committed to the conservation, protection and sustainable use of the aquatic resources of Belize. The participation of stakeholders and partners is an essential factor when considering the management of the resource and the socio-economic impact it would have on those dependent livelihoods. The Fisheries Department is involved in conducting basic research, education awareness, marine environmental monitoring, policy development, marine reserves management and enforcement of the Fisheries Regulations.

The Government has recognized that "Open Access" and over-fishing significantly negatively affect the sustainability of any fishery. Therefore, the Government has invested in the design, implementation and utilization of marine reserves as a management tool for the protection of critical habitats and spawning aggregation sites for species of ecological importance. In 2002, the Government of Belize realized that it did not have enough information to assess the status of the Nassau grouper fishery even though certain reports were indicating that the fishery would collapse in 2011. The Government adopted a precautionary approach policy and closed 11 spawning aggregation sites.

The current assessments have addressed some policy objectives of the Fisheries Department of Belize regarding the status and management of Nassau grouper stock at the spawning aggregation sites. The Government is committed to continue working with its partners and stakeholders to increase monitoring of spawning aggregation sites and seek alternative fishing practices for those displaced from traditional fisheries. The Government will also continue to provide the services it has been providing to the public especially to the fishers of Belize.

1.8 References

Belize Fisheries Department. (2004). Plan for Managing the Marine Fisheries of Belize

Craig A. (1969). The Grouper Fishery of Cay Glory, British Honduras. *Annals of the Association of American Geographers* **59**: No. 2, 252-263.

Paz, G. E., and Grimshaw, T. (2001). Life History Characteristics and Management Recommendations for the Nassau Grouper Population in Belize. Green Reef Environmental Institute. Internet-http://www.greenreefbelize.org/assoc_files/Nassau%20Grouper%20Booklet.pdf

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IV. REPORT OF THE LARGE PELAGIC FISH RESOURCE WORKING GROUP

A. OVERVIEW

As agreed at the plenary session of the Second Annual CRFM Scientific Meeting held in Trinidad and Tobago in 2006, the Large Pelagic Fish Resource Working Group (LPWG) for this the Third Scientific Meeting was comprised of Christopher Parker (Barbados) as Chairman and species rapporteur for wahoo and Ms. Louanna Martin (Trinidad and Tobago) as rapporteur for King Mackerel. Ms. Elizabeth Mohammed, species rapporteur for Crevalle Jack was not present at the meeting.

At this meeting, Dr. David Die was the consultant primarily assigned to work with the LPWG. However additional advice was obtained for specific issues from the other consultants, mainly Mr. Bruce Lauckner, Dr. Clay Porch and Dr. Susan Singh-Renton. The group met initially to review any significant developments that had occurred during the inter-sessional period and other topics of general relevance regarding the goals, mandate and operational procedures for the working group.

Assessments

- Due to the absence of Ms. Elizabeth Mohammed, the species rapporteur for Crevalle Jack, it was regrettably not possible for an assessment of this species to be conducted this year.
- Since no relevant additional information had been obtained during the inter-sessional period that could be used to add to the information regarding the status of the dolphinfish stocks assessed in 2006, it was agreed that this species would not be reassessed this year.
- It was agreed that in keeping with the recommendation made at the 2006 meeting, an assessment of the status of the wahoo stock should be conducted. However, as no additional information that could be used in conducting any other type of stock assessment of the wahoo stock was available, it was agreed that this year's assessment would be limited to a standardization of catch rates using a Linear Model for the period 1996 to 2006. It was also decided that only the datasets for the St. Lucia pirogue and Barbados moses and dayboat fleets would be used. The rationale for this decision will be discussed in the relevant assessment report.
- It was decided that the 2006 assessment of king mackerel would be updated using new length frequency data collected in 2006-2007 as recommended by the 2006 meeting.

