CARICOM Fishery Report No. 10

Caribbean Community Secretariat

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REPORT OF THE 2002 JOINT MEETING OF THE CRFM LARGE PELAGIC FISHERIES WORKING GROUP (CRFM LPWG), THE CRFM REEF AND SLOPE FISHERIES WORKING GROUP (CRFM RSWG), AND THE CRFM SMALL COASTAL PELAGIC FISHERIES WORKING GROUP (CRFM SCPWG)

25-29 November, 2002
CRFM Secretariat, Saint Vincent & The Grenadines

CARIBBEAN REGIONAL FISHERIES MECHANISM (CRFM)

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Executive Summary

During 1991-2001, the CARICOM Fisheries Resource Assessment and Management Programme (CFRAMP) coordinated the collection and analysis of data on pelagic and reef fisheries in CARICOM countries. Preliminary assessments of selected pelagic and reef fish stocks were undertaken during CFRAMP's 2000 Caribbean Pelagic and Reef Fisheries Assessment and Management Workshop. The subsequent establishment of the Caribbean Regional Fisheries Mechanism (CRFM) in 2002 provided an opportunity for CARICOM countries to continue, as well as to expand, their collaborative efforts in the area of fish stock assessment and management. The formation of three CRFM Working Groups were proposed, to facilitate regional coordination of assessment and development of management advice on pelagic and reef fisheries within the Caribbean region: the CRFM Large Pelagic Fisheries Working Group (CRFM LPWG); the CRFM Reef and Slope Fisheries Working Group (CRFM RSWG); and the CRFM Small Coastal Pelagic Fisheries Working Group (CRFM SCPWG). The CRFM LPWG held an informal meeting in November 2000, and has also worked inter-sessionally on several issues pertaining to the management of tunas and tuna-like species. The 2002 meeting is the first formal meeting of all three working groups.

During the CRFM LPWG sessions, participants reviewed recent international developments regarding the status and management of large pelagic species within the Atlantic Ocean and adjacent Seas, and discussed issues directly affecting the further development of large pelagic fisheries in CARICOM countries. The meeting noted recent developments in large pelagic fishing activities in CARICOM countries that would require careful monitoring and management to avoid being negatively impacted by the increasing usage of catch quota limits by the International Commission for Conservation of Atlantic Tunas (ICCAT), e.g. exploratory operations in Haiti to investigate the feasibility of developing an offshore fishery, and joint venture operations being conducted by Suriname. The meeting also discussed and clarified a number of queries regarding reporting of statistical data to ICCAT.

A presentation of the Argos vessel monitoring system provided a description of the system, its capacity to monitor vessel movements and to facilitate real time reporting of fishing operations, and its operational costs. The meeting also accommodated short presentations and reviews of (i) the report of the first workshop on the FAO TCP project on large pelagic resources, and (ii) the results of a 2002 ICRAFD evaluation of the need to expand data information systems to include social and economic data.

Recent research on wahoo was completed by the regional fish age and growth laboratory located at the Institute of Marine Affairs (IMA); this study showed that different age ranges of wahoo were being exploited by different countries, further supporting the notion of a shared resource that must be managed through regionally coordinated efforts. In addition, a proposal for continuing fish age and growth research at the IMA laboratory was reviewed and endorsed by the meeting. It was agreed that a clear set of criteria should be used in future to identify regional research priority needs. Additionally, in future, the motivation of data collectors would need to be adequately addressed to guarantee quality sampling in the field. Sampling programmes would have to be species-specific, as countries would not be able to afford the implementation of a broader biological data collection programme.

During the meeting, several ad hoc working group sessions were conducted to review the current status of, as well as the need to improve management of: (i) large pelagic; (ii) reef and slope; (iii) small coastal pelagic; and (iv) recreational fisheries. These groups made several recommendations for improvement at various levels of the fisheries management process, especially in the areas of data collection and recording, data quality and storage, and reporting. During discussion of the ad hoc working group reports, participants identified the need to address a number of these issues through smaller working groups that would pursue agreed activities in the inter-sessional period. Consequently, three inter-sessional working groups were formed to address the following specific areas of immediate concern: (i) the development of data quality control guidelines; (ii) the incorporation of traditional ecological knowledge and local knowledge; and (iii) the establishment of formal recreational fisheries statistical systems. A chairperson for each inter-sessional group was selected, and a deadline was set for completion of the first task of the working groups, which would be the preparation of terms of reference. Following adoption of each terms of reference, each working group would then determine and undertake a set of agreed tasks during the inter-sessional period.

Also during the meeting, three data analysis sessions were conducted, using: (i) commercial catch and effort data on king and Spanish mackerel from Trinidad and Tobago; (ii) historical fisheries data from The Bahamas; and (iii) commercial data on red hind from St. Vincent and The Grenadines. The range of analyses included, *inter alia*: descriptive statistical analyses, catch rate standardization trials, and estimation of gear selectivity.

During the RSWG and SCPWG meetings, the proposals to establish the CRFM RSWG and the CRFM SCPWG respectively were finalized and approved. In addition, a proposal for studying the movement patterns and distribution of commercially important small coastal pelagic species was considered by the SCPWG. While participants agreed that this was a worthwhile activity, it was clear that the proposed methodology required further refinement.

During the RSWG and SCPWG meetings, several technical presentations were also made. These presentations covered specific issues, but also provided valuable insight into additional available methodologies for analyzing and interpreting fisheries data. In particular, the meeting benefited from presentations that reviewed: (i) the recent development of an ecosystem-based assessment and management model for the southeastern Caribbean, which integrated available ecological and biological information for the region, and fisheries related information specific to Grenada and the Grenadines; (ii) the reconstruction and analysis of a time series of catch and effort data for Grenada; (iii) an exercise in using habitat mapping data to estimate potential yield; (iv) a fisher interview study to elucidate and explain observed fishing and resource trends; and (v) maximizing the usefulness of a range of descriptive and exploratory statistical analyses.

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List of Acronyms and Abbreviations

ANOVA	Analysis of Variance
CARDI	Caribbean Agricultural Research and Development Institute
CARICOM	Caribbean Community
CARICOMP	Caribbean Coastal Marine Productivity Programme
CARIFORUM	Caribbean Forum of African, Caribbean and Pacific States
CARISEC	Caribbean Community Secretariat
CEHI	Caribbean Environmental Health Institute
CFU	CARICOM Fisheries Unit
CFRAMP	CARICOM Fisheries Resource Assessment and Management Programme
CLS	Collecte Localisation Satellites
CRFM	Caribbean Regional Fisheries Mechanism
CPACC	Caribbean Planning for Adaptation to Global Climate
CPUE	Change

EEZ	Catch per Unit of Effort
FAD	Exclusive Economic Zone
	Fish Aggregating Device
FAO	Food and Agriculture Organisation of the United Nations
FIB	Fishing-in-Balance
GDP	Gross Domestic Product
GECAFS	Global Environmental Change and Food Systems
GLM	Generalized Linear Model
GPS	Global Positioning System
ICCAT	International Commission for Conservation of Atlantic
ICLARM	Tunas
	International Centre for Living Aquatic Resource
	Management
ICRAFD	Integrated Caribbean Regional Agricultural and Fisheries
	Development Programme
ICRI	International Coral Reef Initiative
IMA	Institute of Marine Affairs
MACC	Mainstreaming Adaptation to Climate Change
MSY	Maximum Sustainable Yield
NOAA	Natural Resource Management Programme
NRM	National Oceanic and Atmospheric Administration
OECS	Organisation of Eastern Caribbean States
SMMA	Soufriere marine Management Area
TCDC	Technical Cooperation among Developing Countries
TEDs	Turtle Excluder Devices
TURF	Traditional use Rights in Fisheries
UN	United Nations
UNEP	United Nations Environment Programme
UWI	University of the West Indies
VMS	Vessel monitoring system

