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CRFM Fishery Report - 2006

Volume 2

Report of Second Annual Scientific Meeting - Port of Spain, Trinidad and Tobago, 13-22 March 2006




CRFM Secretariat,
Belize & St. Vincent & the Grenadines
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Fishery Management Advisory Summaries

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Foreword

The 2006 CRFM Annual Scientific Meeting took place during 13-22 March 2006. During this Meeting, CRFM Resource Working Groups completed eleven of those analyses that were approved by the Third Annual Meeting of the Caribbean Fisheries Forum: queen conch fisheries of Jamaica, The Bahamas, Turks and Caicos; spiny lobster fisheries of the Bahamas and St. Lucia; the shrimp fisheries of Trinidad ad Tobago; the Atlantic Seabob fishery of Guyana; the lane snapper fishery of Trinidad and Tobago; the red snapper fishery of Guyana; the king mackerel fishery of Trinidad and Tobago; the dolphinfish fishery. The Meeting also reviewed and adopted the Report of the First Meeting of the Ad Hoc Working Group on Methods, with amendments.

The Report of the 2006 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 that met during 2006. National reports, which had been submitted for consideration by the Working Groups, are published as Supplement 1 to Volume 1, while the Report of the First 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. Volume 1 is therefore 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.

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List of Acronyms and Abbreviations

ASPIC	A Surplus Production Incorporating Covariance
CARICOM	Caribbean Community
CFRAMP	CARICOM Fisheries Resource Assessment and Management Programme
CITES	Convention on International Trade in Endangered Species
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 (Turks & Caicos)
EEZ	Exclusive Economic Zone
FAD	Fish Aggregating Device
FAO	Food and Agriculture Organization of the United Nations
FMSP	Fisheries Management Science Programme
GLM	Generalized Linear Models
ICCAT	International Commission for the Conservation of Atlantic Tunas
IMA	Institute of Marine Affairs
LFDA	Length Frequency Distribution Analysis
LPWG	Large Pelagic Fish Resource Working Group
MSY	Maximum Sustainable Yield
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
SCPWG	Small Coastal Pelagic Fish Resource Working Group
SCRS	Standing Committee on Research and Statistics
SEFSC	Southeast Fisheries Science Center
SGWG	Shrimp and Groundfish Resource Working Group
RSWG	Reef and Slope Fish Resource Working Group
TCI	Turks and Caiços Islands
TIP	Trip Interview Programme
UNDP	United Nations Development Programme
USA	United States of America
WCA	Western Central Atlantic
WECAFC	Western Central Atlantic Fishery Commission
YPR	Yield Per Recruit

I. REPORT OF THE CONCH AND LOBSTER RESOURCE WORKING GROUP

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A. OVERVIEW

The Conch and Lobster Working Group meeting was attended by representatives of Jamaica, St. Lucia, the Bahamas and the Turks and Caicos Islands.

At the last meeting, it was recommended that the following stocks be reviewed:-

Bahamas:	conch and lobster
Turks and Caicos:	conch
St. Lucia:	lobster
Jamaica:	conch

These stocks were evaluated at this meeting.

For the next meeting, it is recommended that conch and lobster be reviewed for all countries that are a part of the working group because of widespread concern about the status of both conch and lobster fisheries within the Caribbean Basin.

The general recommendations of the group were:-

- Countries should review their commercial fishery data collection and analysis systems to ensure that the sampling design is appropriate, quality control procedures have been applied to the entire time series of data, and data processing methods are appropriate. Documentation of the data collection and handling process also need to be shared with consultants prior to meetings in order to facilitate their understanding of limitations of the data.

- Consultants needed for particular tasks should be identified and contracted early, and documents should be sent to the consultants, well in advance of meetings. Consultants should be encouraged to visit countries, where appropriate, when they travel to the assessment meetings. This is to facilitate consultants having a greater grasp of the quality of the data to be analyzed.

- An intraregional market analysis is needed to improve export statistics for conch. This is because of the possibility that export statistics from a given country may actually include conch that was previously imported and thus not a part of the conch produced from that country.

- A special meeting, or a portion of the methods meeting, should be devoted to issues of sampling design and data quality.

- Terms of Reference for the working group should be dictated by decision makers and/or managers of the fishery.

B. FISHERIES REPORTS

1.0 The spiny lobster (*Panulirus argus*) fishery of St. Lucia

At the first scientific meeting, held in St. Vincent, a decision was taken by the St. Lucia fisheries representative that our first assessment will be on the Spiny Lobster (*Panulirus argus*) fishery.

1.1 Management Objectives

The main management objective for this fishery is to ensure sustainable use of the stocks and to promote the development of the use of selective fishing gear and practises that minimise the capture of juveniles.

1.2 Status of Stock

The current status of the stocks is yet to be determined. Proper analysis of the status of the lobster stocks will be determined after thorough verification of the data entered into the program versus the hard copy data. Preliminary results suggest some stability in the fishery. Furthermore, the stock is protected by a large minimum size (9.5 cm carapace length), a closed season and a no-take marine reserve.

1.3 Management Advice

The following are recommendations based on the data that were presented for analysis.

Although the available data do not show an immediate problem with this fishery, the data are limited. The time series is short and the length-frequency data are old. Before a great deal of faith can be placed in the results of looking at the commercial catch statistics, they should be reviewed carefully.

- The commercial catch statistics should be examined carefully to see if quality control measures were implemented prior to the 2000 observations.
- The processing of the data to obtain totals (catch and effort) should be reviewed.
- A review of the sampling design and sample sizes should be undertaken.

1.4 Statistics and Research Recommendations

1.4.1. Data Quality

In addition to several years of catch data and annual length frequencies during the open season, Table 1 gives an indication of available data on spiny lobsters. After 1999, the collection of maturity data was terminated.

From 2000 to the present, all catch and effort data have been subjected to integrity checks both prior to and following data entry. Prior to data entry, data sheets are checked for errors and omissions with the data collectors, whilst subsequent to data entry into Trip Interview Programme (TIP), data are also validated and verified for errors and omissions.

Table 1. Summary of data collected on spiny lobsters from 1996 – 1999**.**

Biological data on spiny lobster landed	**Maturity data on spiny lobster collected at sea**
Carapace length (mm) Sex Weight (g) Presence of spermatophoric mass Condition (intact or eroded)	Carapace length (mm) Sex Weight (g) Presence of spematophoric mass Condition (intact or eroded) Presence of eggs (ovigerous) Status of eggs (orange or brown) Effort data (depth, number of pots hauled, soaked time, total catch)

1.4.2. Research

- Further verification of the data is required before estimates can be developed that are suitable for responding to management objectives.

- Assessment of the lobster stocks should be undertaken. This assessment should also include sublegal size lobsters.

1.5 Stock Assessment Summary

Maturity of spiny lobster in St. Lucia

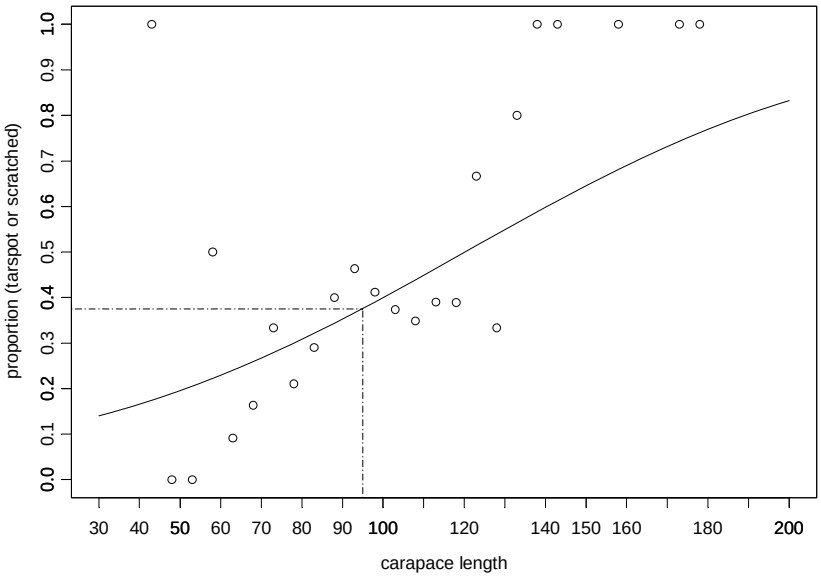

Figure 1. Proportion of lobsters with either a tar spot or a scratched tar spot as a function of carapace length (in mm). The fitted curve is a two-parameter logistic model.

Length-Maturity Relationship

Only mature females have tar spots or scratched tarspots. However, not all mature females will have a tarspot. Therefore, the percentage of females in a length class with tarspots (including scratched tarspots) is a minimal estimator of the percentage of females in the length class that are mature. The proportion of females with tarspots was plotted against carapace length (Figure 1). Sample sizes were greater than 30 animals for all length intervals from 68 to 118 mm cl. All but two of the remaining length classes had sample sizes of 5 or fewer animals.

A two-parameter logistic model was fitted to the data:

$$p(L) = \frac{e^{a+bL}}{1+e^{a+bL}}$$

where *p(L)* is the proportion with tarspots at length *L*, and *a* and *b* are regression coefficients to be estimated. The regression model was fitted using the logistic regression procedure in Splus. The parameter estimates were:

parameter	estimate	standard error	t-value
intercept, a	-2.41815851	0.407478366	-5.934446
slope, b	0.02011872	0.004179924	4.813177

Annual Lobster landings in St. Lucia

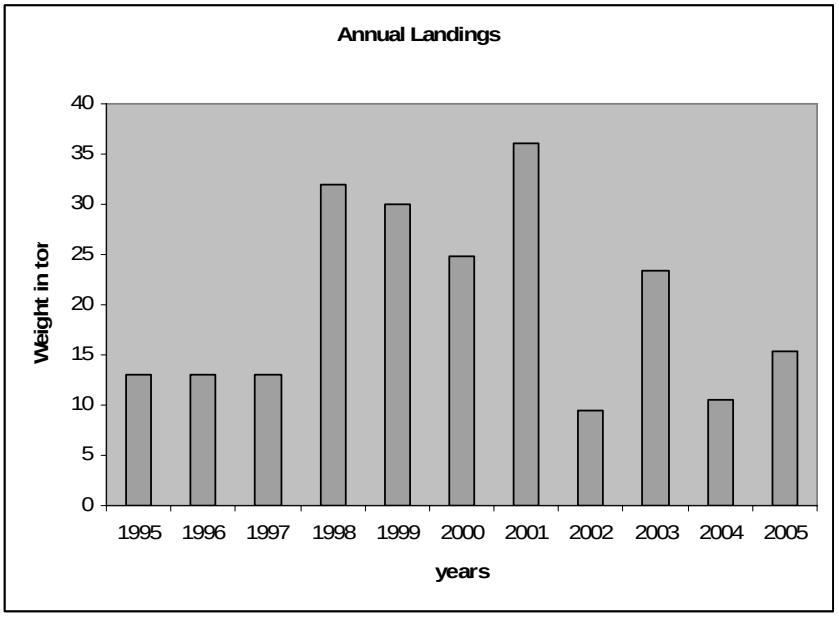

Figure 2. Annual landings are available from 1995 to 2005 (11 years) and have ranged from 13 tons to 37 tons with no apparent long-term trend. The average annual landings from 1995 to 2005 was 20 tons and the average landings over the last three years was 16 tons. Thus, from the perspective of landings, the fishery looks stable.

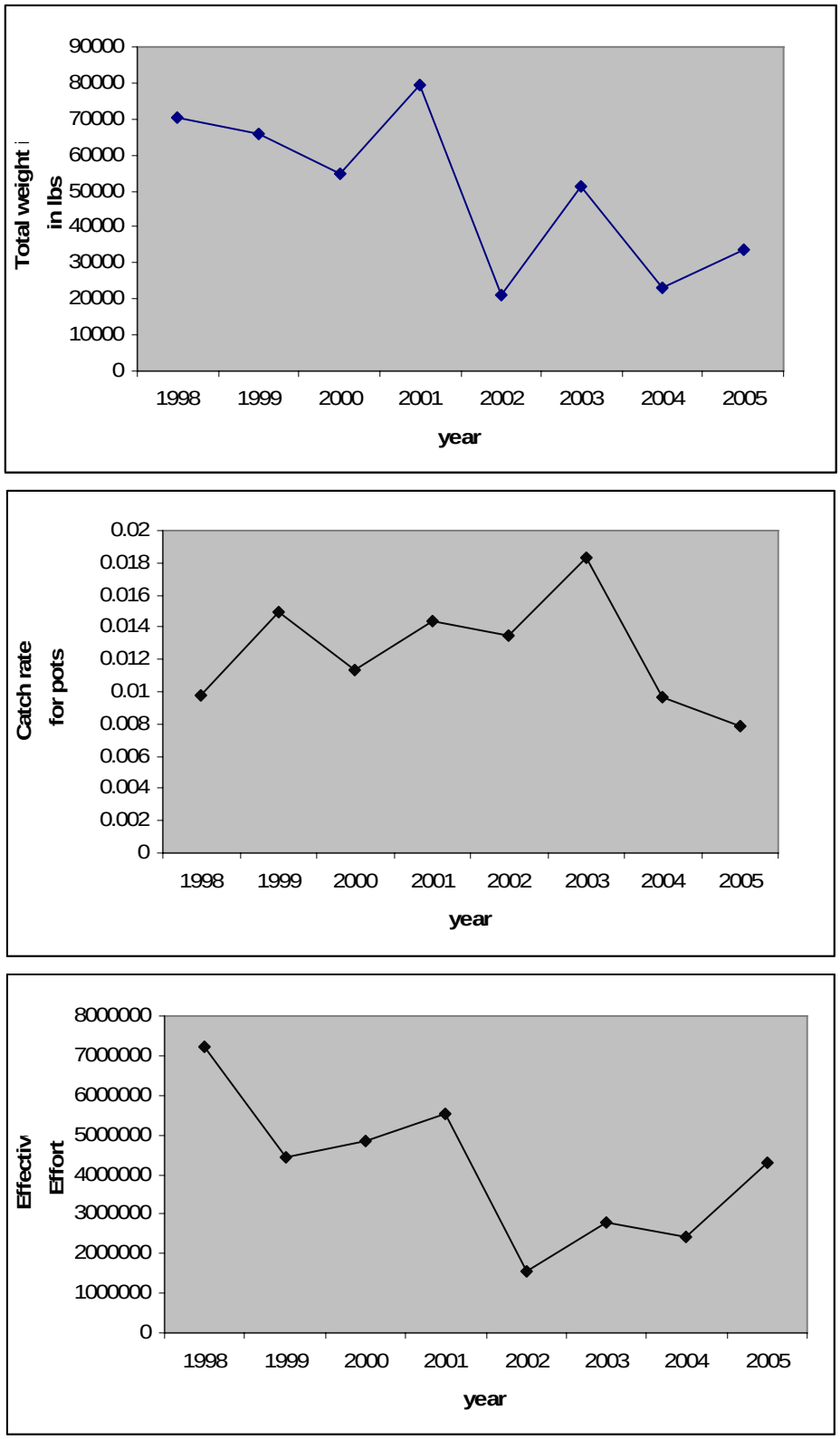

Figure 3. Statistics from the commercial fishery from 1998 to 2005. Top: total weight landed. Middle: catch rate from interviews of pot fishers. Bottom: effective effort.