Other issues

- It was noted that although a number of large pelagic species are of commercial interest to CRFM member countries, only a few of these species have so far been slated for stock assessments and fewer have actually been assessed. It was noted that dolphin and wahoo in particular have been the subject of repeated stock assessments by CRFM, but other species like blackfin tuna, have never been assessed. Member countries should be urged to carefully consider which species they may want to submit to the Large Pelagic Fishery Resource working group for stock assessment. To facilitate this decision-making process it was agreed that during the inter-sessional period the Chairman would circulate a list of species of possible interest to member countries seeking their input on this matter.
- CRFM member countries are not the only harvesters of the stocks examined by the pelagic working group and oftentimes do not catch the majority of the biomass of the

migratory or highly migratory stocks being assessed. However CRFM countries are obliged by being signatories to a number of international agreements to participate in assessing these fish stocks within international forums such as ICCAT and WECAFC. Unfortunately these international organizations have not conducted assessments of these stocks and are unlikely to conduct them in the near future. To improve the information on these stocks provided to CRFM countries a number of possible mechanisms exist:

1. Non-CRFM harvesting entities and other regional organizations may be included in the CRFM assessments. This can be done by:
   - CRFM continuing to formally invite the participation of non-CRFM entities in the CRFM Scientific meetings
   - Utilize existing bi-lateral agreements that exist between CRFM and non-CRFM members to effect joint stocks assessments. The results of these joint assessments in the form of either aggregated data or even overall results will offer additional invaluable information on the status of the species in the region.
2. Promote the assessments of pelagic resources of interest to CRFM by regional organizations. This can be done by:
   - Requesting WECAFC, whose membership embraces most of the major non-CRFM harvesting nations, to undertake the assessments of pelagic resources of interest to CRFM via new pelagic species stock assessment working groups such as that formulated to assess flyingfish.
   - CRFM could present the results of their assessment of species that are under ICCAT's mandate (e.g. wahoo) at the meeting of the small tunas working group to raise the profiles of these stocks within ICCAT

- The issue of mechanisms for sharing raw data to facilitate regional stock assessments was also discussed. It was noted that the option of maintaining a permanent regional database that would house cleaned national datasets for use in multilateral stock assessments has been discussed within several CRFM forums but has hitherto not been developed. A final decision on the feasibility of establishing such a regional-database should be taken. If countries are opposed to having their raw data stored in a permanent regional-database but still want to participate in regional assessments it would be acceptable to share their cleaned raw datasets only for the duration of the assessment meeting. Only for the purposes of the meeting will the national raw databases be combined to form what would be a temporary regional database that will be destroyed at the end of the meeting. However, the caveat to this approach is that the countries must maintain their raw datasets in a standard format that would facilitate a simplified merging process at the time of the assessment meeting. It would simply be unacceptable to devote time each year to re-cleaning and reformatting the national datasets for use in the assessments.
- It was suggested that if there has been a lack of inter-sessional activities of the Resource Working Groups, the reasons should be noted. It was also suggested that the management actions, which have been taken from the recommendations of the Working Groups should be documented and if they have not been implemented, the reasons should be noted.
- Finally it was noted that the CRFM should explain the precise status of the CARIFIS data management program as most countries have not been able to use this program. As a result national data is presented in many formats such as Excel, CARIFIS and TIP and as such must be streamlined into a common format for analysis.
- Given the points listed above it was agreed that decisions on the stocks to be assessed, the timing for species stock assessments and indeed the forums for these assessments should be taken at the plenary.

B. FISHERIES REPORTS

1.0 Assessment of the King Mackerel (*Scomberomorus cavalla*) Fishery of Trinidad & Tobago

1.1 Management objectives

In Trinidad and Tobago, king mackerel (*Scomberomorus cavalla*) is considered part of a multi-species unit of coastal pelagic species taken by a combination of gears and fleets. The fishery lands Serra Spanish mackerel (*S. brasiliensis*), Crevalle jack (*Caranx hippos*) and a number of shark species among others. National management objectives for coastal pelagics have not been formally adopted but focus on 'maintaining the sustainability of the resources' (see *Draft Policy for the Fisheries Sector of Trinidad and Tobago* and draft fisheries management plans).

In Guyana, the management objectives for the large pelagic fishery are 'to develop the capacity for maximising catches of large pelagic species that inhabit or migrate through the country's EEZ; and to establish management linkages with international regulatory bodies, such as ICCAT, in order to access vital information to properly manage these fisheries' (Guyana national report).

Clarification of the management objectives is requested by the group for these and other countries sharing this stock, including any specific reference points adopted by states to quantify their objectives and guide management decision making.

1.2 Status of stocks

The working group assumed a 'southern Caribbean' stock of king mackerel inhabiting at least the waters of Trinidad and Tobago, Venezuela and Guyana. With large catches also recorded in Brazil, and small catches in Grenada, it is possible that the unit stock extends more widely along the shelf waters of the S. American coast. Due to the relatively low catches in central Caribbean waters, away from the continental shelves, the southern stock was assumed to form a separate unit from those stocks found in the coastal waters of the Gulf of Mexico, the Southern US coast and the Greater Antilles.