PART I:

REPORT OF SESSIONS HELD DURING 25-29 NOVEMBER 2002

A. GENERAL PLENARY SESSIONS

1. Opening ceremony.

Acting Chief Fisheries Officer of the Fisheries Division of St. Vincent and the Grenadines, Mr. R. Ryan, delivered the opening and welcoming remarks. Mr. Ryan welcomed the participants, and noted that the meeting was timely in addressing the urgent need for development of management advice. On behalf of CFU, RAU Leader and Senior Biologist, Mr. T. Phillips, also greeted the participants, and referred to the recent establishment of the Caribbean Regional Fisheries Mechanism that will provide an opportunity for countries to continue collaboration at the regional level for improvement of the management of their fisheries. The Chief Agriculture Officer from the Ministry of Agriculture, Lands and Fisheries, Mr. P. Isaacs, gave the feature address. Mr. Isaacs noted with admiration the youthfulness of the gathering. Mr. Isaacs emphasized the urgent need to enhance the performance of the fishing industry for developing Caribbean States, particularly those which are economically challenged as a result of their size and limited resources. Senior Biologist and RAU Leader, Dr. S. Singh-Renton, delivered the vote of thanks. Dr. Singh-Renton thanked the government of St. Vincent and the Grenadines for their offer and support to host the meeting. She also thanked the speakers for their advice regarding the achievement of meeting goals and the resource persons for their technical contributions.

2. Selection of Chairpersons and Rapporteurs.

Given the technical nature of the meeting, various individuals were selected to chair specific sessions. Two rapporteurs were selected to cover most sessions. The final selection of chairpersons and rapporteurs are indicated below.

Session	Chairperson	Rapporteurs
Plenary, Items 1-4, 29-31	S. Singh-Renton	S. Singh-Renton & S. Constantine
LPWG, Items 5-6	S. Singh-Renton	S. Singh-Renton & S. Constantine
LPWG, Items 7-10	L. Straker	S. Singh-Renton & S. Constantine
LPWG, Items 11-16	S. Singh-Renton	S. Singh-Renton & S. Constantine
SCPWG, Items 17-19	R. Ryan/ L. Straker	T. Phillips & C. Isaac
RSWG, Items 20-24	W. Joseph	S. Singh-Renton

RSWG, Items 25-28	T. Phillips	S. Singh-Renton

3. Adoption of agenda and procedural arrangements.

Mr. L. Straker noted that the word 'little' had been omitted from the first line of the last verse of the national anthem of St. Vincent and the Grenadines, as it appeared on the Opening Ceremony Programme. Following one minor change, the meeting agenda was adopted (see Appendices 1 & 2). Dr. S. Singh-Renton also noted that sessions were scheduled to commence at 8.30 a.m., and to end between 4.30 p.m. to 5.00 p.m. Additionally, 15-minute refreshment breaks were scheduled to take place at 10.30 a.m. and 3.30 p.m., although there would have to be some flexibility regarding this.

4. Introduction of country representatives and invited resource persons.

Country representatives introduced themselves. There were two delegates from St. Vincent and the Grenadines. A number of observers and resource persons were also in attendance: Ms. R. Kishore of the CFU/IMA Regional Fish Age and Growth Laboratory, Trinidad and Tobago; Ms. E. Mohammed, PhD candidate in fisheries ecosystem modeling, University of British Columbia; Mr. R. Walters of the United Nations Food and Agriculture Organization (FAO) office in Barbados; Mr. B. Lauckner, Biometrician and Acting Executive Director of Caribbean Agricultural Research and Development Institute (CARDI), and Mr. C. Villaran of Collecte Localisation Satellites (CLS) ARGONET, Peru. A complete list of meeting participants is given in Appendix 3.

B. MEETING OF THE LPWG

5. ICCAT – Brief review of status of stocks and management update.
[*Presented by Dr. S. Singh-Renton*]

Status and management of stocks of Atlantic tuna and billfishes

The International Commission for Conservation of Atlantic Tunas (ICCAT) is the official organization with responsibility for management of over 30 species of tuna and tuna-like fishes occurring in the Atlantic Ocean and adjacent Seas. Several Atlantic large tuna and billfish stocks, such as northern bluefin tuna, swordfish, and the marlins, are considered by ICCAT to be heavily over-exploited. Other stocks, such as yellowfin tuna, bigeye tuna, and albacore, are believed to be either fully exploited or over-exploited. Inadequate and poor data hamper the completion of accurate stock assessments in many cases. Stock rebuilding programmes are in effect for western Atlantic northern bluefin tuna, north Atlantic swordfish, and to some extent, the marlins. The development of more stringent management measures in recent times has caused some vessels to seek 'flags of convenience' in order to continue fishing without being regulated. This has led to the formulation and adoption of specific recommendations pertaining to stricter management of large-scale fishing vessels.

Discussion:

A query was raised regarding the procedure for reporting to ICCAT by Non-Contracting Parties. It was clarified that in accordance with international fisheries agreements, Non-Contracting Parties to ICCAT are obliged to cooperate with, and report the relevant data to ICCAT, as long as they are harvesting the stocks managed by ICCAT. Additionally, ICCAT reporting forms can be downloaded from the ICCAT website. The question was also asked whether ICCAT corresponded with Non-Contracting Parties in order to seek countries' support and cooperation in statistical reporting. It was pointed out that if ICCAT is aware that a country is fishing for species regulated by ICCAT, then usually ICCAT sends a letter each year requesting submission of fisheries statistics.

Clarification was sought on the procedure for determining the appropriate amounts of fish to be harvested, and whether the amount was specific to a particular area. It was explained that ICCAT commonly uses the estimate of Maximum Sustainable Yield (MSY) as a management reference point, and that this was applicable for the area in which the stock was distributed. In the case of the highly migratory tuna and tuna-like species, the stock may be distributed throughout the whole Atlantic, and hence the estimated ICCAT MSYs often applied to large areas of the Atlantic Ocean and its adjacent Seas.

The Haiti representative informed the meeting of recent exploratory large pelagic fishing activities using Fish Aggregating Devices (FADs) that were carried out in Haiti, in collaboration with the Cuban government. The large pelagic catches were significant, and the private sector in Haiti voiced interest in further development of this type of fishing operations. The private sector in Haiti would not likely adhere to the ICCAT recommendations. The education of the stakeholders on the shared nature of the resources and the need for coordinated management by ICCAT were emphasized. It was pointed out that Haiti would have to negotiate with ICCAT for catch allocations, and that a country has to be either a Contracting Party to ICCAT or a Co-operating Party of ICCAT in order to obtain catch allocations.