Given that there were problems with the number or quality of the interviews conducted in 1995, 1996 and 1997, attention was focused on the period 1998 – 2005.

Effective effort was determined by dividing total landings by catch rate of pot fishers. This provides an estimate of the effort that would have been necessary to catch the total landings if all fishers used pots.

For the pot gear (which is the main fishing gear for lobsters in St. Lucia), effort is recorded in terms of hours of soak time, i.e., the number of days the pot was in the water. These data represent effort when recorded as 24 hours or above.

Overall these graphs show a somewhat stable lobster fishery. There is considerable year to year variation in the computed effective effort. This may be due to the fact that effort was derived from catch and catch rate information, rather than being estimated directly, and the catch rate data are variable. Also, the data need to be thoroughly reviewed for quality before the status of the fishery can be determined with confidence.

1.6 Special Comments

None.

1.7 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.
- Promote the development and use of selective fishing gear and practices that minimize by-catch of non-target species and the capture of juveniles.
- 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.

2.0 The Queen Conch (*Strombus gigas*) fishery of the Turks and Caicos Islands (2005/2006 Fishing Season)

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.
- To explore options of optimising economic earnings, including foreign exchange, from the queen conch fishery.
- To explore the feasibility of expanding markets for derivatives of conch (shells, trimmings, ornaments).
- To promote national and international collaboration in research and management in order to improve the effectiveness of managing the conch fishery of the Turks and Caicos Islands.

2.2 Status of Stocks

Although intensively fished and possibly over-fished in certain areas (Ninnes, 1994), the Queen Conch populations of the Turks and Caicos Islands are generally considered to be stable. It is assumed that unexploited 'deep-water' stocks exist that contribute significantly to recruitment of the fished stocks in shallower waters (Ninnes and Medley, 1995). The overall fishing effort under the current national annual export quota of 600,000 lbs. (272,160 kg) is considered to be maintaining the stock size at suitable levels (Anon., 1999). Studies on protected versus fished populations found differences in densities as well as age structure, with juveniles being significantly denser in fished areas than adults (Tewfik and Béné, 2003). For example, total densities in algal plains in fished areas were 687.2 conchs/ha versus densities of 2162 conchs/ha in protected areas. The overall mean density for both protected (EHLCR) and fished areas (Caicos and Turks Banks) was reported to be the highest in the region at 426.53 conchs/ha. According to the assessment conducted at the 2nd Scientific Meeting for CRFM, catch rates are operating at a constant level.

2.3 Management Advice

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

- Continue to assess the conch stock yearly, based on catch and effort data to determine an estimated sustainable yield (MSY).
- 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).
- Do not exceed current effort levels, because the current effort suggests that the fishery is operating within 88.1% of effort at MSY.
- Examine possibilities of hiring an economist to provide understanding of the economic pros and cons for the conch fishery.
- Aid in the development of a local niche market for conch derivatives in order to reduce processing waste and supplement resource users' net income.
- 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)

2.4 Statistics and Research Recommendations

2.4.1. Data Quality

Catch and effort data are collected from the local processing plants. The data is of good quality, but has a few areas of lacking information, such as illegal poaching. However, a visual survey is to be conducted before the end of 2006 to verify biomass levels are being estimated appropriately. The DECR has completed a local consumption survey of Queen conch and has incorporated it within the stock assessment.

2.4.2. Research

- Conduct a second visual survey to determine the abundance of conch before the end of 2006.
- Conduct research on size and length of conch before the end of 2006.
- Work with the Department of Economics and Planning to study economic aspects of the fishery before end of 2006.
- Produce projections for setting a quota at a percentage of the MSY before end of 2006.
- Fill the gaps of information for the TCI Queen Conch Fishery, such as tourist consumption. However, this is not a large priority, considering local consumption and estimated tourist consumption information did not greatly influence the assessment model (i.e. 0.1% more effective with local consumption information) (between 2007-2008).

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 produced that showed a high correlation of between 60 and 70% between observed and expected catch rates (CPUE). The model fits better when information on local consumption is added (figure 1). A decline in effort occurred during the 1980's when many of the fishers moved to the Bahamas for steady construction work.

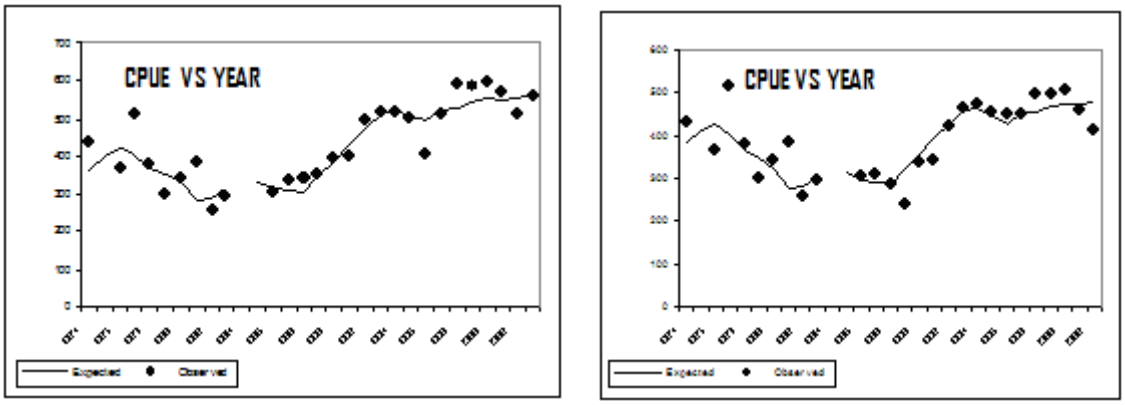

Figure 1. Observed vs. Expected CPUE for two models fitted using Excel's Solver. The model to the left has local consumption information added to the recorded catch while the model to the right does not include local consumption.

Stock Assessment Utilizing Local Consumption Data	Stock Assessment Utilizing ONLY Catch and Effort Data
p = 0.356777888	p = 0.43872712
r = 0.43641528	r = 0.39654584
K = 18674920	K = 17586991
q = 0.00005	q = 0.00005
Sum of Squares = 8.830E+11	Sum of Squares = 1.22E+12

The Schaefer model appears to fit the data well, and the data suggest that conch production is operating at or near optimum level.

Sensitivity was then considered between the two analyses. The following was determined:

Assessment (recorded catch & effort) only (1974-2003)	1,743,512 lbs. 3984.70 boat-days 54% 88.1%	MSY f_{MSY} B/B_{Vigrin} Effort as % of f_{MSY}	Quota for 2003-2004 1,587,227 lbs. 3511 boat days
Assessment (include local consumption) (1974-2003)	2,037,505 lbs. 3980.84 boat-days 54% 88.2%	MSY f_{MSY} B/B_{Vigrin} Effort as % of f_{MSY}	Quota for 2003-2004 1,972,233 lbs. (-400,000 lbs. local consumption) 3511 boat days

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 0.1% of the most conservative MSY. However, if the assessment is based on the addition of local consumption, the TCI government must remember that approximately 400,000 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

The TCI Government has an extensive collection of catch and effort data. However, there needs to be a verification of the stable stocks, since the model appears to indicate a fishery operating near the maximum sustainable level, which is not necessarily an optimum level. Within the next year, the DECR is to conduct another conch visual survey across the Caicos Bank to determine if the stock abundance is indeed near the level predicted by the model. It would also be reasonable for the TCI to conduct conch studies on size and weight to determine growth and mortality rates.

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 warrants 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. It is founded on the belief that all natural marine living resources of the TCI, as well as the environment in which they exist and in which mariculture/aquaculture activities may occur, are national assets and the heritage of all the people, and should be managed and developed for the benefit of present and future generations in the country.

The long-term vision of the Government of the TCI includes:

- Pursuance of well-informed strategic, economic and financial policies, which promote sustainable development and a decent standard of living for the people of the TCI.
- Achievement of greater functional and geographical diversification of economic activity, so as to reduce the TCI's economic vulnerability and to spread the benefits of economic growth more widely among its inhabitants.
- Implementation of policies and strategies to protect the interest of the TCI Islanders, thereby empowering them to derive optimum benefits from the development of the TCI.

- Initiation of measures contributing to the fusion of a dignified and confident nation at peace with itself and the world, a nation whose people believe in themselves and who, in their entrepreneurial, professional and other daily pursuits, and energized by dignity and national pride.
- Provision of sound health and educational services, which are available to all.
- To use our natural resources wisely, being fair to present and future generations.

2.8 References

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Tewfik, A. and C. Bene. (2003). Effects of Natural Barriers on the Spillover of a Marine Mollusc: Implications for Fisheries Reserves. Aquatic Conservation: Marine Freshwater Ecosystem. 13:473-488 p.

3.0 The Queen Conch (*Strombus gigas*) Fishery of Jamaica

3.1 Management Objectives

(i) To monitor and control the conch capture fishery to maintain optimum sustainable yields.
(ii) To promote the rehabilitation of overexploited stocks.
(iii) To obtain an optimum foreign exchange earnings from the export of conch
(iv) To obtain an optimum yield for local consumption by residents and tourists.

3.2 Status of Stocks

The 2002 visual survey assessed two zones, the 10 – 20 m zone, and the 20 – 30 m zone. Thus stock status determination was limited to these two zones. Results are available from three visual surveys as follows.

Year	Less than 10 m zone	10 – 20 m zone	20 – 30 m zone
1994	Surveyed	Surveyed	Surveyed
1997	Surveyed	Surveyed	
2002		Surveyed	Surveyed

10 – 20 m zone: Total abundance (57.9 million conch) in 2002 has decreased by 56% when compared to the 1997 survey (103.5 million conch). The mean exploitable stock density (adults) was 138 conch/ha. This is a 187 % increase over the 48 conch/ha found in 1997 (see Table 1).

It would appear that the abundant recruits in 1997 became adults in 2002, and were replaced by a much smaller recruitment (see Figure 1).

20 – 30 m zone: Total abundance (129.5 million conch) has increased by 26% when compared to the 1994 (102.4 million conch). The mean exploitable stock for the 20 – 30 m zone was 245 conch/ha for 2002, which is 20.7% above the 1994 estimate, which was 203 conch/ha (see Table 1).

3.3 Management Advice

The increase in exploitable stock in the 10 – 20 m zone could be a function of decreased fishing effort from 2000 - 2001 and the entry of conch into the fishery (recruitment) for the period. As it is not clear what may have accounted for the increase in the exploitable stock perhaps it would be prudent to keep exploitation levels stable in the fishery.

3.4 Statistics and Research Recommendations

3.4.1 Data Quality

Catch and effort data

Catch and effort and biological data collection should continue, and should sample the whole fishery (artisanal, mainland and all of the fishery on the Pedro Bank).

3.4.2 Research

- Estimates of unreported catch from Pedro Bank (requires two surveys to be conducted).
- There is a visual survey scheduled for November 2006. If a second survey could be done in a year's time (November 2007), this would allow for a current estimation of survival, fishing mortality, catchability coefficient and unreported catch (see Section 3.8).

3.5 Stock Assessment Summary

(a) Estimates of population density (number/ha) and abundance (total population).
(b) Population structure (size/age)

Table 1 shows estimates of population density and population structure for visual surveys done in 1994, 1997 and 2002.

Table 1. Estimates of mean density per hectare per age/class and total abundance, by management zone

MANAGEMENT ZONE	Year	Sites	Small juvenile	Medium juvenile	Large juvenile	Sub adult	Normal adult	Stoned adult	Total density	Total abundance	Juveniles/ha	Exploitable stock/ha
Artisanal (ART)	**1997**	5	48	92	33	48	65	28	316	11,673,500	222	93
	1994	7	0	8	0	7	20	53	89	3,293,000	15	73
10-20 m												
	2002	36	79	50	22	6	38	77	287	57,887,900	157	115
	1997	17	285	141	11	29	32	16	513	103,481,921	466	48
	1994	40	17	20	2	13	64	88	204	41,146,800	52	152
20-30 m												
	2002							245	350	129,500,000	105	245
	1997	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
	1994	11	12	44	1	16	29	174	277	102,490,000	73	203

NB Abundance was calculated by multiplying the total density by the area of the stratum (37,000 ha, <10 m zone; 201,700 ha, 10 – 20 m zone; 37,000 ha, 20 – 30 m zone)

Figure 1 shows the abundant recruits found in 1997. It is possible that these recruits became adults in 2002, and were replaced by a much smaller recruitment.

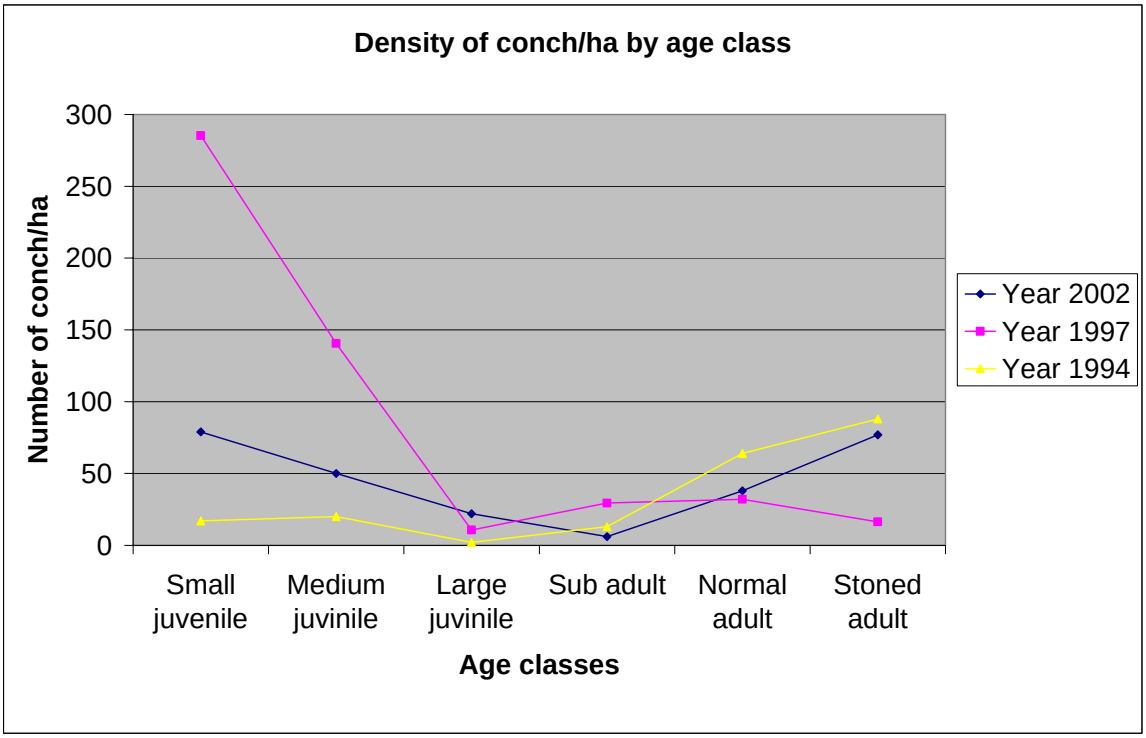

Figure 1. Density of conch/ha by age class observed for the 1994, 1997 and 2002 survey in the 10 – 20 m zone of Pedro Bank.