A similar result to that obtained in 2006 was obtained in 2007 and the updated stock assessment for king mackerel remains inconclusive. The status of the stock as measured by the target reference point (F0.1) and limit reference point (F20%SPR) varies greatly depending on the growth/natural mortality parameter combination used in the analysis. The working group was unable to significantly reduce this uncertainty during 2007; in fact the review of growth data from other neighbouring stocks suggested that there is greater uncertainty in growth than reported in 2006. It is imperative that such uncertainty is reduced before similar assessments are updated.

The comparison of mortality rates between the 1996-98 period and the 2006-2007 period however, suggests that there has not been a significant change in fishing mortality in the last 10 years. The fact that total catches (as estimated from FAO statistics) have fluctuated without a trend during this period is consistent with a stock that is being harvested sustainably. Unfortunately it is not known whether the stock is over fished or not, thus the current exploitation level may be sustainable, but may not be the level desired by management.

1.3 Management advice

The King mackerel resource is a valuable resource for Trinidad and Tobago with annual landings valued at TT$10M. The uncertainty in stock status forces management to take a precautionary

approach. Current levels of fishing effort should not be increased. If a decline in catches or catch rates is detected the CRFM should facilitate prompt collaboration among the countries fishing the stock to develop consensus on the management strategies to be adopted. Finally, the participation at CRFM assessment meetings of scientists from other countries that harvest the same stock should be encouraged, as to also provide additional assessment data. It is quite likely that the data that these countries can provide can significantly reduce the uncertainty in the evaluation of stock status.

1.4 Statistics and research recommendations

1.4.1 Data quality

The 2006 assessment made some important recommendations, many of which remain relevant:

- Catch and effort data are available for Trinidad and Tobago at the 'raw' trip interview level, but not for the other countries. Trinidad and Tobago data records also exist for the years prior to 1991 in the form of the original paper log sheets, most of which have not yet been computerised. Entering these records would enable biomass dynamic analyses to be conducted on the trends in abundance over time, and provide an independent estimate of the state of stocks. Such data should be made available before the next catch/effort assessment is attempted.

- Detailed 'raw' catch-effort data including gear type, and relevant fishing effort measures (e.g. hours fishing, manpower, number of hooks, gill net numbers and lengths etc) should also be sought by the working group for the other countries sharing the stock (including those available from other neighbouring countries that are members of ICCAT and which have logbook or on-board observer programs e.g. USA, Venezuela and Brazil). Catch per unit of fishing effort data should include trip records from fishing gears which target king mackerel (or other pelagics) for trips even when the species was not caught, thus the data should also include records of zero catch.

- Information is also required on the histories of developments in the fishing fleets and fishing methods in each country. Any significant changes in fishing practices or the power of vessels, or locations fished etc can change the 'catchability' of the fleet and need to be accounted for in assessments.

- To strengthen the assessment, length frequencies should also be sought from the other countries sharing the stock. Such information may clarify the migration patterns of the stock and would provide independent estimates of the fishing mortality rate.

1.4.2 Research

- Due to the critical importance of basing stock assessment and management on a clearly defined unit stock, a better understanding is required of the stock range and migration patterns of the species, and the validity of the 'Southern Caribbean' stock assumption in this analysis. If more comprehensive literature searches do not resolve the matter, genetic or other research should be conducted to clarify the stock distributions.

- To reduce uncertainty in the growth and mortality rate parameters, otoliths or other 'hard parts' methods of ageing king mackerel may also be investigated, e.g. at the IMA growth laboratory. The IMA growth laboratory should seek to expand the collection of hard parts for this stock.

- Monitoring of the fishery and research on its biology should be undertaken to reduce the uncertainty in population parameters by continuing to obtain fish size data to allow for future monitoring of mortality rates.

- Monitoring and collation of historical catch per unit of fishing effort should be intensified to be able to provide alternative sources of data for stock assessments.

- Another assessment of the status of the stock may be recommended provided that pertinent data and/or information are acquired that would result in a more refined stock analysis.