The representative from Suriname sought clarification on reporting responsibility in instances of foreign-flagged vessels fishing in Surinamese waters. It was noted that the flag country, i.e. the country in which the vessel is registered, is responsible for reporting the relevant statistics to ICCAT. However, in such cases, Suriname should monitor the activities of the vessels concerned, to ensure compliance with the agreed fishing arrangements. The Suriname representative informed the meeting that some American vessels were interested in fishing for tuna and swordfish in Surinamese waters. If these vessels become registered with Suriname, then Suriname would have to fulfill its flag state reporting responsibilities to ICCAT.

In response to a question concerning penalties for non-compliance, it was noted that trade restrictive measures have been imposed on many of the countries concerned.

Clarification was sought on the frequency of ICCAT assessments. It was pointed out that detailed stock assessments were attempted annually up to the late 1990s. The very poor data on some stocks have made assessments difficult, if not impossible. In most instances also, the status of stocks did not change dramatically from one year to the next. In view of this, and the increasing burden of stock assessment report preparations as more stocks become fully and over-exploited, ICCAT now conducts only a limited number of detailed stock assessments each year. Consequently, each major stock is subjected to a detailed evaluation at least every 2-5 years.

Revision of ICCAT catch allocation criteria

ICCAT recently completed a revision of catch allocation criteria to facilitate more equitable harvest sharing arrangements among Atlantic tuna fishing countries. A number of CARICOM Member States developed a common position that differed in several important respects from that of the larger industrialized fishing countries. The principles underlying these positions depended on interpretations of the relevant UN Agreements regarding the treatment of new participants in

the fishery, the provisions for Developing States, and the capacity for responsible management, as well as other factors.
The new criteria include qualifying criteria that indicate that a country must be either a Contracting Party to ICCAT or a Cooperating Party of ICCAT, and must be able to fulfill its contributions to statistics, research and management. There are also criteria relating to the status of the stocks and existing levels of fishing effort, and the occurrence of the stock in a country's waters. A number of socio-economic criteria have now been incorporated, that take into account artisanal fishing interests, coastal state rights and the needs of Developing States. ICCAT also specifies a number of conditions for application of the catch allocation criteria. CARICOM countries now urgently need to develop the application of the new criteria in negotiations with ICCAT for equitable catch quotas.
Discussion:
Participants questioned the economic advantage of being a member of ICCAT. It was emphasized that ICCAT Member States are able to have their concerns addressed prior to the finalization and adoption of any ICCAT recommendation. It was also clarified that ICCAT recommendations are usually adopted by consensus. This advantage would be crucial in a situation in which a country was seeking an increase in its catch quota. One participant intervened to indicate that the associated ICCAT membership fees and cost of participating in ICCAT meetings should be considered in addressing the issue of economic advantage of ICCAT membership. In response to this last comment, it was pointed out that ICCAT membership fees are largely determined by a country's reported level of tuna catches and tuna canning operations. Additional fees are also charged for species panel membership.

6. Fulfillment of ICCAT Contracting Party and Co-operating Party Obligations. [*Presented by Dr. S. Singh-Renton*]

The International Commission for Conservation of Atlantic Tunas (ICCAT) is the official organization with responsibility for management of over 30 species of tuna and tuna-like fishes occurring in the Atlantic Ocean and adjacent Seas. In accordance with international agreements, countries fishing for ICCAT-managed species are thus obliged to cooperate fully with ICCAT to ensure responsible management of the resources concerned. Such cooperation must necessarily include adequate contributions of statistical data on the fisheries for scientific and monitoring purposes, contribution to improved knowledge of the resources through the conduct of research, and full compliance with agreed conservation and management recommendations adopted by ICCAT.
The definitions of ICCAT Contracting Party and ICCAT Cooperating Party were explained. It was pointed out that Cooperating Parties have to comply fully with ICCAT conservation and management measures, and hence have the same obligations as ICCAT Contracting Parties. Statistical obligations to ICCAT include the submission of Task I and II catch and effort data, Task II size frequency data. There are specific deadlines for data submission, as well as submission of national reports and compliance data. Parties are also obliged to contribute to ICCAT research: this could include a wide range of biological and ecological studies, completed during the implementation of ICCAT species programs, or as national research projects. Management obligations involve full compliance with ICCAT management regulations, which would have to be supported by appropriate policies and legislation.
Discussion:
Clarification was sought in respect of the obligations of Non-Contracting Parties to ICCAT. It was noted that in accordance with international fisheries agreements, countries fishing shared resources are obliged to cooperate with the relevant regional/international fisheries

organization(s) responsible for coordinating management of the resources concerned. ICCAT has been given the authority and responsibility for management of tuna and tuna-like resources occurring in the Atlantic Ocean and its adjacent Seas. It was also pointed out that countries should study international agreements carefully before taking the decision to become signatories.

7. ArgoNet, the VMS integrated solution. [*Presented by Mr. C. Villaran*]

ARGONET is the system used to track the movement of fishing fleets. At present, it is an environmental satellite system, which has 5 polar satellites that provide 100% coverage of the earth's surface in a specified period of time, and two global processing centers. The equipment can be installed in about one hour, and the relevant software is provided to the ship owners. Data are received via a simple internet connection. The system can be used to assist in monitoring the movements of fishing vessels, and to facilitate real time reporting of data, including observer data.

Discussion:

It was asked whether countries or agencies usually established the system: in response, it was noted that different situations exist in different countries. If the relevant legislation was not enforced, then usually ship owners did not feel obliged to install the system. A clarification was sought on the types of vessels currently using the Argos VMS (vessel monitoring system). It was indicated that the system was usually installed on steel boats greater than $36m^3$ capacity. However, the Argos system is currently also used to monitor coastal fishing operations in Peru. It was pointed out though that while the use of VMS may be predominantly restricted to vessels operating on the High Seas, further developments in the future would facilitate a more widespread use of the technology. Regarding a question concerning the cost of the system, it was noted that the equipment could be rented or purchased. Usually the ship owners pay, and only internet connection costs need to be covered by the fisheries administrations concerned. The owner of the data is the ship owner. Reasons for installing VMS may include: necessity by law in a country where the vessel is registered; a ship owner wants to monitor the movements of his fishing vessels; necessity by law in a country where the vessel is fishing; joint venture operations, requiring monitoring. A query was raised regarding the monitoring of illegal fishing in national waters. It was noted that the Argos system could deliver data to countries wishing to monitor the entry of fishing vessels into national waters. Participants were also interested in knowing whether the Argos system could supply other types of data, such as environmental data. It was confirmed that certain environmental data could be provided, based on an agreement with CLS.

8. Case studies: St. Vincent and the Grenadines, Belize, Grenada, and Trinidad and Tobago. [*Presented by Mr. R. Ryan, Dr. S. Singh-Renton, Mr. C. Isaac, and Ms. L. Martin*]

<u>St. Vincent and the Grenadines and Belize (ICCAT Non-contracting Parties)</u> [*Presented by Mr. R. Ryan and Dr. S. Singh-Renton respectively*]

Both St. Vincent and the Grenadines and Belize have open ship registries that flag a significant number of large-scale fishing vessels. In view of the recent deteriorating status of many major Atlantic tuna stocks and the increasing number of ICCAT management regulations, there has been an increase in the registration of large-scale fishing vessels in countries that are not members of ICCAT, especially those with open registries and which do not enforce ICCAT regulations. This shift to 'flags of convenience' is also associated with evasion of high taxes.