(c) Determine from the three visual surveys done the amount of unreported catch.

Formula to be used:

$$unreported\ catch = (recruited\ animals + recruits)\ in\ survey\ 1 - recruited\ animals\ in\ survey\ 2 - reported\ catch.$$

We were unable to estimate poaching as we were missing vital information

3.6 Special Comments

None.

3.7 Policy Summary

To manage the capture fisheries resources of Jamaica, to harvest each resource as close as possible to its optimal sustainable yield, which means reversal of over-fishing in overexploited fisheries and increasing fishing effort in under-exploited fisheries, and in the process to recover resource rents to finance the fishery management process.

4.0 The spiny lobster (*Panulirus argus*) fishery of the Bahamas

4.1 Management Objectives

The primary management objective for the spiny lobster fishery is to ensure that spiny lobsters are harvested for maximum economic benefit and in a sustainable manner.

4.2 Status of Stocks

The current status of the lobster fishery is not known. Time constraints did not allow for an in depth analysis of the lobster fishery due to a higher priority being placed on conch.

4.3 Management Advice

Given the great economic importance of the lobster fishery, every effort should be made to improve assessments and take advantage of future assessment opportunities such as those offered by the FAO and CRFM. In addition, efforts need to be made to build the capacity to assess the fishery as needed. This is in order to facilitate the best management possible for the fishery.

4.4 Statistics and Research Recommendations

4.4.1. Data Quality

Data collected by the Bahamas appears to be of sufficient quality to assess the biological status of the fishery. It is unknown if the economic data collected would enable the success of the earlier stated management goal for the fishery to be measured.

4.4.2. Research

For lobster, it is recommended that export data be used to recreate length-frequencies in order to calculate growth rates and mortality rates. This could also be used in conjunction with catch per unit effort data to determine biomass trends. It is also recommended that economic indicators be incorporated into analyses of the fishery in order to measure the success of implementing the goal of the fishery.

Management goals may also need to be revised to reflect a more specific aspect of maximum economic benefit, e.g., maximum employment, maximize profits per fisher or maximize profits for the country.

4.5 Stock Assessment Summary

4.5.1. Spiny Lobster

Records of total weight of commercial export grades were used in conjunction with samples of tail length from each commercial grade in order to recreate tail length frequency (Figure 1) of the catches that the exports originated from. Multiple modes were evident, thus the recreated data appears to be suitable for length-frequency analyses.

4.6 Special Comments

None.

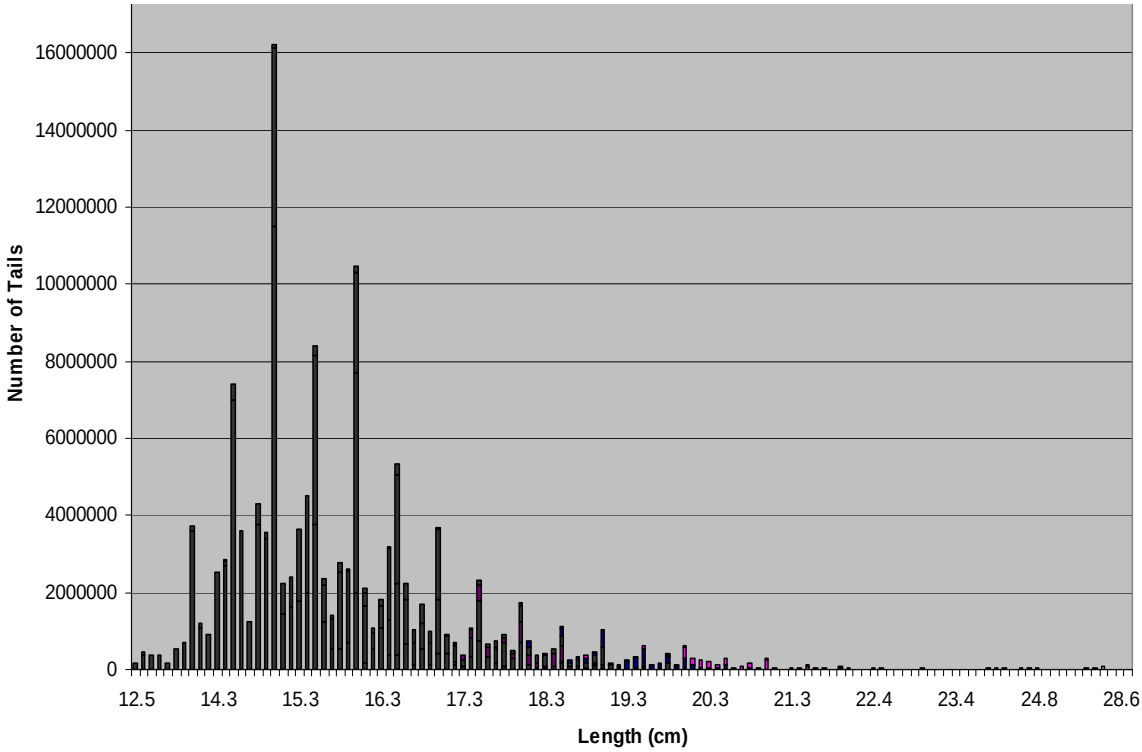

Figure 1. Recreated Tail Length-Frequency Distribution of *Panulirus argus*

4.7 Policy Summary

The policy for the lobster fishery calls for maximum economic benefit to be achieved within the parameters of sustainable utilization of the resource. The limited analyses conducted on spiny lobster at the present workshop did not allow for the policy to be addressed.

5.0 The queen conch (*Strombus gigas*) fishery of the Bahamas

5.1 Management Objectives

The management objective for the conch fishery is to ensure that conch is harvested in a sustainable manner while attempting to meet local demand firstly and foreign demand secondly.

5.2 Status of Stocks

Based on landings and catch per unit effort trends, the conch fishery appears to be stable as a whole. Of particular note in this fishery was that there were signs of little fluctuation in population size in some areas while other areas had evidence of population growth. There were also signs of localized depletions.

5.3 Management Advice

Although there are indications of stability on most fishing grounds, given the uncertainty involved with stock assessments in addition to the relative complexity of this fishery, that spans multiple fishing grounds that each occupy vast areas, additional precautionary management tools are recommended in order to further protect the fishery. Given the insights into the status of different fishing grounds that were made available through the work completed at the present workshop, management tools focused at possibly problematic fishing grounds are also more of a management option.

5.4 Statistics and Research Recommendations

5.4.1. Data Quality

The data provided allowed for the general biological status of the fishery and major fishing grounds to be ascertained. This can thus help to focus the government's limited resources on the areas that most need them and thus help to achieve the goal of managing the fishery in a sustainable manner.

5.4.2. Research

Greater sampling coverage in terms of area specific and total landings estimates and area specific and total catch per unit effort would enhance biological assessments of the fishery and help to determine suitable yields for the fishery. Obtaining growth statistics such as shell length and lip thickness may also enhance assessments of the fishery.

5.5 Stock Assessment Summary

Analyses of catch per unit effort and landings trends indicated overall stability with no strong trend in both indicators of fishery performance when they are considered as a whole over the last 17 years and 27 years respectively (Figures 1 and 2). On an individual basis there were signs of constant abundance (Figures 3 and 4), increasing abundance (Figure 5), decreasing abundance (Figure 6) and low abundance (Figure 7).

In general, the catch per unit effort trends and landings trend concur with anecdotal observations concerning the fishery, i.e., if one area becomes depleted there are many other areas to turn to.

Application of a Schaefer Dynamic Model was also attempted and resulted in a good fit to the observed data. However, the parameter estimates were not stable thus making conclusions from this aspect of the analysis unreliable at the moment.

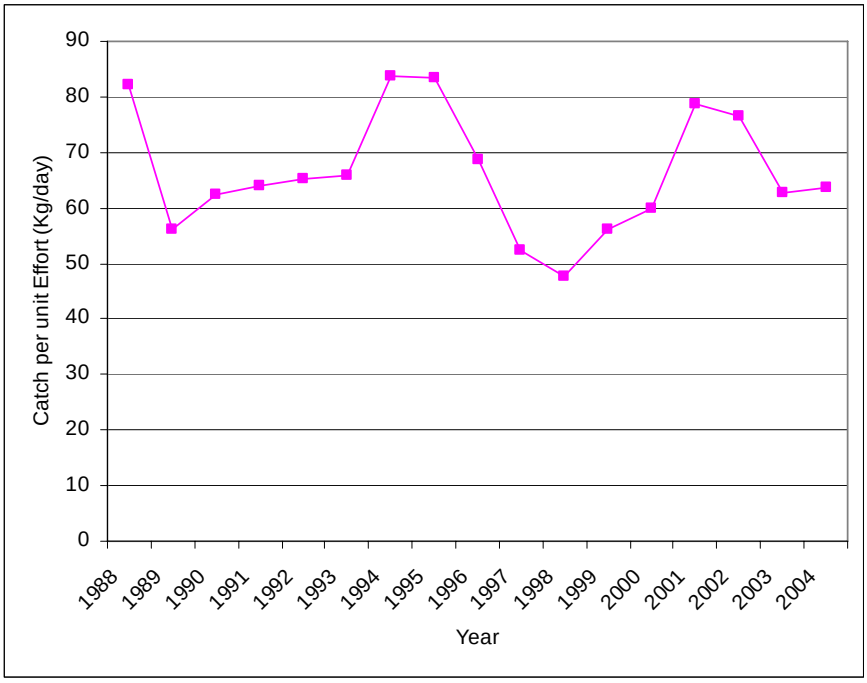

Figure 1: Catch per unit Effort in The Bahamas (1988-2004)

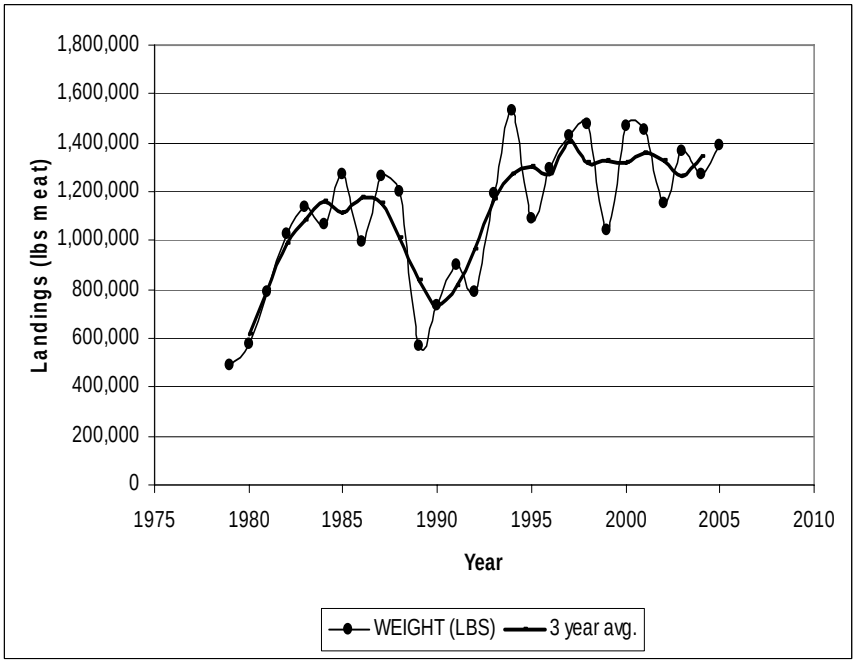

Figure 2: Landings in The Bahamas (1988-2004)

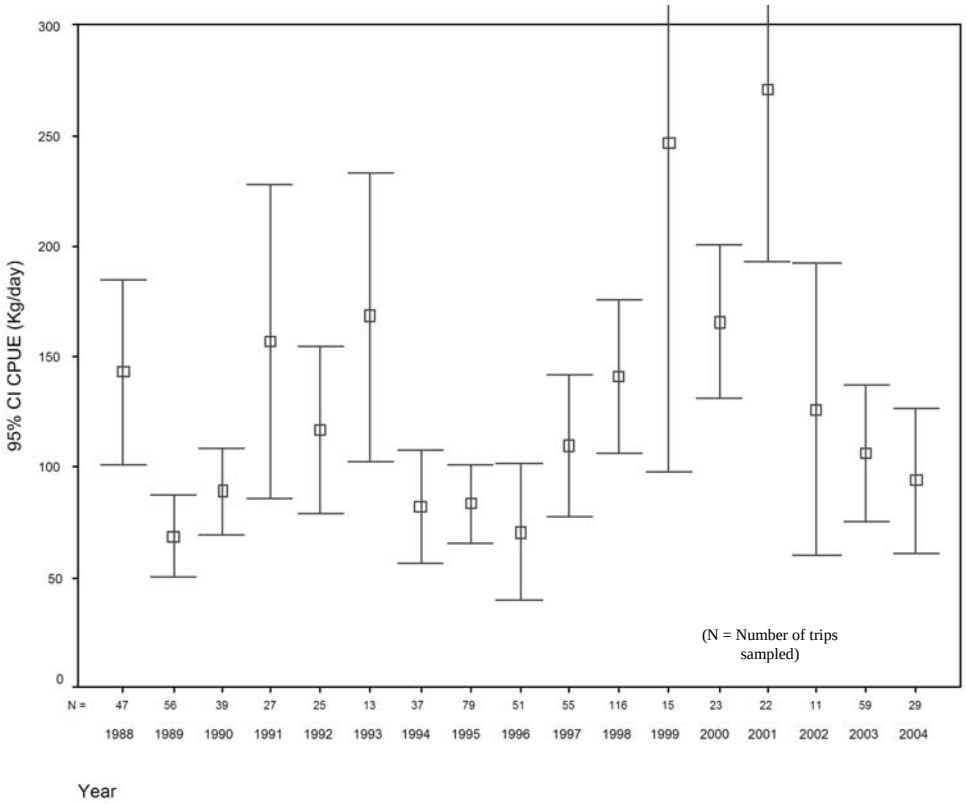

Figure 3: Catch per Unit Effort at Abaco (1988-2004)