1.5 Stock assessment summary

- Catches in recent years have been at historical high levels of 4-7 000 t. In most years the largest catches are reported as being taken by Venezuela and Brazil.
- Growth parameters obtained in the 2006 assessment show a much greater growth rate than those estimated for the neighbouring stocks of the Gulf of Mexico and the US South Atlantic (Brooks and Ortiz 2004). Although such differences may be real their presence suggests that uncertainty in growth parameters is greater than that reported in 2006. It is imperative that such uncertainty is reduced before similar assessments are conducted.
- In 2007 the Working group decided to update the 2006 assessment by expanding the range of possible growth parameters and by using the length frequency data collected during 2006-2007 to estimate recent mortality rates. The following conclusions were reached from this analysis:
    - The updated stock assessment for king mackerel remains inconclusive. The status of the stock as measured by the target reference point (F0.1) and the limit reference point, (F20%SPR) varies greatly depending on the growth/natural mortality parameter combination used in the analysis. Estimated fishing mortality rates were anywhere from well above the limit F20%SPR reference point (indicating severe overfishing) to below the target reference point of F0.1 (indicating there is room for expansion) depending on which of the sets of growth parameters and corresponding natural mortality estimates were used (Table 1).
    - The comparison of mortality rates between the 1996-98 period and the 2006-2007 period estimated for any particular set of growth parameters, however, suggests that there has not been a significant change in fishing mortality in the last 10 years. The fact that total catches (as estimated from FAO statistics) have fluctuated without a trend during this period is consistent with a stock that is being harvested sustainably.
    - It is not known whether the stock is over fished or not, thus the current exploitation level may be sustainable, but may not be at the level desired by management. The status of the stock remains uncertain, however, the possibility that fishing mortality is already above the limit reference point exits, therefore management should be precautionary and invest the necessary resources to reduce the uncertainty in the evaluation of stock status by supporting the research recommendations outlined in this report.

Table 1: Comparison of estimated fishing mortality rates (2006-2007) with the estimated 'threshold' or limit reference point levels, for the three possible sets of growth parameters. Values in brackets show fishing mortality as percentages of the reference points. Percentages above 100% indicate overfishing.

Model fit	Limit reference point, $F_{20\%SPR}$	Estimated fishing mortality rate, F (indicator of fishing pressure on the stock)	
		For years 1996-98	For the year June '06-June '07
Low $L_{infinity}$ (2006)	0.80	0.67 (84%)	0.82 (103%)
Med. $L_{infinity}$ (2006)	0.66	1.19 (180%)	1.13 (171%)
Gulf of Mexico & Florida	0.55		0.18 (32%)

1.6 Special comments

None.

1.7 Policy summary

The working group agrees with the Trinidad and Tobago government (Fisheries Division, 1992) and ICCAT positions that management for the coastal pelagics should be coordinated among neighbouring countries sharing the stock. Options for assessing and managing the stock in collaboration with Venezuela, Brazil and any other relevant countries should be explored, by actively encouraging ICCAT and WECAFC to provide data and expertise for the assessments of these stocks.

1.8 References

Fisheries Division. (1992). Management Plan for the Artisanal Fishery for Coastal Pelagics of Trinidad and Tobago (Draft).

2.0 Wahoo (*Acanthocybium solandri*) Fishery

2.1. Management objectives

The management objectives for wahoo specifically for most CRFM member countries were again not available to the authors at the time of writing. As a result, the CRFM Large Pelagic Fish Resource Working Group requests guidelines from the Caribbean Fisheries Forum on the individual country management objectives for wahoo to direct future stock assessments and further refine management recommendations for the species.

2.2 Status of stocks

It should be noted that unlike the previous stock assessment carried out on wahoo by the CRFM LPWG in 2004, the current update of the stock assessment only utilized landings datasets for the Barbados moses and dayboat fleets and the St. Lucia pirogue fleet for the period 1996-2006. There were a number of rationales for this decision, which will be discussed in section 1.5 No declining trend was observed in the catch rates over the 11-year period considered here (1996-2006) (Figure 1). Based on this observation it may be inferred that the local abundance of the stock is sustainable at these levels of harvest at least in the short term.

2.3 Management advice

The assessments conducted at this workshop cannot be considered extensive enough to predict the long-term sustainability of the fishery at current or increased levels of exploitation. With this in mind a precautionary approach should be adopted in managing and further developing this fishery until the stock dynamics are better understood.

Given the number of nations that are likely to be fishing the wahoo stock within the WECAFC area and the possible interests of some fishing nations to expand their pelagic fisheries, management of the wahoo fishery should be based on collaborative arrangements between the CRFM and major non-CRFM fishing nations in the region. The information obtained on the status of the stocks from these CRFM stock assessments is very valuable. However, collaboration with non-CRFM nations fishing in the area would further enhance the level of knowledge of the stocks and thus the management advice offered. As such collaboration with these non-CRFM fishing nations should be further encouraged. Possible mechanisms for such collaboration or information gathering are outlined in the Chairman's report for the large pelagic working group.