Both St. Vincent and the Grenadines and Belize were recently identified by ICCAT as countries fishing in contravention of ICCAT conservation and management measures. Several species trade sanctions were imposed on Belize, while a bigeye tuna trade sanction was imposed on St. Vincent and the Grenadines. Both countries developed and commenced implementation of remedial action plans in 2001. To date, each country has made progress in enforcing the relevant legislation, and is in the process of developing a licensing system and regulations. In 2003, ICCAT will again review the progress of remedial actions taken, in order to determine if the trade sanctions could be lifted in January 2004.

Discussion:

Regarding St. Vincent and the Grenadines, the question was asked whether the OECS's harmonized legislation regarding licensing of vessels was applicable to High Seas fishing activities. It was confirmed that it was not. Clarification was sought regarding the persons responsible for development of the remedial plans and their statuses of implementation. Given the need to involve the Customs and Legal Departments, St. Vincent and the Grenadines established an Inter-Ministerial Committee, and this Committee has been responsible for developing and implementing the remedial action plan. An Inter-Ministerial Committee had also been established in Belize, with similar responsibility for developing and implementing remedial measures. To date, the action plan for St. Vincent and the Grenadines was estimated to be 85% complete, with demonstration of management compliance remaining to be addressed. A clarification was sought regarding implementation of the penal code of the relevant High Seas legislation, and it was indicated that third countries were expected to assist with this process. Additionally, it was clarified that while a registration certificate is issued once, a licence would have to be renewed each year.

It was noted that while the registry is a source of income to the two countries, it was important to pay attention to the cost of maintaining the registry, i.e. the cost of complying with ICCAT regulations and negotiating for catch quotas. A cost-benefit analysis has been completed for St. Vincent and the Grenadines, and should also be conducted for Belize. A concern was raised that other Caribbean countries were becoming interested in establishing open ship registries, and that governments were not adequately informed about the implications with respect to ICCAT. It was asked whether CFU could provide assistance in advising national authorities on the implications of registering foreign-owned large-scale fishing vessels. In response, it was noted that CFU staff could participate in national consultations dealing with the issue. The Inter-Ministerial Committee in St. Vincent and the Grenadines has been very effective, and the method may be applicable in other countries.

Grenada (ICCAT Non-Contracting Party) [*Presented by Mr. C. Isaac*]

Grenada's swordfish fishery attracted international attention (specifically ICCAT's) when landings increased dramatically from 3.50 metric tons to 84.3 metric tons between 1996 and 2000. Grenada Fisheries Authorities proposed two reasons for this increase: (1) greater efficiency of the local longline fleet resulting in increased catches and (2) possible transshipment reflected in export data. Although Grenada is not a Contracting Party to ICCAT, ICCAT wrote to Grenada to inform Grenada of its swordfish rebuilding programme, and that Grenada's reported catches had exceeded that country's allocated catch limit. ICCAT demanded that Grenada reduce its swordfish catches immediately and co-operate fully with ICCAT's swordfish rebuilding programme. Grenada agreed to co-operate and informed ICCAT of the measures being taken to facilitate this cooperation. In addition Grenada also proposes to resume its activities under the ICCAT Enhanced Programme For Billfish Research in 2003.

Discussion:

A clarification was sought whether the ICCAT letters to Grenada resulted from an examination of data reported by Grenada. It was confirmed that this was true in respect of the swordfish query. There had been another case in which ICCAT had accused Grenada of conducting a fishery, which was in fact non-existent. The importance of developing strong positions for negotiating with ICCAT was also emphasized.

Trinidad and Tobago (ICCAT Contracting Party) [Presented *by Ms. L. Martin*]
Trinidad and Tobago first attended the ICCAT's Commission Meeting in 1997 as an Observer and became a Contracting Party to ICCAT in 1999. Since then, there have been improvements in data collection, data analysis and industry monitoring systems especially with respect to the semi-industrial longline fleet. In addition, significant improvement with regard to monitoring of the operations of the transshipment port will be realized with the imminent enactment of the Memorandum of Agreement between the Government and the relevant fishing entities. Contracting Party status and attendance at the Commission Meetings have granted Trinidad and Tobago some influence with respect to the nature of management measures adopted by the Commission and have resulted in the establishment of a more favourable position for the fishing industry than obtained in the mid to late 1990s.
In the mid 1990s, ICCAT had also sent letters to Trinidad and Tobago concerning that country's swordfish fishing activities. This query resulted from examination of import data submitted by the USA on Trinidad and Tobago. At the time, it was suspected that fish being landed at the local transshipment port was being conveyed over land, and exported as fish caught by Trinidad and Tobago fishing vessels. On becoming an ICCAT Contracting Party in 1999, Trinidad and Tobago worked to improve its statistical reporting to ICCAT, as well as to revise its historical statistics. This resulted in upward adjustments in 2001 and 2002 of the current swordfish catch allocation for Trinidad and Tobago.
Discussion:
The question was raised whether the USA data could be useful for monitoring countries' catches. It was recognized that access to these data could be useful. However, it was pointed out that the issue of transshipment landings was increasingly being brought under the control of the port state involved, and that countries need to appreciate their obligations to signed agreements. It was noted that countries should have a clear fisheries development plan that includes a well-defined system to facilitate an acceptable level of monitoring, control, and compliance.

9. Review of first FAO TCP workshop report and recommendations. [*Presented by Mr. R. Walters*]

The activities scheduled during this first Phase of the project included the identification of the key coastal and oceanic large pelagic species being exploited and a synthesis of existing information on their distributions, migration routes, stock structure and stock status. The resulting 'field report' served as a working paper for the first Regional Workshop. Consultants considered feasible alternative management options for utilising large coastal pelagics in the WECAFC area and evaluated the biological, social and economic consequences of each option. Participants selected the preferred option(s) for management of large pelagics by CARICOM countries and provided a rationale for this choice; they also indicated the key steps in implementing the associated risks or constraints. Additionally, participants expressed the conviction that participation at the highest possible decision-making level was essential at the second workshop (Phase 3). It was recommended that the CFU should prepare a brief of the workshop results for communication to the CRFM Forum.
Discussion:
It was agreed to discuss this topic together with other topics noted in item 11.

10. Expansion of existing data collection systems to capture social and economic data for fisheries management and decision-making. [P*resented by Mr. T. Phillips*]

During the 1990s, the CARICOM Fisheries Resource Assessment and Management Programme (CRFAMP) worked to establish fisheries data systems in CARICOM Member States in order to provide information for fisheries management. These data systems specifically focused on the accumulation of catch and effort data, licensing and registration data, and biological data (weight, length frequency and age data). The issue of collection and collation of economic and socio-economic fisheries data throughout the CARIFORUM/CARICOM countries was reviewed during a CFU consultancy study earlier in 2002. This consultancy study undertook to develop guidelines and methods for the expansion of each country's present data collection programme, in order to obtain data and information on the economic value of national and sectoral fisheries. The present verbal presentation informed participants of the relevant guidelines and methods proposed by the CFU consultancy study and related workshop for incorporating the collection of social and economic data into sampling programmes.

Discussion:

A query was raised concerning the handling of depreciation of vessels, as it was not parallel to the depreciation of other articles such as a motor vehicle. It was agreed that this posed some difficulty, and would have to be given further attention. A similar problem was faced with respect to the handling of data on wages. Clarification was sought regarding the incorporation of environmental data into stock assessments. It was noted that some stock assessment models try to incorporate environmental data, as well as to provide measures of risk and uncertainty.