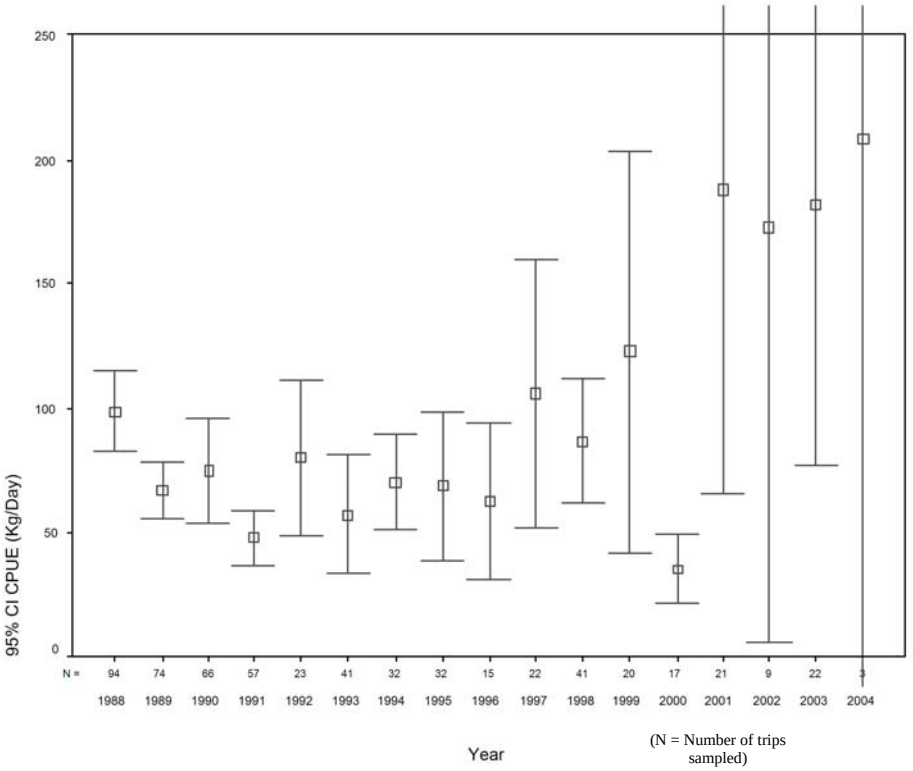

Figure 4: Catch per unit Effort at Andros South (1988-2004)

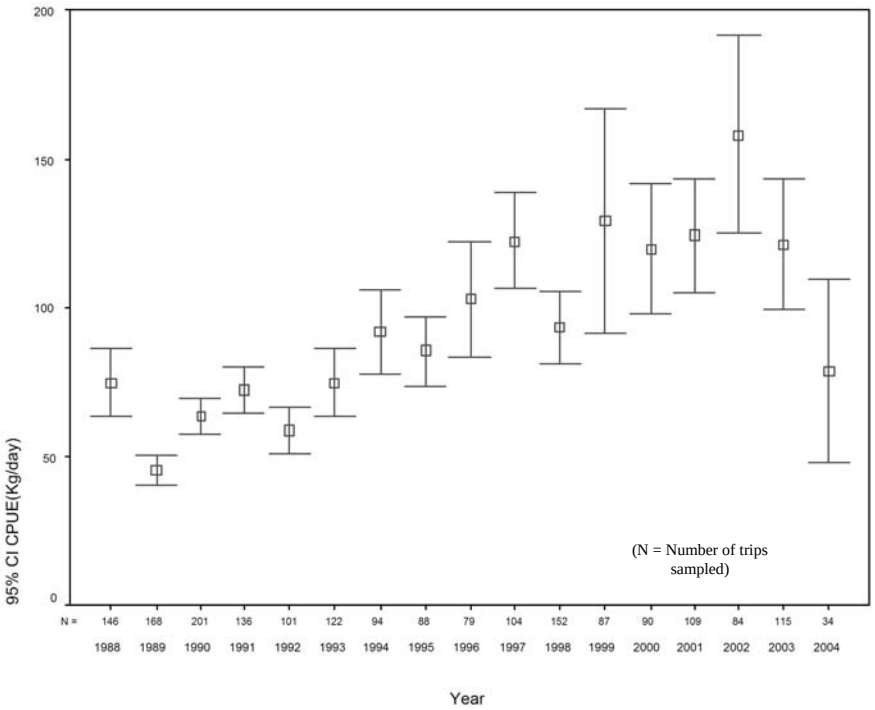

Figure 5: Catch per unit Effort at the Berry Islands (1988-2004)

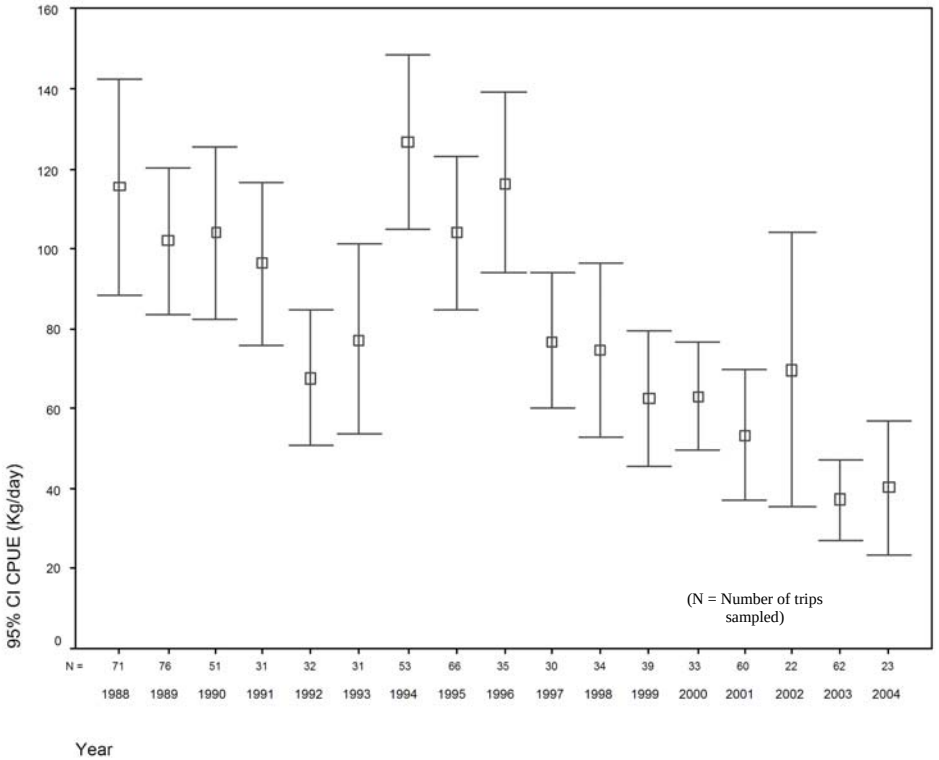

Figure 6: Catch per unit Effort at Fishing Grounds at Exuma (1988-2004)

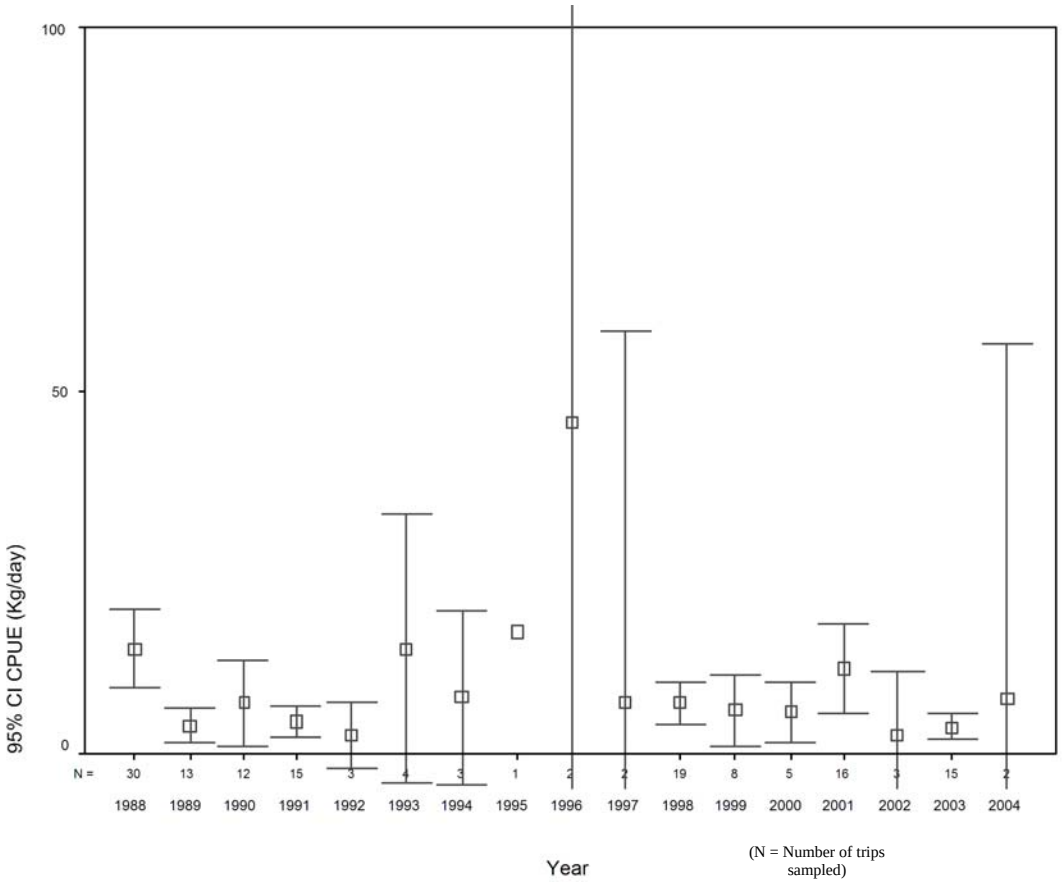

Figure7: Catch per unit Effort at New Providence (1988-2004)

5.6 Special Comments

The last thorough biological assessment of conch fisheries in the Bahamas was completed in 1999 and showed that the fishery was stable at that time with abundant biomass (Ehrhardt and Deleveaux 1999). Analyses conducted at the present workshop give evidence that the conch fishery remains stable and that harvests in the near future will not be detrimental to the fishery.

5.7 Policy Summary

The policy for the queen conch fishery calls for sustainable use of the resource with emphasis on supplying the Bahamian market firstly and the foreign market secondly. The analyses provided during the present workshop suggest that the fishery has been stable overall. Given that commercial exports have been taking place since 1993, the fishery's stability suggests that it can sustain exports in addition to meeting local demand.

5.8 References

Ehrhardt, N. M. and V. Deleveaux. (2001). Report of the Assessment and Management of the Queen conch, *Strombus gigas*, Fisheries of the Bahamas. Nassau. Government of Bahamas.

II. REPORT OF THE SHRIMP AND GROUNDFISH RESOURCE WORKING GROUP

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A. OVERVIEW

Species to be Assessed and Data Available

Groundfish

Three species are listed for assessment (*Cynoscion virescens, Lutjanus synagris, Macrodon ancylodon*). Data for *C. virescens* and *M. ancylodon* were not available at this meeting.

Lutjanus purpureus is listed as one of the species to be assessed under the RSWG Working Group, however, neither the Chairperson nor the Rapporteur for this group were present at the meeting. It was decided to consider this species under the SGWG since the habitat of the species in this case is the muddy-bottom substrate associated with shrimp and groundfish fisheries of the Guianas-Brazil Continental Shelf and not a reef environment.

Guyana: *Lutjanus purpureus*

Catch and effort and length frequency data are available for 1996 to 2005 from hook and line and traps. The government of Guyana is currently considering the promotion of the use of hook and line gear over traps due to environmental concerns with regard to ghost fishing. An assessment was conducted for *L. purpureus* which looked at selectivity and parameters were determined for a YPR.

Trinidad and Tobago: *Lutjanus synagris*

Catch and effort data available for 1995 to 2004 for artisanal gillnet, line and trawl fleets and for 2000 to 2004 for the industrial trawl fleet. Some historical catch and effort data are also available from 1963 and 1975. Length frequency data are available for 1996 to 1998 for artisanal gillnet and lines. A YPR analysis using data from fish pots and trawl gear in Trinidad (Manickchand-Dass 1987) provided biological parameters, which could be used for comparison. It was noted that this resource is considered to be shared with Venezuela however no data are available at this meeting.

Shrimp

Four species are listed for assessment (*Farfantepenaeus notialis, F. subtilis, F. brasiliensis, X. kroyeri*). The rapporteur for *F. subtilis* and *F. brasiliensis,* Ms. Yolanda Babb from Suriname, was not present at this meeting. However data for these two species were still submitted for analysis.

Suriname:

Monthly production, counts of individuals by commercial size categories, number of vessels and days at sea for 2000 to 2004 are available for *F. subtilis* and *F. brasiliensis.*

Trinidad and Tobago:

Catch and effort (1992-2004) and length frequency data (1992-2002) are available for all four species listed as well as *Litopenaeus schmitti*.

Guyana:

Weights by commercial size category, number of vessels and days for 1998 to 2005 for *X. kroyeri* are available.

It was agreed that with respect to Trinidad and Tobago, a previous assessment conducted of the shrimp stocks shared with Venezuela using a surplus production model could be updated. In addition discussions would be initiated regarding the development of a population model in AD Model Builder, which was one of the research recommendations coming out of the preliminary assessment of *F. notialis* and *X. kroyeri* conducted at the First Scientific Meeting in 2004. Depending on availability of time, attempts could also

be made to determine growth parameters from the length frequency data using the software LFDA (Length Frequency Distribution Analysis).

With respect to Guyana, the data for *X. kroyeri* would be used to update and expand the work on a population model previously developed.

The data submitted for Suriname was considered too short a time series to attempt a worthwhile assessment at this meeting. It is known that much more data exists which can be collated and made available for assessment at a future meeting.

Recommendations/Conclusions

General

1. The CRFM should urge countries which are not members of the CRFM but with which resources are shared to attend the CRFM scientific meetings and participate in the assessments. If their participation is not possible, the CRFM should request that they submit the relevant data for analysis. The shrimp and groundfish resources are shared with other countries on the Guianas-Brazil continental shelf which includes countries which are not members of the CRFM (Venezuela, Brazil, French Guiana). Consideration should be given to networking with the FAO/WECAFC Ad hoc working Group on the Shrimp and Groundfish Resources of the Guianas-Brazil Continental Shelf.
2. Species rapporteurs must keep in contact with other country scientists during the inter-sessional period to ensure that all necessary data are available for analysis at the scientific meeting and any preliminary analyses are conducted. Species rapporteurs and country scientists should make every effort to gather and bring to the scientific meetings as much data on the fishery to be assessed including historical data and as much data as are available in as raw a form as possible (unraised) to maximize utility. In many cases the data brought to these scientific meetings are only a small portion of the data that are available. If possible, entire computerized databases can be brought to meetings.
3. Species rapporteurs should review the progress of data preparations at least every four months during the inter-sessional period so that decisions can be made with regard to which species can be assessed at upcoming scientific meetings. For species already assessed, the conduct of further analyses at the next meeting should be conditional on whether sufficient new data are available.
4. The working group need not meet every year unless sufficient new data are available to assess or update assessments. Alternatively the group can meet for only as many days as required before the plenary.