Although for this year's assessment the decision was taken to analyze the data from only two CRFM countries, it must be noted that the lack of a fully functional common data management program for member countries will continue to make the prompt sharing of data for collaborative assessments such as these difficult in the future. CRFM should therefore urgently finalize the development of the CARIFIS programme for member countries to facilitate the storage of national data in a common format that would facilitate the merging of national databases for joint stock assessments.
It is therefore recommended that the CRFM:

1. Continues to monitor catch rate trends at a regional level.
2. Further promote and coordinate more extensive stock assessments and management through collaboration with non-CRFM nations fishing this resource.
3. Finalize the CARIFIS programme for collecting fisheries catch and effort data and facilitate the use of the programme by CRFM member countries.
4. Encourage countries to individually track catch rate trends of the fishery to allow early detection of any changes that may signal stock decline.

5. In the event that catches or catch rates decline, facilitate prompt collaboration among countries to achieve consensus on the appropriate management strategies to be adopted.

2.4 Statistics and research recommendations

Following are a number of recommendations to be addressed by the CRFM and individual countries for improvement of the quality of future assessments. It should be noted that all have not been introduced in the text so far and most have been recommended in the wahoo assessment report of 2004:

2.4.1 Data Quality

Recommendations for the Caribbean Regional Fisheries Mechanism

1. Review systems (e.g. logbook and or observer based programs) for recording more refined estimates of fishing effort among countries particularly in quantifying unsuccessful fishing trips.
2. Renew and intensify efforts in finalizing CARIFIS for practical use by CRFM member countries.
3. Encourage and assist countries with development of a regional database on historical catches and fishing effort, extending to a time period prior to the commencement of the CARICOM Fisheries Resource Assessment and Management Programme. This exercise will involve intensive data mining from scientific, historical and administrative documents (published and grey literature) designed to expand the time series of available data and glean other information that can be utilized in other assessment models.

Individual countries

1. Countries must ensure that appropriate systems are in place to capture, record and report at least representative landings data for wahoo.
2. Provide accurate and complete data on total catches (or landings) of wahoo in the format and level of detail required by the CRFM for incorporation into stock assessments.
3. Provide more detailed information on fishing effort associated with each catch record e.g. boat/ gear type and number of gear units as well as number of hours fishing or the number of hooks used. This information can facilitate improved estimates of catch per unit of effort and fish abundance.

2.4.2 Research

Recommendations for the Caribbean Regional Fisheries Mechanism

1. Monitor trends in regional catches and catch rates to identify signs of stock decline and promote regional collaboration on appropriate management strategies to be implemented.
2. Continue to encourage participation and further collaboration of non-CRFM territories in the WECAFC region e.g., USA, Venezuela and the French territories in future stock assessments.
3. Implement a tagging programme for wahoo to collect the range of information for this species that such studies can generate, such as migration patterns and ranges.
4. Formally work with the IMA in conducting otolith based ageing of wahoo aimed at providing information on the age structure of catches and refined estimates of growth parameters for future assessments.

Individual countries

1. Future analyses should take into account ‘zero’ catch trips to improve estimates of total fishing effort. Where necessary, revisions to sampling strategies should be considered to improve estimates of fishing effort and fish abundance.

2. Conduct extensive review of historical data (data mining) aimed at providing information on historical catch rates and catches to improve fitting of model parameters in future assessments.
3. Submit fleet information to CRFM outlining on-going and historical developments to allow elucidation of the effects of changes in the fleet, fishing methods and technology on catch rates.
4. Implement programs to collect fleet and landings information for recreational fisheries this would include but be confined to data on fishing tournaments.
5. Work with CRFM/IMA to develop and implement periodic sampling programmes to collect and provide specimens as required for use in assessments to track growth parameters and age structure of the wahoo stock.