11. Ad hoc working groups to: (a) improve management of large pelagic commercial and recreational fisheries, and (b) improve management of reef and slope and small coastal pelagic fisheries. [*Introduction presented by Dr. S. Singh-Renton*]

The allocated tasks of the two working groups (Appendix 4(a) & 5(a)) were briefly reviewed. The Working Groups were requested to consider what could be achieved at the national and regional levels, in terms of improvements in statistics, reporting and promoting active fisheries management. Furthermore, the Working Groups were asked to set their recommendations within the limits of current resources available to national and regional fisheries administrations. The two Working Groups were then provided with key reference material on recent developments in the activities of ICCAT, ICRI (the International Coral Reef Initiative), and GECAFS (Global Environmental Change and Food Systems). Participants were also asked to consider various sample ICCAT data forms, as well as data forms developed by CFU for specific countries' fisheries, and to indicate the possibility of improving current national data forms and hence field sampling programmes. The two Working Groups worked simultaneously during Tuesday's morning session and part of Wednesday's morning session to complete their work.

12. Ad hoc working groups to examine, prepare and commence assessment analyses of available pelagic and reef fish species. [*Introduction presented by Dr. S. Singh-Renton*]

The importance of extracting the most information from available data was highlighted, in order to develop simple indices that could be used to provide practical fisheries management advice. A list of specific data analysis tasks was presented to guide working group analyses (Appendix 6(a)).

Three ad hoc data analysis groups were established to complete the following tasks.

Analysis Group I - Conduct exploratory analyses of catch and effort data obtained from the king and Spanish mackerel fisheries of Trinidad and Tobago.

Analysis Group II - Conduct statistical analyses of historical data on the fisheries of The Bahamas, and to explore the usefulness of simple indices for development of management advice.

Analysis Group III - Review new available dataset on the red hind fishery of St. Vincent and the Grenadines, and commence updated assessment analyses.

Given the limited time available, it was agreed that the three working groups would use Tuesday's afternoon session to begin to work through the suggested list of data analysis tasks. Each set of data was slightly different in content and stage of preparation. Additionally, in two cases, some preliminary analyses had already been completed. Hence, it was agreed that each working group would conduct a specific subset of the recommended data analysis tasks, based on the type of data available and the analyses already completed to date.

13. Report of ad hoc working groups on data preparation and analyses - Analysis Group I report. [*Presented by Ms. L. Martin*]

Very basic analyses were conducted on raised catch and effort data on king and Spanish mackerel for the period 1995-2000. The data consisted of point estimates of mean landings, effort and value. The data were not in a suitable format for import into SPSS, and so the group spent much time in preparing the data for this. The group showed annual trends in catch and value. Additionally, catch per trip (mean monthly estimate) was calculated. A preliminary GLM was attempted, and the estimated mean annual and monthly trends were plotted. The estimated mean variation in catch per trip with gear was also investigated. In view of the very preliminary nature of the analyses and the quality of the dataset, no written detailed report was submitted by the group.

Discussion:

Clarification was sought concerning the banning of the monofilament net in T&T. It was explained that it was not possible to ban the use or importation of the net, owing to existing protective legislation. An increase in mesh size was considered to be the alternative available option to controlling harvests by this gear. A suggestion was made regarding the inclusion of area and depth data in the GLM, and that this idea should be discussed further with the statistician.

14. Age and growth studies of the wahoo, *Acanthocybium solandri*, from the southern Caribbean. [*Presented by Ms. R. Kishore*]

Age and growth studies of the wahoo in the Caribbean involved St. Lucia, Barbados, St. Vincent, and Trinidad and Tobago. Ages ranged from 0 to 3 years, 0 to 2 years, 2 to 10 years and 2 to 6 years for St. Lucia, St. Vincent, Barbados, Trinidad and Tobago respectively. Most of the commercial fish exploited in St Lucia are about one year old. In comparison, about 50% of the fish caught in Barbados and St Vincent is in this age group. About 90% of the fish exploited by recreational fishers from Trinidad are from the 4-6 year age groups while in Tobago, 50% are between 4 and 5 years old. Growth analysis shows that the wahoo is a relatively fast growing fish early in its life history, reaching a length of approximately 80 cm by the time it is one year old. This growth gradually slows down and then levels off at about 8 years. This kind of research on the wahoo, using ear bones for the purpose of aging, is the first such described for the region for which growth rates and growth parameters have been produced.

Discussion:

Participants acknowledged the quality of work completed by the Lab on wahoo. Given that the age and growth lab staff had to collect and process a significant portion of the wahoo heads examined by the study, they were familiar with the difficulties experienced in the field by national data collectors. Clarification was sought on the timing of delivery of the final publication on this study. It was confirmed that the final version for publication would be available in six weeks. While the difficulties of interpreting banding patterns and obtaining realistic growth curves is a long process, the timely provision of feedback to the data collectors and fishers was emphasized. This feedback was considered necessary, in order to show how the data had been utilized, and to obtain support for continued sampling, where required. Various levels of reporting were identified, to accommodate different stakeholder needs and capacities, and the Lab should assume responsibility for this task.

There was an enquiry concerning the collection of maturity data. In response, it was clarified that due to sampling time constraints in the field, this limited the amount of maturity data collected. This was considered unfortunate, as growth patterns can be affected during spawning periods.

Participants expressed their support for continuing the regional age and growth research carried out by the Lab. Having noted this, however, the need to re-train data collectors was recognized. The meeting was informed about the results of wahoo genetic studies that were recently completed by UWI (NRM). These genetic studies indicated a single Atlantic stock. The Atlantic fish showed distinct genetic differences to wahoo samples obtained from around the Galapagos Islands.

15. Proposal for extended operation of the Regional Fish Age and Growth Laboratory. [*Presented by Ms. R. Kishore*]

In view of the fact that many countries reduced their biological sampling programme since the cessation of funding of same by CFRAMP in 1998, it was considered important to obtain countries' commitment to the continued operations of the Lab at this time. A proposal was therefore presented, which reviewed the available options for continuing research at the IMA/CFU Regional Fish Age and Growth Laboratory (Appendix 7).

Discussion:

The meeting was reminded that the Lab had funded its own operations since 1998, and that the CFU budget allocation for continued operations was comparatively small. However, there was full appreciation of the importance of training attachments and supply of equipment. It was hoped that CFU could provide funding for purchase of key equipment, training attachments, laboratory exchanges (short working attachments), field visits and training. It was agreed that it was preferable for the Lab to focus on a handful of species at any one time. Consequently, there was some discussion regarding the choice of species, and the meeting agreed that criteria needed to be developed to facilitate species selection, and that this task was probably best assigned to a smaller working group. Nonetheless, preliminary suggestions on suitable criteria were put forward, for example: commercial importance, whether the species had been aged previously, whether the species was being assessed, species distribution and biomass. It was also suggested that countries should provide a description of fisheries for the species selected, as essential reference material for the Lab.

In view of the incomplete work on species selected by countries during the 1994 CFRAMP Large Pelagic, Reef and Slope Subproject Specification Workshop, a report on the status of work progress for each species could be useful in determining if work should continue on these species. In addition to the status of work progress, Lab staff should give details on the remaining samples required and the timing for completion of each of the investigations. It was agreed that the Lab would complete and submit this report to CFU in January 2003.