Groundfish

1. Recommendations for improving the data sets for *L. synagris* and *L. prupureus* will be addressed in the inter-sessional period. For the snappers, data and information from other neighbouring countries with fleets exploiting the shared resources, whether as a targeted fishery or taken as bycatch, must be sourced and included in future attempts to evaluate the snapper fisheries. On the national level, all attempts must be made to obtain more representative statistical coverage of gear. Data on the ageing of these snappers would also be very useful for incorporation in assessments.
2. In the absence of Suriname, who had initially recommended the placement of *M. ancylodon* and *C. virescens* on the list of species to be assessed, it was decided that the current groundfish species listed remain unchanged. However another species, *Micropogonias furnieri* (Whitemouth croaker) which is a main groundfish species in Trinidad and Tobago, will be added for future analyses. In addition, *L. purpureus* will remain as one of the species listed under the SGWG.

Shrimp

1. It is recommended that for the next meeting a joint assessment can be attempted for Guyana and Suriname. *F. subtilis* and *F. brasiliensis* were identified by Suriname as priority species for assessment at this meeting and as indicated above this was not achieved. The CRFM would need to obtain feedback from Guyana and Suriname regarding this recommendation and the identification of priority species for the next meeting. It is felt that at the very least a surplus production model for all shrimp species (as was done for Trinidad and Tobago and Venezuela) can be developed. This may require an inter-sessional meeting to prepare datasets. The species identified for analysis at the Third Scientific Meeting are the four species listed for the Second Scientific Meeting, namely *F. subtilis, F. brasiliensis, F. notialis*, and *X. kroyeri*. In addition, *Litopenaeus schmitti* would be added to the list.
2. The surplus production model for Trinidad and Tobago and Venezuela can be updated every few years. If a closed season is implemented in either or both countries the CPUE can be monitored and the model updated. The model can also be further developed to address specific management questions if required. It may be useful to include data for Guyana and Suriname in this production model.
3. Develop a species-specific population model, which would provide more detailed management advice and which could be applied to the shrimp fisheries of Trinidad and Tobago, Guyana and Suriname where length frequency data are available.
4. During the inter-sessional period Trinidad and Tobago will attempt to estimate growth parameters from the length frequency data using Length Frequency Distribution Analysis (LFDA). Morphometric relationships will also be determined.
5. Jamaica is interested in assessing their shrimp resources at a future scientific meeting as soon as the necessary data can be compiled.

References

Manickchand-Dass, S. (1987). Reproduction, age and growth of the lane snapper, *Lutjanus synagris* (Linnaeus), in Trinidad, West Indies. *Bulletin of Marine Science,* Vol. **40**, No. 1: 22-28 p.

B. FISHERIES REPORTS

1.0 The Atlantic Seabob (*Xiphopenaeus kroyeri*) Fishery of Guyana

1.1 Management Objectives

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

- To maintain the seabob stock at all times above 50% of its mean unexploited level.
- To maintain all non-target species, associated and dependent species above 50% of their mean biomass levels in the absence of fishing activities.
- To stabilize the net incomes of the operators in the fishery 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.

1.2 Status of Stocks

The data are not sufficient to determine the status of the stock precisely. However, the preliminary results from the assessment indicated that the seabob fishery is fully- to over- exploited.

1.3 Management Advice

The current closed season should be moved from September to May. Empirical and theoretical results indicate that the smallest shrimp are landed in May, when the largest recruitment occurs, and therefore the most should be made of these new recruits by allowing them to grow.

The current closed season should be increased from 6 weeks to 8 weeks. The results from this assessment indicate that there would be an overall improvement in yield with increasing the length of the closed season.

A precautionary approach to exploitation should be adopted. Current fishing effort needs to be limited to current levels and will probably need to be reduced in the longer term. A longer closed season will also contribute to controlling the effective fishing mortality. The sizes of shrimp have been falling, which is consistent with a significant increase in fishing mortality detected by the stock assessment.

1.4 Statistics and Research Recommendations

1.4.1 Data Quality

Catch and effort data quality needs to be improved. Raw data records need to be reviewed and computerized, so that accurate, reliable catch and effort statistics can be produced. Some trip sampling data may also be available, but will need to be computerized to be used in assessments.

1.4.2 Research

It is strongly recommended that a biological sampling programme be initiated for at least one year to obtain seasonal changes in size, sex and maturity compositions. This information can be used to improve the assessment and verify optimal placement and length of the closed season.

1 Because the working group was unable to address the current management objectives in the draft management plan, it recommends that data collection be reviewed to identify data variables and methodology appropriate for these objectives.

2 Guyana should combine data with Suriname for a joint assessment. It is likely that the seabob stock is shared between Suriname and Guyana. This will also give an opportunity to explore simpler models, which may give more reliable management advice on stock status. It will be

necessary to reconstruct a time series particularly of total catch and, to a lesser extent, effort data, to allow the stock status to be evaluated.

3 A time series of an environmental variable to link to recruitment and stock productivity (e.g. growth rate) should be gathered to help determine past population dynamics and provide the basis for predicting future catches. This would also be useful in determining alternative management controls if required, such as individual quotas which could be allocated to the fishing industry.

1.5 Stock Assessment Summary

A virtual population analysis was carried out on the commercial size category catch data, fitted to the available effort data. Catches are reported in size categories by the fishing industry. No data were available to check the size distribution within these categories as would be provided by a biological sampling programme. Effort is measured as number of trips, but is estimated from the number of registered vessels rather than observed directly.

The catch-at-size data were converted from size to age using a growth model. No growth model parameters were available for this species in Guyana, but reasonable parameter estimates were available for this species from the scientific literature.

Once acceptable catch-at-age data are available, a standard assessment method can be applied to obtain fishing mortality (approximately the proportion of the stock being removed by fishing) and selectivity. These results were used in a yield-per-recruit.

A yield-per-recruit (YPR) account for the effective weight each new shrimp recruited to the stock contributes to the catch. It allows for the fact that shrimp are growing, so when they are caught they contribute increased weight when they are older, but that they are also dying from natural causes, so that as they get older there are also fewer of them. As the stock is fished harder, the catch tends to consist of larger numbers of younger smaller shrimp (Figure A). This will tend to increase the yield but with diminishing returns. The YPR used the selectivity and fishing mortality estimates from the virtual population analysis.

Yield-per-recruit was used to advise on the length and timing of the closed season. Increasing the closed season delays fishing allowing the shrimp to grow. The yield-per-recruit was maximized with a closed season between 2 and 3 months. A greater proportion of small shrimp are landed in May (Figure B). As a result, it was found that yield-per-recruit from a closure in May would provide the greatest benefit to the fishery (Figure C).

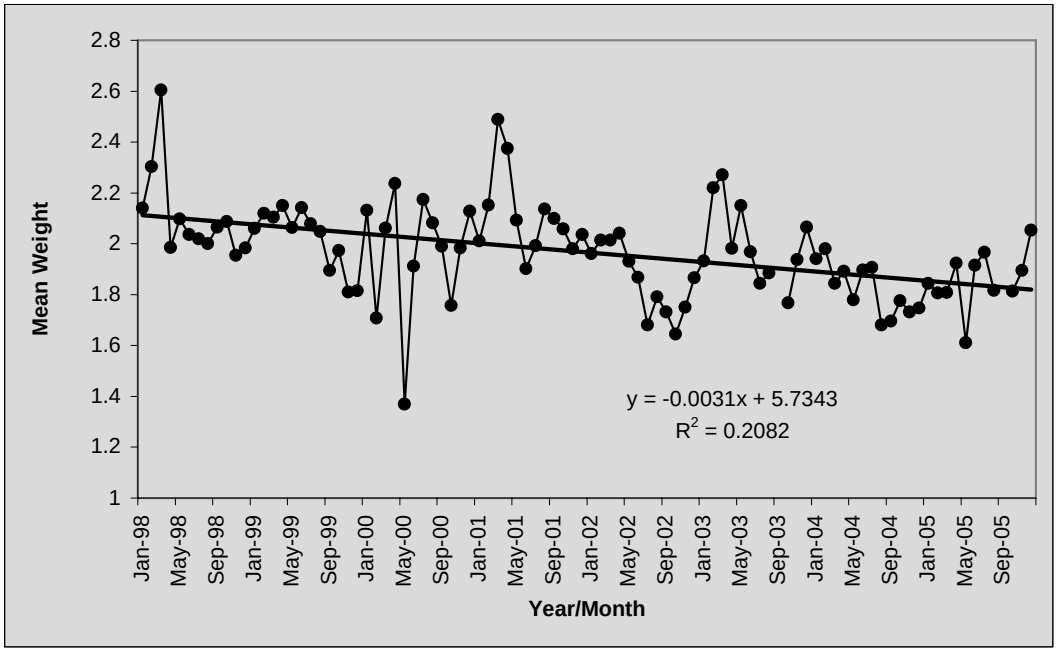


Figure A. Mean size of shrimp estimated from the commercial size composition data. The linear trend line indicates a decline in average size over the seven year period consistent with increasing fishing mortality.

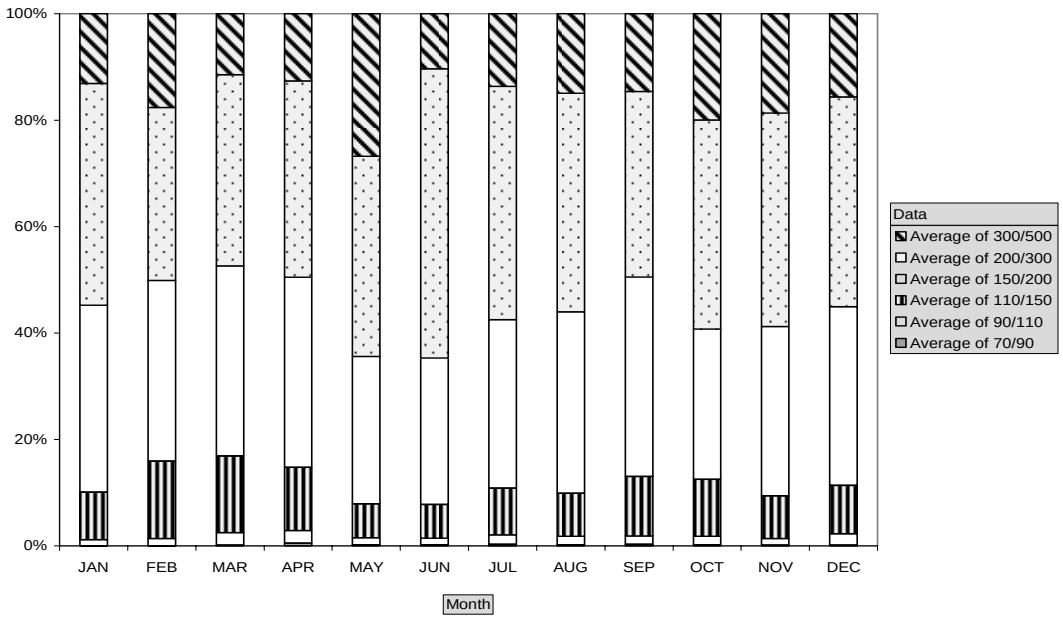


Figure B. Commercial size category composition of seabob for each month as reported by the fishing industry. The smallest shrimp seem to be landed in May. There is some evidence of growth as the 300/500 category shrinks and the 200/300 category expands in June.

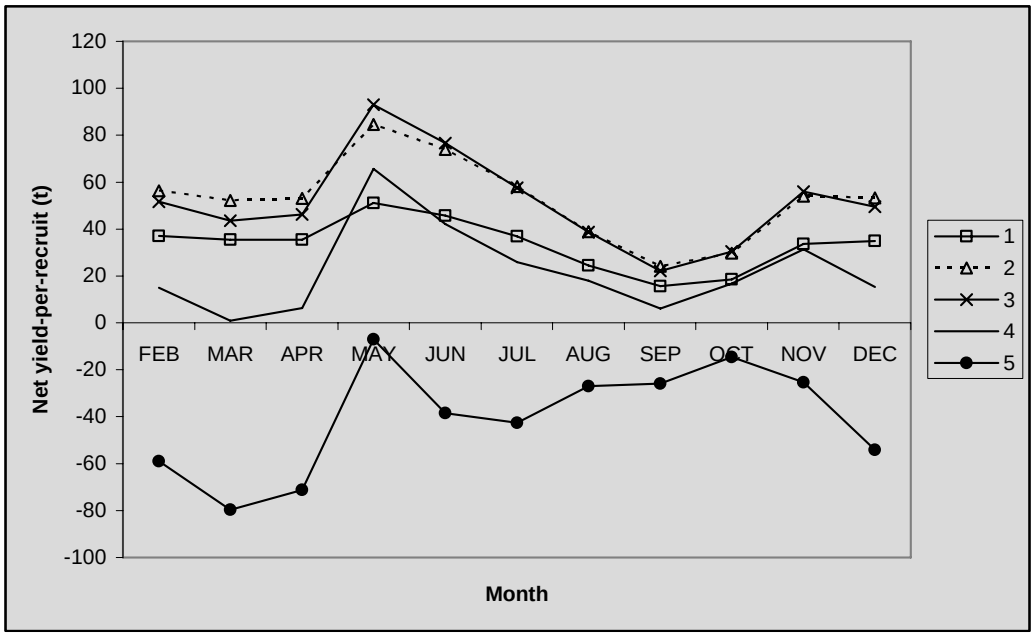


Figure C. Yield-per-recruit score for season closure in each month. A closure of 2 or 3 months gives maximum benefit, close to the current closed season in September / October of 1.5 months. It is most apparent, however, that most benefit would be obtained from a closure in May and June, when the majority of the smallest shrimp are landed.

1.6 Special Comments

The management objectives set out in the Draft Fisheries Management Plan could not be addressed because the data were not sufficient to estimate the necessary indicators. Thus, the Draft Fisheries Management Plan must be revised and/or the data being collected need to be reviewed in order to meet the management objectives.

1.7 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.

2.0 The Shrimp Fisheries Shared by Trinidad & Tobago and Venezuela

2.1 Management Objectives

The management objective for the shrimp trawl fishery of the Government of the Republic of Trinidad and Tobago is "full utilisation of the resource consistent with adequate conservation, and minimal conflict between the artisanal and non-artisanal components of the fishery" (Fisheries Division and FAO, 1992). Within the context of this assessment, the primary objective is interpreted as maintaining the stock size above that required for maximum sustainable yield (MSY).