2.5 Stock assessment summary

As mentioned earlier, only the landings datasets for the Barbados moses and dayboat fleets and St. Lucia pirogue fleets were used in this years update of the stock assessment analysis. The rationales for this decision are as follows:

- The Barbados and St. Lucia datasets were the most complete national historic datasets available to the meeting in terms of the fewest missing years of data.
- St. Lucia contributes the largest proportion of wahoo captured amongst the CRFM member countries (48% based on mean annual catches reported to FAO for the period 1990-2004 that presently report wahoo catches to FAO (7) and therefore should be the most significant driver of any regional catch trends.
- Barbados iceboats and longliners typically fish for a number of days (not recorded) and as such their fishing effort is not comparable to the vessels that typically have fishing trips of less than 1 day in duration. Therefore to reduce burdening the models with having to adjust for these differences the iceboat and longline vessels were not included in the assessment.
- By the same token, longline gear would have a much higher potential fishing power than the troll and handline gears used on the other fishing vessels to capture wahoo.
- In the end therefore, only catches taken by single-hook handline and trolling gear used by vessels of more similar fishing power were used.

As no additional information was collected during the inter-sessional period which would facilitate any other in-depth analyses, it was decided that a simple comparison of catch rates (standardized catch per trip) over the period would be the most informative analytical tool. The Univariate Multifactor ANOVA of the SPSS program was used to standardize the log cpue data with respect to the key factors identified (vessel type, season and year). Two seasons were defined based on relative aggregated catch weights during months for all years of the study period and were categorized as follows: high (January to May) and low (June to December).

It must be noted that present records for wahoo landings available for this assessment are necessarily positive catches and at present there is no means of quantifying the numbers of times that a fisher attempts to catch wahoo without success. The numbers of these unsuccessful or zero catches at any point in time are obviously important indicators of fishing abundance and should be taken into account when utilizing temporal catch rate trends as relative indices of stock abundance.

In this study an attempt was made to estimate zero catches by counting the numbers of catch records for pelagic species other than wahoo (*viz* dolphinfish, tunas, billfishes and swordfish) taken by Barbadian vessels using handline and trolling gears. However, the number of observations of zero wahoo catch was relatively greater in the “high” season than in the low

season. This is markedly counter to the expected trend. This result may be an artifact arising from the procedure used to define a zero wahoo catch. As such a trend may confound the interpretation of the results from this method of estimating zero wahoo catches this data was not used.

The best methods for estimating zero catches rely on country reporting of fishing activities whether through interviewing fishers, monitoring vessel activities at the landing sites (i.e. noting if a vessel has gone fishing and subsequently determining if wahoo was caught) or the use of catch logbooks.

2.6 Special comments

None.

2.7 Policy Summary

The working group requires more information and guidance from the CRFM Fisheries Forum on regional policies for wahoo.

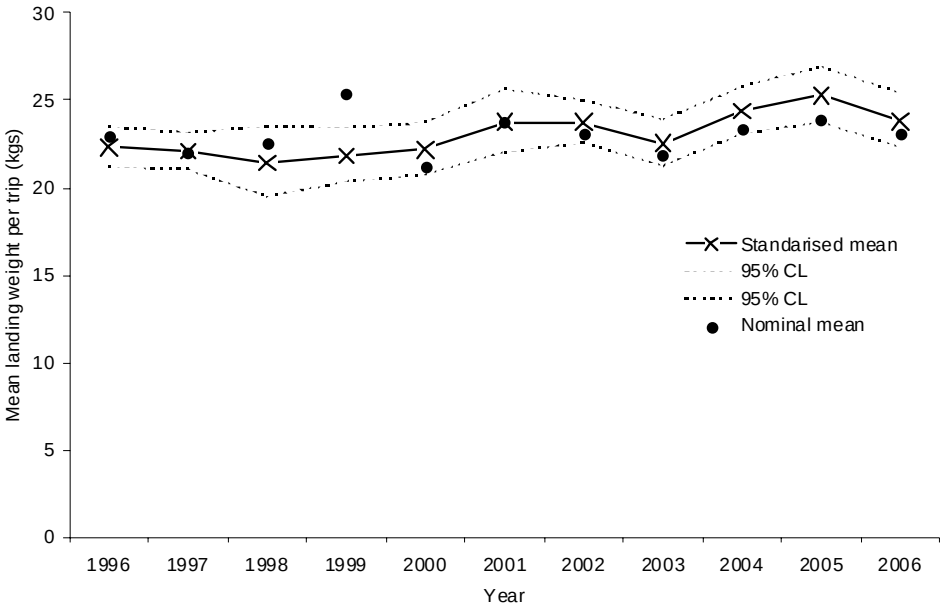

Figure 1: Standardized catch rates for Barbados moses and dayboats and St. Lucia pirogues for the period 1996 to 2007