On the issue of resuming fieldwork for collection of fish hard parts, it was pointed out that the motivation of data collectors needs to be adequately addressed, and this idea was wholly supported. Additionally, the sampling programme may have to be species-specific, as countries may not be able to afford the implementation of a broader biological data collection programme. The meeting considered the possibility of including the study of fish age and growth in regional university programmes. It was clarified that this area of research is already covered by the NRM programme at UWI (Barbados).

Concern was raised regarding the continuing lack of collaboration with other laboratories. It was noted that potential collaborators were sometimes reluctant to share information. However, the Lab representative believed that publication of the wahoo work would generate much interest in the Lab, and this should help to advance the process of inter-laboratory collaboration in this and other age and growth studies carried out by the Lab.

16. Review of report of the ad hoc working group to improve management of large pelagic commercial and recreational fisheries. [*Presented by Mr. C. Isaac*]

The report of the ad hoc working group is given in Appendix 4 (b).

Discussion:

It was noted that the FAO document on fisheries management plans could serve as a useful reference for countries. It was pointed out that fisheries management plans are dynamic and should be updated from time to time. It was also pointed out that the development of co-management and consultative mechanisms would require stakeholders to be organized; this process could vary by fishery type. The representative from St. Lucia highlighted the time taken and difficulties endured, to develop the co-management approach in the SMMA area.

Given the multispecies nature of most Caribbean fisheries, improvements in all forms of data collection should be considered. Regarding the issue of quality control, all countries noted the need for improvements, and different approaches were being employed. The development of specific guidelines for data quality control was recommended. Regarding data entry, the need to back-up data was emphasized. Additionally, given the frequent changes of staff that take place in some offices, it was important to ensure that more than one person was trained in data entry at all times. Where data had not been computerized and analysed, this task should not be ignored.

The contribution of the recreational fisheries was considered to be significant, and hence monitoring of these fisheries was recommended. A suggestion was made that log forms could be considered for collection of data on recreational fisheries. Additionally, the linkage of the recreational fisheries to tourism was highlighted. In this regard, it was noted that much of the revenue generated by recreational fishing activities are being claimed by tourism, resulting in an undesirable representation of the contribution of these fisheries to the overall economy.

Further examination of the country plans indicated the following common areas of concern for which specific actions were then recommended:

A) Data entry and storage

a. *Need for capture of all types of local knowledge* – The meeting recommended the establishment of a smaller ad hoc working group that would investigate and develop approaches for the capture of these data (appropriate terminology, e.g. ethno-scientific data; identify and develop suitable tools; identify the skills and staff suited to this work; advise on the incorporation of these data into national and regional fisheries databases). This small ad hoc working group would complete the task inter-sessionally. Mr. C. Isaac (Grenada) was elected to lead the activities ad hoc working group on the development and application of local knowledge /ethno-scientific information. Other participants who volunteered to serve on the group were: Mr. L. Straker (St. Vincent and The Grenadines); Ms. I. Peters (Guyana); Ms. L. Martin (Trinidad and Tobago); Ms. S. Constantine (CFU). It was agreed that the first task of this group would be to develop its terms of reference for review and adoption by the larger Working Group. The terms of reference would be circulated for review in January 2003.

b. *Need for capture of environmental data* – The meeting recommended that national fisheries administrations would identify the types of data required, and the agencies involved in the collection and storage of such data.

c. *Need to capture data on recreational fisheries* - Prior to deciding on the suitability of log forms or other methods, the meeting recommended that countries should document a description of these fisheries, based on an agreed information template. It was agreed that this issue would be best addressed and further developed by a small ad hoc working group during the inter-sessional period. Ms. L. Martin (Trinidad and Tobago) was asked to lead this small group on the development of recreational fisheries statistics. Other participants who volunteered to serve on the group were: Mr. L. Straker (St. Vincent and the Grenadines); Mr. C. Isaac (Grenada); Mr. L. Sang (Dominican Republic); Ms. W. Joseph (St. Lucia). The group was asked to develop its terms of reference for review and adoption by the larger Working Group by January 2003.

B) Data review and quality control

a. *The need for good quality control* - Long time lag in input of data and preparation of reports does not support good quality control. The meeting therefore recommended the development of quality control guidelines. It was agreed that this task should be completed inter-sessionally by a small ad hoc working group, specifically established for the purpose. Ms. W. Joseph (St. Lucia) was elected to lead the activities of the small ad hoc working group on quality control guidelines. Other participants who volunteered to serve on the group were: Ms. I. Peters (Guyana); Ms. C. Jardine (St. Vincent and the Grenadines); Mr. C. Isaac (Grenada); Mr. A. Llewellyn (British Virgin

Islands); Ms. S. Constantine (CFU). Mr. B. Lauckner (CARDI) also offered to serve as an advisor to the group. As in the case of the other inter-sessional groups established, it was agreed that the first task of the small group would be to develop its terms of reference and to circulate these to the larger Working group members for review and adoption. The terms of reference would be circulated for review in January 2003.

b. *The need for re-training of relevant personnel*.

C) Reporting

a. *Need to make use of local knowledge and ensure that reports are more meaningful to recipients.*
b. *Need to make better use of fisher meetings* – This forum provides a good opportunity to discuss technical aspects of fisheries management with fishers.
c. *Need for regular internal (office) seminars* – this was required to increase inter-departmental and staff connectivity, so that extension staff and data collectors could be kept updated of issues and developments in statistics, research and stock evaluations.
d. *Various levels of reporting* – This was required to ensure that all stakeholders could readily absorb and appreciate the technical issues pertaining to fisheries management.

The Group generally recognized the need for recommended improvements to be pursued actively through participants' own efforts. This would ensure greater acceptance, practicality and sustainability of the adopted solutions.

C. MEETING OF THE SCPWG

17. Review and finalization of SCPWG Terms of Reference. [*Presented by Dr. S. Singh-Renton*]

The draft proposal for establishment of the SCPWG, prepared by CFU staff, was reviewed. Following the incorporation of a number of modifications, the proposal was adopted (Appendix 8).

18. Proposal to determine the distribution and movement patterns of selected small coastal pelagic species. [*Presented by Ms. S. Constantine*]

In 1996, CFRAMP had developed a proposal for studying the distribution and movement patterns of selected small coastal pelagic species (Oxenford, 1996). Unfortunately, due to increasing financial constraints at that time, the study was put on hold. However, in view of the widespread commercial importance of the small coastal pelagic fisheries to CARICOM countries, and the continuing lack of adequate data for developing suitable management strategies for these fisheries, the CFRAMP proposal was updated to respond to a current need for information on the sharing of the resources concerned. The current study proposal aims primarily to study fish movement patterns through tagging studies. Genetic studies for identification of separate unit stocks, as well as age and growth research, will also be pursued if sufficient funding becomes available. The current study proposal is provided in Appendix 10.

Discussion:

A question was asked about the type of growth increment required for validation. In response, it was indicated that daily growth rings were likely to be important. There were also queries regarding the choice and use of oxy-tetracycline, and whether fish were to be injected in situ or in a controlled environment. It was indicated that there would be a period of field trials to determine the feasibility of various approaches. It was pointed out that oxy-tetracycline had an associated comparatively high post-marking mortality. In response to a suggestion about keeping fish in tanks for marking, it was noted that this might not be a reasonable approach for the handling of schooling species.