2.2 Status of Stocks

The overall shrimp stock is overfished relative to the MSY. The stock biomass is declining. Current catches probably cannot be maintained in the long term.

For many of the years since 1988, the shrimp catches have been unsustainable with landings being greater than the estimated MSY. The biomass at the MSY is estimated to be half of the unexploited biomass, and the biomass since 1988 has been below the biomass at MSY and declining steadily to the current time.

2.3 Management Advice

The target sustainable yield should be between 1583 and 1905t to avoid overexploitation. It is recommended that new fishing controls be introduced (in both Trinidad and Tobago and Venezuela) to decrease the total number of days at sea permanently in order to allow the stock to rebuild. Two such controls are recommended below followed by two general recommendations for the management of the trawl fishery.

(1) Implement a closed season for trawling. Projections for the catch per day and annual catch per vessel were explored under a range of scenarios including: no change; 2% increase in effort per year; and a closed season ranging from one month (January) to four months (November to February) (Figures 1 and 2). The months for a closed season should be those when the greatest percentage of small shrimp is landed. The results suggest that there could be considerable benefit from rebuilding the stock. The disadvantage is that there will be an initial loss to the fishery during the rebuilding process (Figure 1).

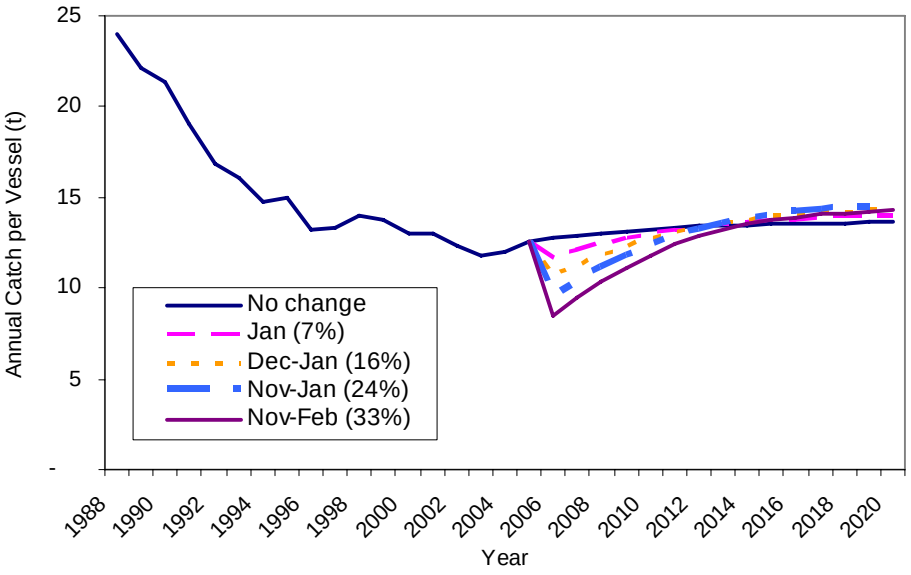


Figure 1. Estimates of the impact of implementing different closed seasons on the average shrimp catches for a representative reference vessel. The total catches and therefore annual earnings from a vessel will show an initial dip, but this should be followed by a longer term recovery increasing above the "no change" trajectory after 6 years.

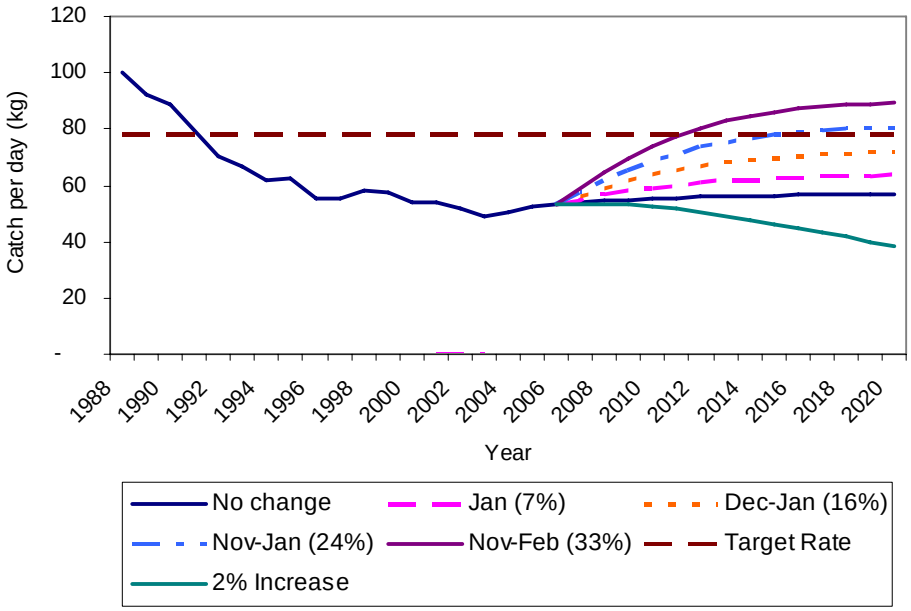


Figure 2. Projected catch per unit effort changes under different management actions. The target rate is the catch per day at the MSY. The model indicates that maintaining the current fishing effort will maintain the "status quo" and allowing effort to increase, will result in a fall in CPUE and hence a decrease in vessel earnings. Closures of one to four months should bring about a recovery.

The following activities are recommended as part of the groundwork in implementing a closed season:

- Investigate the social and economic implications of the closed season option.
- Prepare a strategy in consultation with the stakeholders as to how the closed season option should be implemented. This may include compensation or alternative employment opportunities for fishers during the closed season.

(2) Limit the numbers of trawlers with a view to reduction in fleet size:

- Update fisheries legislation to facilitate a limited entry fishery
- Implement a licensing system for trawlers

(3) Strictly enforce the current regulations for the trawl fishery as this will contribute to the sustainability of the stocks. The Fisheries [Control of Demersal (Bottom) Trawling Activities] Regulations 2001 specify a minimum cod-end mesh size as well as areas of operation including a zoning regime in the Gulf of Paria according to trawler type.

(4) Set appropriate and specific reference points for the fishery, that is, constraints within which the fishery must operate, since the management objectives for this fishery outlined in the policy document and management plan are very broad. Key issues to be considered are how the fishery will be monitored and how and what controls can be applied to affect the performance. This should be addressed through discussions among all stakeholders.

It should be noted that this analysis assumes the decline is due to fishing alone. During consultations, while accepting overfishing has a role, stakeholders have indicated that pollution from the oil industry may also have contributed to the decline in shrimp biomass. This implies that estimates of recovery may be over-optimistic, but may only be determined once management has reduced fishing mortality.

2.4 Statistics and Research Recommendations

2.4.1 Data Quality

(1) Review historical records and consult with Trinidad industrial trawl fleet operators in an attempt to verify or refine shrimp catch estimates prior to the year 2000 when sampling of this fleet was very low or non-existent. Since this fleet takes a large proportion of the total catch, poor estimates will add considerably to the uncertainty of the assessment.

(2) Continue and complete computerization of the Trinidad historical catch and effort data from the 1950s to the present. The 1975 base year was important in estimating the unexploited state and hence MSY and the current state of the stock.

(3) Obtain more detailed information, including on species life history, to account for other factors affecting productivity, such as pollution, which was suggested as a contributing factor by stakeholders.

2.4.2 Research

(1) Develop a species-specific population model which would provide more detailed management advice. Activities would include developing software, improving growth parameter estimates and morphometric relationships, and developing time series of environmental variables, including levels of pollution. This model will provide the basis to address the concerns of stakeholders as it would be able to include pollution effects. Some progress has been made on this research area.

(2) Determine growth parameters from the Trinidad shrimp length frequency data using such software as Length Frequency Distribution Analysis (LFDA). This was begun at the meeting and should be continued during the inter-sessional period. These parameters will be input for the model in (1) above.
(3) Refine morphometric relationships for input to population model in (1) above. This activity is currently in progress and should be continued during the inter-sessional period.
(4) Re-run the current model to provide better estimates of parameters. If management action is introduced resulting in a reduction of the fishing mortality, the recovery in CPUE should improve the model's ability to detect the state of the stock and predict optimum management actions. No other special action, apart from implementing the recommended management controls, will be needed.

2.5 Stock Assessment Summary

The assessment used the simplest biomass dynamics model, which provides advice on a limit reference point, the MSY. This limit reference point can be used to restrict the risk of unsustainable fishing to an acceptable level. All shrimp catches from the Trinidad and Tobago and Venezuela trawl fleets were treated as a single stock in the model since the group felt unable to disaggregate Trinidad catches by species accurately. The assessment is an update of that conducted under the FAO/WECAFC ad hoc Working Group on Shrimp and Groundfish Fisheries of the Guianas-Brazil Continental Shelf.

The model requires a complete series of catch data and as long a series of catch-per-unit effort (CPUE) data as possible. Total catches for the period 1988 to 2004 had to be reconstructed from various sources, and two possible time series of catches were used to check the robustness of the procedure to estimate catches. CPUE data were provided for four Trinidad trawl fleets and two Venezuela trawl fleets.

Additional information was necessary to determine the state of the stock in 1988 when the population model was started. It is known that the stock was relatively lightly fished in 1975, with an approximate total catch around 600t. This was used to estimate the approximate stock state in 1975, which helps to provide a useful reference point, the expected CPUE when the stock was only lightly fished.

The Trinidad Type IV (industrial) fleet index was not used since only part of the series (2000-2004) was considered reliable (as sampling of this fleet prior to 2000 was poor or non-existent) and this part has no trend in common with the other indices. As such only using this period does not make any difference to the fit.

A reasonable fit for the model was obtained with relatively stable results. The general results indicate the state of the stock is well below MSY and the current fishing mortality is causing the stock to continue to decline. The biomass appears to have consistently declined since 1988 (Figure 3). The MSY is in the region of 1700t and catches higher than this will not be sustainable. Rebuilding the stock could realize 35-80% increase in the current catch rate, while making the same catch as currently being landed. A benchmark vessel obtaining a catch per day of 105kg in 2005 could obtain a catch per day of 156 kg at MSY (49% increase).

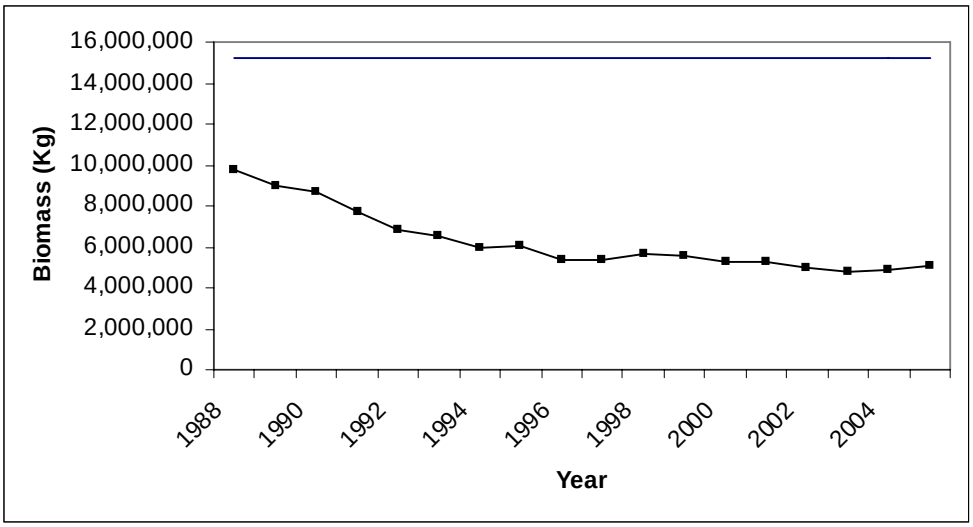


Figure 3. Estimate of stock biomass relative to the unexploited state (top line) shows a steady decline since 1988 following the average CPUE trend.

2.6 Special Comments

The shrimp stocks of Trinidad and Tobago are assumed to be shared with neighbouring Venezuela and hence any assessment of these stocks should ideally be done jointly with Venezuela with management recommendations being applicable to the fisheries of both countries. Joint assessments using shrimp data from both countries have been conducted in the past through the FAO/WECAFC Ad hoc Working Group on the Shrimp and Groundfish Resources of the Guianas-Brazil Continental Shelf. Venezuela should be urged to participate in the CRFM Scientific Meetings or, if this is not possible, to submit the relevant data for analysis.

2.7 Policy Summary

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

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

The current assessments address primarily objective (2). The Government recognizes that a major factor contributing to over-fishing and over-capitalisation is the present “Open Access” regime, which allows unregulated fishing effort. The Government in association with the fishing industry will attempt to manage fishing effort on the resources by controlling the number and type of local vessels within a given limit, and by implementing time and area closures, and fishing gear changes. The Government will

embark on a licensing programme for all commercial fishing vessels as a means of monitoring the effort applied to the fisheries. Bearing in mind the stability fishing has traditionally provided to rural communities, the Government will give priority to the maximization of employment opportunities through the development of projects for those displaced from the fishery due to effort limitations. The Government will also, through negotiation with neighboring countries, aim to reduce levels of fishing effort on shared fishing grounds. It will also increase its capacity for fisheries surveillance to prevent unauthorized fishing operations in the waters of Trinidad and Tobago. With regard to financial assistance to the fishing industry, the Government intends to phase out many elements of the concessions, rebates and incentives since increased fishing activity is not to be encouraged.

2.8 References

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

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

Fisheries Division, Minist. of Agriculture, Land and Marine Resources. (2002). Draft Strategic Plan 2002/ 2005.

3.0 The Red Snapper (*Lutjanus purpureus*) fishery of Guyana

3.1 Management Objectives

According to the Draft Marine Fishery Management Plan for Guyana (Revised February 2006), the management objectives for this Fishery are to:

- 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.

3.2 Status of Stocks

The preliminary results from the present analysis indicate that the stock may be overfished.

3.3 Management Advice

Given the possibility that the stock may be overfished current levels should be reduced. However, the precise optimal levels of effort have not been reliably determined. Further extensions of the model are required to set proper reference points. It may be possible to improve the exploitation pattern as well as alter the overall effort. This technical solution to improving yields may include changes in mesh size and gear types, if these management measures are considered acceptable.