There was some discussion about the time elapse before fish were recaptured, as many participants noted that seine operations are repeated at regular intervals, and may occur in close proximity. There could be a high rate of recaptures per day, and so the budget allocation for handling fish recoveries was questioned. It was clarified that the budget would have to take this into account.

19. Review of report of the ad hoc working group to improve management of reef and slope and small coastal pelagic fisheries – Small coastal pelagic fisheries report. [*Presented by Ms. W. Joseph*]

The report of the ad hoc working group is given in Appendix 5(b).

Discussion:

The small group was complimented for its good work and the ideas presented. It was recommended that the group provide additional information in its final report on the usage of fisheries reports by the various agencies to which they were delivered. Clarification was sought regarding the need for collecting environmental data. In response, it was confirmed that the group recommended that FDs identify their environmental data requirements, and the relevant agencies for accessing these data. It was also confirmed that the group intended this to be an inter-sessional activity. A question was asked regarding the need for St. Kitts and Nevis to ban beach seining operations. It was pointed out that these activities are conducted in very shallow water, and cause a high mortality of juvenile fish. Considering this, the need for impact assessments in this area was questioned. The group clarified that the relevant study that was being recommended was intended to address habitat use in the BVI.

The point was also made that countries should set fewer goals, and ensure that these are done well, before expanding to other activities. In addition, FDs should try to obtain public support for their work. It was clarified that the statistics were being linked to the corresponding objectives for which they provided measures of achievement; not all tasks would be possible to undertake during the inter-sessional period.

The meeting noted the similarities of conclusions drawn by both ad hoc working groups, as well as additional recommendations made by this group.

1) Data entry and storage

a. *Need for improvements in collection of all types of catch and effective effort data, both by species and area, and also improvement in coverage of small coastal pelagic fisheries* - The meeting noted that countries usually did not make full use of the data available to them, and recommended that a workshop be held to focus primarily on data analysis. The development of simple indices for measuring the achievement of fisheries management objectives should also be given close attention.

b. *Possible need for ongoing training of relevant personnel* - This was considered important, in view of the problem of frequent staff changes. The meeting therefore recommended the development of a training course that would provide comprehensive training in data collection. The training course should be prepared and stored on CD, for easy access and delivery within FDs.

2) Data review and quality control

a. *Need to improve supervision of data collectors* - The small ad hoc working group on quality control guidelines should address this need in the development of quality control guidelines.
b. *Need to improve timeliness of data entry, so as to facilitate more effective quality control checks* - This issue would be addressed by the small ad hoc working group on quality control guidelines.
c. *Need to address difficulties associated with visual estimation of large quantities of small coastal pelagic catches* - This issue should be addressed by the training course recommended in 1b, and the 'intra-FD' seminars recommended in 2d.
d. *Need to motivate data collectors* - The meeting recommended increased frequency of 'intra-FD' seminars, in which all FD staff would be updated on the progress of each aspect of its work. These seminars should be conducted in a manner to maximize positive exchanges among the staff concerned, and to inspire data collectors to strive for perfection in their difficult task.

3) Reporting

a. *Need to improve content of reports, and produce them more frequently* -This was considered very important, especially in the context of ensuring an active fisheries management cycle. The meeting noted the need to identify clearly the components of national fisheries management cycles, and that annual work programmes could assist in identifying the stages and processes involved in these cycles. The meeting further noted that national fisheries management plans (FMPs) were often not available to all fisheries officers. It was agreed that countries should exchange information concerning the format of their various national reports, and to determine the best means of communicating information to the public. The meeting therefore recommended that each country prepare a national status report that would contain: (i) report formats; (ii) a list of the current avenues for flow of information and reports; and (iii) an outline of the stages of the national fisheries management cycle, noting the Parties concerned, and the flow of information and tasks associated with each stage. The meeting requested country representatives to submit their national status reports by 31 January 2003. The point was also made that FDs should improve their reporting to CFU.
b. *Need to build capacity in reporting* - This issue should be revisited following examination of the compilation of national status reports requested in 3a.

Participants recognized that countries shared similar weaknesses in the conduct of fisheries management work. Additionally, several participants emphasized the need for individual commitment and respect of the agreed deadlines, for ensuring successful implementation of the meeting's recommendations.

D. MEETING OF THE RSWG

20. Review and finalization of RSWG Terms of Reference. [*Presented by Dr. S. Singh-Renton*]

The draft proposal for establishment of the RSWG, prepared by CFU staff, was reviewed. Following the incorporation of a number of modifications similar to those made on the SCPWG proposal, the proposal for establishment of the RSWG was adopted (Appendix 9).

21. A preliminary marine ecosystem model for the EEZ of a small island state: A case study for Grenada and the Grenadines. [*Presented by Ms. E. Mohammed*]

The presentation reviewed the construction, parameterisation and balancing of a preliminary marine ecosystem model for the southeastern Caribbean using the Ecopath with Ecosim software. The model integrated available ecological and biological information for the region, and fisheries related information specific to Grenada and the Grenadines. The main objectives were to better understand the structure and functions of components of the ecosystem, to examine the impacts of fishing on the living marine resources and to explore fisheries management policy options. Data limitations and associated suggestions for further refinement of the model were noted and hypothetical policy exploration scenarios demonstrated.

Discussion:

It was pointed out that the ICCAT MSY estimates needed to be updated, as the reference used was now relatively old. The possibility of updating the data from CARICOMP was also highlighted. Clarification was sought on the meaning of the statement that the fishery was operating at a mean trophic level of 4.34. In response, it was noted that this was simply the average of the trophic levels attributed to the species harvested by the fishery. A query was raised concerning the use of data from only the north coast of Trinidad rather than data from both the east and north coasts. Given the predominance of demersal fishing activities on the east coast, and the greater use of line gear along the north coast, it was considered that the north coast data were more comparable to data from the study area. Clarification was sought regarding the incorporation of mangrove inputs into estimates of primary production. It was confirmed that these inputs were not accommodated by the current model.

22. Quantifying the impacts of fishing on marine resources by analysis of reconstructed fisheries time series data: a case study for Grenada and the Grenadines. [*Presented by Ms. E. Mohammed*]

The sources and methods of reconstruction of annual time series data on fisheries catches and fishing effort from Grenada for the period 1942 to 2001 were presented and reviewed. Fisheries related (trends in annual catches, fishing effort, catch per unit effort and catch per unit area), biological and ecological (annual mean trophic level, length and fishery-in-balance index) indicators were used to examine the impacts of fishing on the marine resources during the period 1978 to 2001. Suggestions for further improvement of fisheries statistics were also proposed.

Discussion:

There was some debate regarding the possible causes of the observed peaks in total catches during the late 1970s and late 1980s. It was clear that further collaboration with the Grenada FD was warranted, in order to explain the observed trends, as well as some of the greater discrepancies with the FAO data.

Clarification was sought on the applications of the FIB index. It was noted that a decrease in this index indicated that the fishery was in trouble. It was further noted that the index was linked to a measure of change in the species composition of catches.

23. Estimating potential yield from habitat mapping data – An Example.

[*Presented by Ms. S. Constantine and Mr. L. Straker*]

This study is still in progress. A brief review was presented of the most popular methods of calculating potential fish yields from habitat area data: trophodynamic models, biomass turnover models, empirical relationships and surplus production models. The present study aims to apply a trophodynamic model for the estimation of potential fish yield from marine habitats in St. Vincent and the Grenadines.