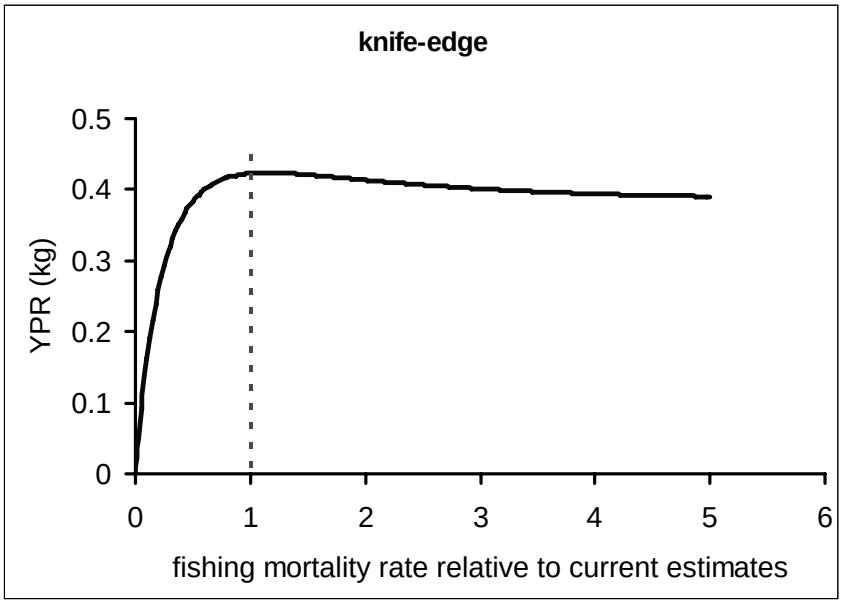
3.4 Statistics and Research Recommendations

- On-going collection of a minimum, accurate and adequate catches, effort, size frequency and age data
- There is a clear needed to collect catch and effort data for all months and areas where fishing is occurring and to take this information into account when developing CPUE series.
- Produce regular national updates of assessments to determine the status of stocks and desirable management measures such as suitable effort
- Collection of data for each month etc including data for Pots and Traps and Trawls.
- Collaborate with countries such as Suriname, Venezuela and Brazil for stock assessments.
- Raise and compute length frequencies at various areas.

3.5 Stock Assessment Summary

Catch per unit effort (CPUE) series were generated for the hook and line fishery from 1995-2005 for all months combined and for July and August in particular (summer period). Available landings and CPUE statistics represented only a fraction of the total fishery. Instead, the fishing mortality was estimated from the length frequency data alone using a modification of the mean-size method of Gedamke and Hoenig (1995) by C. E. Porch (unpublished Excel spreadsheet). This model is similar to that published by Beverton and Holt (1958), but allows the fishing mortality rate to vary through time and fits a series of annual mean-size observations. The preliminary results from the present analysis indicate that the stock may be overfished.

The assessment appears to indicate that overfishing is occurring in the sense that the fishing mortality rate is probably greater than the natural mortality rate. From a maximum yield per recruit perspective the fishery appears to be operating near optimally under either assumed selection pattern (see Figure A); however, continued fishing at this level implies a belief that future recruitment will continue at current levels.



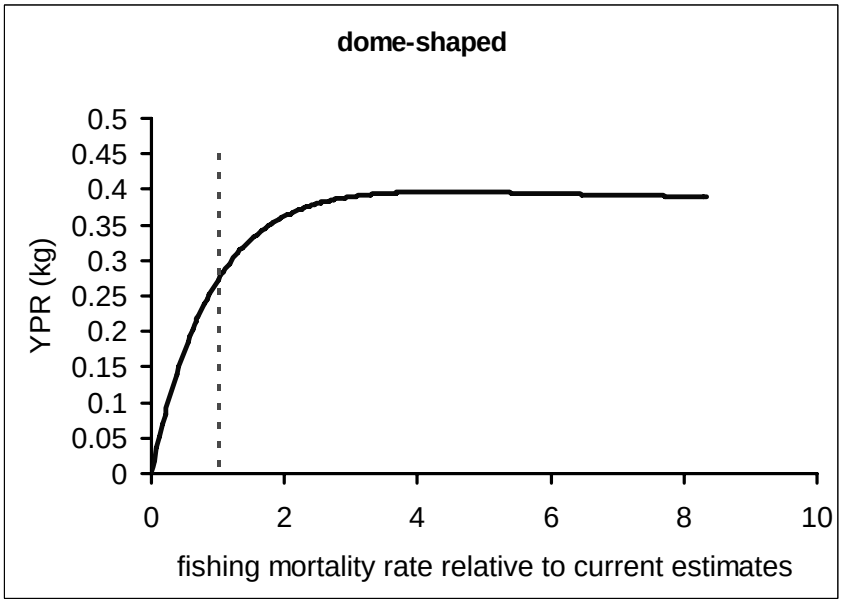


Figure A. Yield-per-recruit estimated assuming the knife-edge and dome-shaped selection patterns. The horizontal axis may be interpreted as effort levels relative to the current levels estimated under the corresponding assumed selection patterns.

3.6 Special Comments

All catches need to be assembled for this multispecies, multigear fishery. Total catch data by gear are required because of this only one gear was analyzed. Data from other countries such as Suriname and Venezuela are needed so that a comparison analysis can be done among the countries as the resource is shared.

3.7 Policy Summary

The policy summary is 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.

3.8 References

Gedamke, T. and Hoenig, J. M. (2006). Estimating mortality from mean length data in non-equilibrium situations with application to the assessment of goosefish. *Transactions of the American Fishery Society*. **135**:476-487.

4.0 The Lane Snapper (*Lutjanus synagris*) fishery of Trinidad and Tobago

4.1 Management Objectives

General management objectives for the marine fisheries of Trinidad and Tobago were used as a guide to this assessment with particular note to the objectives that state:

- Ensure through proper conservation and management, that the fisheries resources are not endangered by over-fishing" and
- Ensure that the exploitation of the fisheries resources and the conduct of related activities, are consistent with ecological sustainability (eg for target and non-target species, and marine environments) (Fisheries Division and FAO, 1992)

4.2 Status of Stocks

Results of the assessment indicate a high fishing mortality rate, which may have affected the overall biomass however it appears that recruitment has not been affected. Results suggest that the landings of the lane snapper, *L. synagris*, are largely comprised of fish less than 2 years old and before they can spawn. Results also suggest that the population of *L. synagris* in Trinidad is not a unit stock, but part of a larger population on the adjacent continental shelf that is perhaps not so heavily exploited and supplies a steady stream of recruits into Trinidad waters.

4.3 Management Advice

The Working Group noted that there were data gaps that influenced the ability of the assessment to give good results. In view of the need to review the quality of the available data for the fishery there is no specific management advice at this time. In the short term fishing effort should be monitored and not allowed to increase.

4.4. Statistics and Research Recommendations

4.4.1 Data Quality

Data from Venezuelan fleets operating in the Gulf of Paria and the Colombus Channel need to be included in future attempts to evaluate the fishery.

Catch and effort data from the offshore fishpot fleet in Trinidad and Tobago need to be collected to obtain more representative statistical coverage of fishpot activities.

Catch per unit effort need to be derived from nominal data to eliminate biases, especially with regard to sampling area that may occur from raising to total catches.

Total landings of the species need to be improved by extracting the information for *L. synagris* that is currently recorded under broad species categories or within mixed groups of fish.

4.4.2 Research

Studies on the local migration and distribution patterns of the lane snapper aimed at identifying the extent of stock distribution need to be undertaken. These studies will be able to corroborate the validity of the assumption that there may be constant recruitment and to determine possible factors contributing to the apparent high fishing mortality values.

Given the proximity of Trinidad to Venezuela, the extent to which the existing stocks in the Gulf of Paria and off the south coast of Trinidad are shared with Venezuela needs to be established. In this respect, it is recommended that joint length based assessments between Trinidad and Tobago and Venezuela for the snapper should be conducted.

There is also uncertainty as to whether the lane snapper caught by Trinidad and Tobago and other countries on the Brazil-Guianas Shelf belong to a unit stock. It is therefore recommended that length frequency data from the 1988 Fritdjof Nansen fish surveys in the region be sourced and assessed to help determine this. Tagging studies and aging of fish can be conducted to obtain estimates of mortality and selection to corroborate the results of this assessment.

4.5 Stock Assessment Summary

The analysis utilized recent (1995-2004), historical (1963, 1975) and reconstructed (1908 to current) annual catch per unit effort (CPUE) levels for artisanal gillnet, line and trawl fleets operating in Trinidad in addition to length data obtained from fishpot and banking (handline) in 1996-1997. Biological parameters were obtained from a previous assessment for the lane snapper in Trinidad (Manickchand-Dass, 1987).

The assessment utilized two programmes: (a) a mean size model that observed growth using the length frequency information (Gedamke and Hoenig 1995); and (b) a catch-free model that observed stock abundance trends and fishing mortality from CPUE information (Porch *et al*. 2006).

(a) Mean size Mode:
Mean lengths showed that selection of fish from as early as age 1 was common and selectivity for fishpots and banking were similar after an age of two years. This implied that the availability of all fish sizes above 30 cm is the same for both gears in spite of their very different natures.

The truncated length composition data used in this model suggest a highly exploited population.

(b) Catch-free Model:
The stock was assumed to be only lightly exploited prior to 1950.Fishing mortality was estimated using the time series of reconstructed total landings as an index of relative fishing effort for the years prior to 1994.

CPUE indices for seven gears were examined. Five indices showed relatively flat trends (multifilament gillnet, monofilament gillnet, a la vive, semi-industrial trawl, banking). Two indices suggested recent increases in abundance (artisanal trawl, fish pot). Figure 1 shows the relative CPUE derived for artisanal gillnet, line, fishpot and trawl.

The estimates of fishing mortality and spawning biomass that were generated are somewhat uncertain and, contrary to the mean size model, they generally indicate a lightly exploited population that is well above the level that would produce the maximum sustainable yield with the current selectivity pattern.
The flat or increasing CPUE trends over time suggest that recruitment of ages 1 and 2 individuals to the fishery has not changed a great deal.

Overall, results indicate that there may be a constant recruitment to the lane snapper fishery in Trinidad since in spite of the high fishing mortality the CPUE trends are relatively constant. It is also possible that the rarity of larger animals in the catch is partly due to emigration out of the fishing area which was not accounted for in the mean size model and may have lead to over-estimates of fishing mortality.

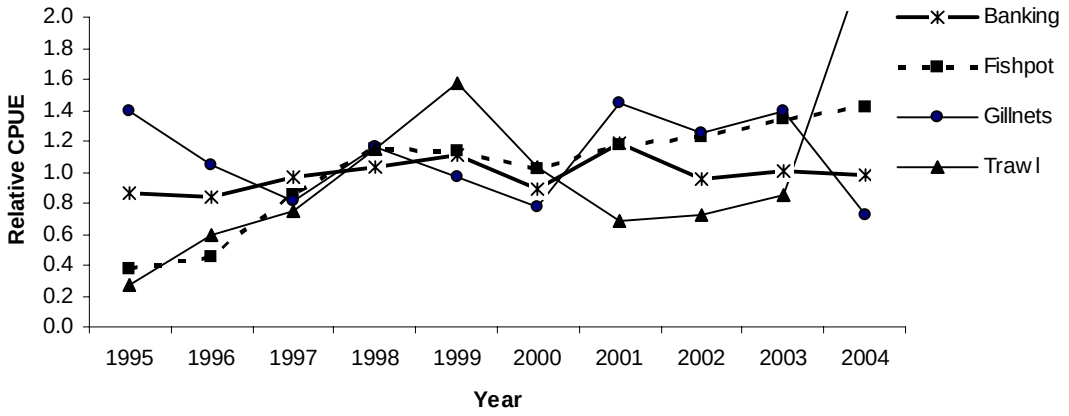


Figure 1: Relative catch per unit effort (CPUE) for artisanal gears including gillnets (monofilament and multifilament), lines (banking), fishpot and trawl (artisanal fleet only), for 1963, 1975 and the period 1995-2004.

4.6 Special Comments

None.

4.7 Policy Summary

Trinidad and Tobago is currently updating its fisheries policy. The management objectives and main policy directions as however outlined in the marine fishery policy document (Fisheries Division and FAO, 1994).

4.8 References

Fisheries Division. (1994). Policy Directions for Marine Fisheries of Trinidad and Tobago in the 1990's. Policy Mission Report of the FAO Project TCP/TRI/2352[A].

Gedamke, T. and Hoenig, J. M. (2006). Estimating mortality from mean length data in non-equilibrium situations, with application to the assessment of goosefish. *Transactions of American Fishery Society*. **135**: 476-487.

Manickchand-Dass, S. (1987). Reproduction, Age and Growth of the Lane Snapper *Lutjanus synagris* (Linnaeus), in Trinidad, West Indies. *Bulletin of Marine Science*, **40** (1): 22-28 p.

Porch, C. E., Eklund, A. and Scott G. P. (2006). A catch-free stock assessment model with application to goliath grouper (*Epinephelus itajara*) off Southern Florida. *Fishery Bulletin*. **104**: 89-101 p.

III. REPORT OF THE LARGE PELAGIC FISH RESOURCE WORKING GROUP

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The king mackerel (*Scomberomorus cavalla*) fishery of Trinidad and Tobago

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A. OVERVIEW

As agreed at the plenary session of the 1st Annual CRFM Scientific assessment meeting held in St. Vincent in 2004, the Large Pelagic Fisheries Working Group for this the 2nd Scientific Assessment workshop consisted of Mr. Christopher Parker (Barbados) as Working Group Chairman and species rapporteur for dolphinfish and Ms. Louanna Martin (Trinidad and Tobago) as rapporteur for king mackerel.

At this meeting, Dr. Daniel Hoggarth (SCALES - Great Britain) and Dr. Joshua Nowlis (Southeast Fisheries Science Center - USA) were the assessment advisors attached to the Working Group. Kristen Kleisner (RSMAS - USA), a student of Dr. Nowlis, also participated in the working group.

During the period of work the entire Working Group met formally on three occasions to discuss common issues.

- The first order of business for the group was the formation of individual species assessments groups. It was agreed that Dr. Nowlis and Ms. Kleisner would work with Mr. Parker on dolphinfish and Dr. Hoggarth would work with Ms. Martin on King Mackerel assessment. It should be noted that Serra Spanish mackerel was not assessed at this meeting as the information recommended at the 1st scientific meeting for advancing the assessment had not yet been obtained.
- The group agreed that decisions pertaining to the most appropriate data analyses to be conducted on the two species being assessed would be left to the species assessment sub-groups and would be mainly controlled by the type and quality of available data.
- It was agreed that the individual species assessments would be reported in separate documents following the format previously used for the 1st Scientific Meeting.

During the course of the meeting the group agreed on a number of issues that they considered should be raised at the general workshop plenary session. Following is a brief summary of these points. It should be noted that the more detailed recommendations, related more directly to the individual species assessments are presented in the species assessment reports.

- It was agreed that the group would include crevalle jack as species for assessment in the future given that this species is taken as a bycatch in the large pelagic fisheries. The working group attempted to list all the species that should be covered by the group. However, the working group decided to defer completion of the list to the plenary.
- In the case of dolphinfish it was agreed that the work being conducted by Ms. Kleisner would prove very beneficial to future assessments of this species once she has completed her work. As such it is proposed that another assessment of dolphinfish should be scheduled for 2007 provided that the results of Ms. Kleisner prove to be useful and available in time.
- The Working Group discussed briefly the need to contribute to ICCAT assessment activities covering the highly migratory large pelagic species of interest to CRFM member states.
- The Working Group should also contribute data to ICCAT and promote assessment of the small tunas and tuna-like species of interest to CRFM members (e.g. wahoo, blackfin tuna, king mackerel and Spanish mackerel) at ICCAT through active representation and participation by CRFM scientists in ICCAT SCRS meetings.
- Given the points listed above it was agreed that decisions on the timing for species stock assessments and indeed the forums for these assessments should be taken at the plenary.
- It was also agreed that the CRFM should consider the formation of a Scientific Committee to guide the working groups and to report to the Forum.

Ms Rosemarie Kishore of the IMA was invited to give a presentation of her Institute's work on using hard parts analysis primarily for crevalle jack and some aspects of ageing of wahoo and Spanish mackerel.

- The working group agreed that the work on aging conducted by the IMA would be useful in assessing large pelagic stocks and that the CRFM has to enhance its working relationship with the IMA both in respect of funding and future collaborative research.

B. FISHERIES REPORTS

1.0 The king mackerel (*Scomberomorus cavalla*) fishery of Trinidad and 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 includes Serra Spanish mackerel (*S. brasiliensis*) 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 fisheries management plans).

In Guyana, the management objectives for the large pelagic fishery are 'to develop the capacity for maximizing 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 as submitted to meeting). 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 and around the Dominican Republic and Florida.

Given Trinidad and Tobago's stated objective of 'maintaining the sustainability of resources', guidance on the status of the stock is provided relative to the $F_{20\%SPR}$ reference point. This is the estimated value of the fishing mortality rate (or fishing pressure) that would reduce the spawning stock biomass per recruit to 20% of its level in an unfished stock. Fishing at higher than this rate has been found to cause recruitment failures in many well-studied stocks around the world. It is thus suggested as a limit reference point or threshold which should not be exceeded. It represents a higher level of fishing pressure than that suggested to achieve the maximum sustainable yield (for which $F_{40\%SPR}$ or $F_{30\%SPR}$ are commonly used) (Gabriel and Mace, 1999).

Fishing mortality rates were estimated for Trinidad and Tobago using available data for the combined 3-year period 1996-98 and for 2004. Separate estimates were made for two different growth models, both of which gave equally good fits to the data. As shown in Table 1, the 1996-98 fishing mortality rates were either 16% below or 80% above the $F_{20\%SPR}$ reference point, depending on which model was used. The 2004 estimates of fishing mortality rates, however, were much higher, with both models suggesting that the fishery is operating far beyond the levels of the threshold $F_{20\%SPR}$ reference point (i.e. 85-202% above, see Table 1).

Table 1. Comparison of estimated recent fishing mortality rates with the estimated 'threshold' or limit reference point levels, for the combined 1996-98 data set and the 2004 year, and for the two growth model fits used in the analysis. Values in brackets show the F indicators as percentages of the reference points.

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 year 2004
Low $L_{infinity}$	0.80	0.67 (84%)	1.48 (185%)
Medium $L_{infinity}$	0.66	1.19 (180%)	1.99 (302%)

1.3 Management advice

The analysis suggests that reductions in the fishing mortality rate by as much as two-thirds may be required to reduce the risk of stock collapse (i.e. to bring fishing pressure down to the 20% threshold of $F_{20\%SPR}$). As a possible alternative, a six month closed season would increase the relative spawning stock biomass per recruit (%SPR) from the 10% currently estimated in the medium $L_{infinity}$ model up to 22%. Increasing the size at first capture in the fishery (e.g. by enforcing fish and/or mesh size limits) from the current 50cm up to 60cm would also raise %SPR up to 19%. Such management measures have been identified as possible management options in Trinidad and Tobago, in addition to introducing a limited entry regime to replace the current free access. Combinations of such measures could be used to achieve the necessary adjustment. Further options could be investigated as requested.

Due to the uncertainty in which of the two growth models is most appropriate, and recognizing the small sample sizes used in estimating the 2004 mortality rates (see detailed report), the group recommends that the fishery is re-assessed as soon as possible to confirm or update this management advice. In the meantime, no increase in fishing pressure should be permitted until stock dynamics are better understood. Collection of additional length frequency data from non-selective gears in the 2006 season should enable the uncertainty in the assessment to be reduced, and also clarify whether the current fishing mortality rates are really as dangerously high as estimated in this assessment. Since the highest catches are taken in the two middle quarters of the year, sampling should begin immediately (see data needs below).

For this wide-ranging species, effective control of exploitation levels will require the cooperation of all states sharing each local (sub-)stock. No national or sub-regional regulations are currently in place on the numbers of fishing effort units allowed on southern stocks of king mackerel, though some size and gear restrictions are in place. Although ICCAT provides regional coordination for Atlantic tunas, no specific regulations are set for king mackerel, which, on a wider-regional scale, is one of the less important stocks. ICCAT (2005) endorses the need for a sub-regional approach for this species. The northern Caribbean stocks are managed by the US management councils, at least within US territorial waters. Given the importance of king mackerel to the southern Caribbean CRFM countries, and the assumption of a widely distributed and shared stock, it is proposed that the CRFM should continue to promote the participation of neighbouring non-member states in the scientific meeting. Prior to such participation CFRM member states should promote the assessment of the species at the ICCAT meetings, where other relevant states are represented.

1.4 Statistics and research recommendations

1.4.1 Data quality

The Trinidad and Tobago data were found to contain few errors and to be highly appropriate for the stock assessment needs. Problems exist more in the availability of the data (e.g. due to missing years or time periods) than with data 'quality'.

Catch and effort data were available for Trinidad and Tobago at the 'raw' trip interview level, but not for the other countries. Original 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 computerized. 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.

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 as available in the ICCAT observer database). In order to allow for zero catches in the abundance estimates, databases should include trip records from fishing gears which target king mackerel (or other pelagics) even when they did not catch the species on that trip.

For the reliable analysis of long-term time series of catch and effort, 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 on the stock and need to be accounted for in assessments.

The discrepancies in pre-1963 total catches reported by FAO and ICCAT for Venezuela also need to be resolved (see technical report).

The Trinidad and Tobago length frequency data were found to be potentially valuable in estimating both growth and mortality rates for this species. Continued sampling of length frequencies is encouraged, both in 2006 and future years to monitor fishing mortality rates. Samples of approximately 200 fish per gear type per month should be collected from those line-based gears that appear to catch the widest size ranges of fish (e.g. a-la-vive, switchering and trolling). Fish caught in beach seines should also be measured when sampled, as these were found to include the 'young of the year' fish, and therefore provide valuable information on the origin of the growth curve. Length frequencies from the highly selective gill net gears provide little information on growth or mortality rates and sampling of these gears may be discontinued (unless required to monitor changes in selectivity if mesh sizes are changing).

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 indicator.

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. If feasible, fishing mortality rates may then be estimated using the more powerful age-based methods.

1.5 Stock assessment summary

- Catches in recent years have been at historical high levels of 4-7 000 t. The largest catches are reported as being taken by Venezuela (and Brazil) in most years.

- Detailed analysis of the catch/effort data was postponed until the outstanding historical data records from Trinidad and Tobago have been entered, and the true values of the early Venezuelan catches have been confirmed.
- The parameters of the von Bertalanffy growth model were estimated from the Trinidad and Tobago length frequency data. Although the length frequency data had clear modes believed to represent age classes, the analysis was unable to reliably determine between two similar growth model fits, a low-$L_{infinity}$ model (129cm, associated with a K of 0.35), and a medium $L_{infinity}$ model (155cm, associated with a lower K of 0.30). Further analysis of the data set is warranted and reassessment based on any new length data.
- Total mortality rates were estimated in the range 1.13-1.76 for the 1996-98 data set, and at 1.63-2.90 for 2004. Natural mortality rates estimated at 0.51-0.59 were subtracted from these values to give the reported F estimates. The total length frequency sample size used in 2004 (n=558 from the 'low selectivity gears) is less than that used for the 1996-98 data set (n=2200), and so the 2004 estimates are considered less reliable.
- The $F_{20\%SPR}$ and $F_{0.1}$ reference points were estimated using the FMSP 'Yield' software, as were the potential effects of alternative closed seasons and size limits.

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 coastally distributed large pelagic species should be coordinated among neighbouring countries sharing these sub-stocks. Options for assessing and managing the stock in collaboration with Venezuela, Brazil and any other relevant countries should be explored, including at ICCAT meetings.

1.8 References

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

Gabriel, W.L. and Mace, P. M. (1999). A review of biological reference points in the context of the precautionary approach. In V.R. Restrepo (Editor), Proceedings of the Fifth National NMFS Stock assessment Workshop: Providing Scientific Advice to Implement the Precautionary Approach under the Magnuson-Stevens Fishery Conservation and Management Act, p. 34-45. U.S. Dep. Commer., *NOAA Technical Memorandum. NMFS-F/SPO*-**40**.

2.0 Dolphinfish (*Coryphaena hippurus*) fishery

MANAGEMENT SUMMARY – EASTERN CARIBBEAN

2.1 Policy and objectives

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

2.2 Status of stocks

Based on the data available for the present study, mean catch rates (standardized catch per trip) of dolphinfish in the eastern Caribbean have fluctuated between about 50.3 kg/trip and 61.6 kg/trip, with a possible slightly increasing temporal trend overall during the period 1995 to 2004 (Figure 3). It should be noted that the possible increase in CPUE is not considered to reflect any real increase in the abundance of dolphinfish over time. Nonetheless, if there is any real increase the change appears to be very minor. Given no decline in catch rates, catches may be presumed to be sustainable at these levels of harvest. Attempts to estimate stock biomass using a surplus production model proved problematic, and therefore these results were not used to develop management advice at this time.

2.3 Management advice

The assessments conducted at this workshop cannot be considered conclusive enough to predict the long-term sustainability of the fishery at current or increased levels of exploitation. A time series of landings was constructed back to 1950, albeit based on a number of assumptions. A major limiting factor was the lack of adequate measures of abundance through time. Ideally, abundance indices are developed from scientifically designed surveys, which use consistent sampling methods over time. Because surveys of this sort are rare for this region, the alternative is to examine catch per unit effort from various sectors of the fishery. However, these indices may prove misleading, especially if the effort involved is characterized in gross measures such as the number of trips without considering factors that effect changes in the fishing efficiency of each trip which may have taken place during the study period. Fishing efficiency is affected by both readily quantifiable parameters such as the number of hooks used, the time each gear was in the water (soak time) etc. and less quantifiable factors such as improved fisher knowledge in fishing techniques, locating good fishing grounds and even the creation of good fishing areas through the use of moored FADs.

Although adequate data was not available at the time of this meeting, anecdotal information suggests that dolphinfish is being increasingly targeted by pelagic fishers both in the Caribbean, the USA and possibly by extra-regional fishing fleets fishing in the region. 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 fishing the same dolphin stock, management of this fishery must be based on collaborative arrangements between the CARICOM and major non-CARICOM fishing nations in the region including Venezuela in the South to the French Islands of Martinique and Guadeloupe and the US. The suggestion to form such a multinational management body as well as available options, have previously been presented in detail in FAO (2004). Once the mechanisms for

collaboration in management are in place, appropriate management measures which consider the trade-offs between meeting individual country needs and stock conservation can be agreed upon for implementation.

It is noteworthy that despite the importance of the dolphinfish fishery to the Caribbean, only six CRFM countries submitted data for inclusion in this assessment. It is further noted that records for dolphinfish were available from the FAO database for only 13 Caribbean nations. Clearly working with such limited databases will continue to be a cause for concern when stock assessments are attempted. All dolphin fishing nations must therefore improve their efforts at capturing and reporting at least national catch data so that they can be adequately included in these stock assessments.

1. The CRFM should continue to monitor catch rate trends at a regional level and coordinate more intensive stock assessments particularly encouraging wider collaboration with non-CRFM nations fishing this resource.
2. However, individual countries must also be encouraged to track the catch rate trends of their own fishery to allow early detection of any changes that may signal stock decline.
3. In the event that catches or catch rates decline, the CRFM should facilitate prompt collaboration among countries to achieve consensus on the appropriate management strategies to be adopted.

2.4 Stock assessment summary

The Working Group initially examined approximately 64,000 trip catch records for five CRFM nations (Barbados, Dominica, Grenada, St. Lucia, St. Vincent) spanning the period 1995 to 2004. Only Barbados and St. Lucia provided trip data series for all years. Dominica and Trinidad submitted summarized data for the period under consideration. However as these data were not disaggregated to the level of individual trips they could not be included in the abundance analyses that were undertaken at this meeting. Following the data preparation process for the analyses, it was necessary to delete a number of records for various reasons (see detailed report) to enhance consistency in data over time, and in the end a total of just over 60,000 records was used.

Changes in annual mean catch per unit effort (trip) were used as indices of abundance for the Eastern Caribbean and Southeastern US dolphinfish fisheries. Generalized Linear Models (GLMs) were applied to each of the datasets to standardize the data with respect to key factors identified (e.g. gear type, season). For the Eastern Caribbean dataset, the standardized annual CPUE estimates appeared to remain fairly constant with a slight positive increase over the ten-year time period examined (1995-2004).

Attempts were also made to apply surplus production models using the standardized CPUE estimates and historic catch records from countries fishing dolphin in the Western Atlantic going as back as far as 1950. A Surplus Production Incorporating Covariance (ASPIC) programme was used for this procedure. However, the models produced unrealistically high estimates of biomass and MSY, suggesting that the data available were not adequate to sufficiently resolve the model.

2.5 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:

2.5.1 Recommendations for the Caribbean Regional Fisheries Mechanism

1. Continue to encourage participation and further collaboration of non-CRFM territories in the Western Central Atlantic (WCA) region e.g., USA, Venezuela and the French territories in future stock assessments. It should be noted that the US did actively participate in this meeting.
2. Review systems (e.g., logbook and/or observer) for recording more refined estimates of fishing effort among countries (e.g., linking catches to gear type; specification of gear configurations; identifying

when there is a switch in target species), estimation of total catches from recorded data, and validation of data before submission for consideration in assessments.

3. Monitor trends in regional catches and catch rates to identify signs of stock decline and promote regional collaboration on appropriate management strategies to be implemented.
4. Encourage and assist countries to develop 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 (CFRAMP) in the early 1990s. This exercise will involve intensive data mining from scientific, historical and administrative documents (both published and gray literature) designed to expand the time series of available data, improve the contrast in the data set and contribute to improved parameter fitting in assessment models.

2.5.2 Individual countries

1. Countries must ensure that appropriate systems are in place to capture, record and report at least representative landings data for dolphinfish.
2. Provide accurate and complete data on total catches (or landings) of dolphinfish 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.
4. 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.
5. 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.
6. 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.

2.6 Special comments

None.

2.7 Policy Summary

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

2.8 References

FAO. (1994). World Review of Highly Migratory Species and Straddling Stocks, *FAO Fisheries Technical Paper* **337**. Rome.