Discussion:

A query was raised concerning the expectation of higher production from a population predominated by large numbers of young fish, as large female fish have been shown to be more fecund than smaller female fish. It was pointed out that the presence of relatively larger numbers of young fish is probably associated with the fact that these fish have yet to realize their full production potential, and that at least a portion of the older population would be expected not to contribute further to production. Further review of the literature was recommended, in order to confirm the point, and to investigate whether there would be any link to 'r' and 'k' life history strategies.

Further clarification on the estimation of ecotrophic efficiency was sought from the ECOPATH resource person.

24. Review of historical fisheries data from The Bahamas – Analysis Group II report.

[*Presented by Ms. S. Constantine and Mr. L. Straker*]

This study is still in progress. The presentation updated participants of the work completed to date (Appendix 6(b)). Both commercial and recreational data on the fisheries of The Bahamas were examined, cleaned, and prepared for basic statistical analyses in SPSS. Summary tables of production and unadjusted CPUE trends were presented. Plots showing the number of fishing days per area and per year were also constructed and examined.

Discussion:

There was a query concerning the usage of data from processing plants, and it was confirmed that these data were included. Conversion factors were used where available. The need to examine changes over time in the species composition of the catch was emphasized. In respect of this, it was suggested that available historical literature could provide useful data for dis-aggregating data where necessary.

Regarding the offshore pelagic fisheries of The Bahamas, concern was expressed with respect to the significance of the recreational fisheries and the absence of these data from the dataset. It was agreed that the capture of recreational fishing data should be given greater attention in the future, not only by The Bahamas, but also by other countries known to have measurable recreational fishing activities.

25. Survey of the red hind fishery in St. Vincent and the Grenadines. [*Presented by Ms. S. Constantine*]

The results of a survey conducted on mainland St. Vincent and Bequia, targeting red hind (*Epinephelus guttatus*) fishers are presented in this paper. Of the total number of red hind fishers on the two islands, 56.8% originate from Bequia and the other 43.2% originate from St. Vincent. Pirogues, double enders and speed boats are used to get to the fishing grounds which are spread around mainland St. Vincent and along the Grenadine shelf. Once the preferred grounds have been chosen, fishers engage in bottom long lining, vertical bottom lining, trapping using fish pots, spearing and handling which is locally called "banking" or "keeping up". Comparisons of the weight–length relationships for samples of red hind collected over the period September to October 2002 and those collected in 2000 (CFRAMP, 2002), indicated that certain size categories of individuals are in better condition in 2002 than those in 2000 and vice versa. Fulton's condition factor and Relative condition factors calculated for samples collected from fishing grounds around Mustique and Canouan on the same day indicated that overall, the Mustique population of red hind is in better condition than the Canouan population. The findings of this survey may have important consequences for the development of effective management initiatives for the resource.

Discussion:

There was a query regarding the restricted period in which the study had been conducted, i.e. during September and October only. It was noted that sampling was limited to these two months because of time constraints. In response to a question concerning the occurrence of night fishing operations, it was confirmed that the usual fishing day extended from 4.00 a.m. to 8.00 p.m. The question was asked whether differences in sizes caught by different gears might have influenced the estimated length-weight (L-W) relationship. It was clarified that the L-W relationship had been estimated for all gears combined. It was also pointed out that area was not considered in developing the relationship presented in 2000 (CFRAMP, 2002).

Another participant asked about the occurrence of red hind spawning aggregations in St. Vincent and the Grenadines, and whether these aggregations were specifically targeted by the fishers. The presenter stated that she was unsure that fishers actively targeted the aggregations, but that there was evidence that spawning took place 2-3 times a year and fishers appear to know of the occurrence of spawning aggregations. The need to conduct statistical tests on the estimated L-W relationship, as well as to obtain an adequate sample size, was noted and agreed. In response to a comment that the L-W relationship estimated in 2002 appeared inconsistent with that quoted in 2000 (CFRAMP, 2002), it was pointed out that this may have been due to a difference in the size range of fish sampled during the two studies. Noting that the sample of red hind may have come from different populations, participants recognized the need for an independent study of the distribution and movements of these fish.

26. Review of available data on the red hind fishery of St. Vincent and the Grenadines, and updated analyses – Analysis Group III report. [*Presented by Dr. S. Singh-Renton*]

This study is still in progress. A preliminary assessment of the commercial red hind fishery of St. Vincent and the Grenadines was conducted in 2000, using available catch, effort and length frequency data for the period 1994-1998. Additional available data collected during 1999-2001 provided an opportunity to update the assessment of this fishery. The presentation focused on analyses completed to date: rationalization of the decision to group data for analyses, according to revised interpretations of fishery operations provided by the study presented under agenda item 25; and attempts to correct the size frequency data for possible biases caused by gear selectivity (Appendix 6(c)). A full quantitative assessment of the red hind fishery operating in the Canouan area is planned.
Discussion:
The comment was made that the gear selectivity procedure appeared not to have provided a reasonable correction of the observed length frequency sample. The Group agreed with this comment, and it was pointed out that the selectivity method did not yield credible results for the size ranges in which it was most needed. The apparent change in mean size of fish caught by different gears was also noted.

27. Using statistics to analyse and interpret commercial fisheries data.
[*Presented by Mr. B. Lauckner*]

Using a sample dataset on the red hind fishery of St. Vincent and the Grenadines, procedures for cleaning and summarizing data were reviewed. Methods of entering data, as well as handling of data entry errors and missing data, were also examined. The importance of conducting simple summary and descriptive statistical analyses and of their interpretations was emphasized. It was noted that care is required to ensure that analyses are valid and meaningful; in particular, concomitant variables (covariates) have to be considered.
Discussion:
It was noted that the weight variable examined was total weight of catch and not of individual fish, and hence the data might not be expected to be normally distributed. Regarding missing data, the importance of making educated guesses based on ancillary information on the fishery was emphasized. Other data fields could also be examined to provide an indication of the likely value of the missing data points.

28. Review of the report of the ad hoc working group to improve management of reef and slope and small coastal pelagic fisheries – Reef and slope fisheries report. [*Presented by Ms. W. Joseph*]

This report was combined and presented together with the corresponding report on small coastal pelagic fisheries covered by agenda item 19 (see also Appendix 5 (b)).

A. GENERAL PLENARY SESSIONS (Continued)

29. Other business.

Dr. S. Singh-Renton sought reconfirmation of countries' commitments to provision of juvenile wahoo otoliths for completion of the current regional age and growth research on this fish. Several countries noted that it was their understanding that CFU would provide the necessary funds for such sampling. Without these additional funds provided by CFU, obtaining such samples may be very difficult.

30. Review of draft report.

A first draft of the report of the plenary sessions covering items 1-23 was delivered to participants. Given time constraints, it was decided that participants would provide their comments by e-mail.

31. Adjournment.

The meeting was adjourned at 3.15 p.m.

E. REFERENCES

Banks, R., Hoggarth, D. & Macfadyen, G. 2002. Expansion of Existing data Collection Systems to capture, store and manage social and economic data from the fisheries sector. CARICOM Fisheries Unit Consultancy Report: 81pp.

Oxenford, H. 1996. Investigation of stock movements, distribution and migration of the primary seine fishery species, jacks (*Selar crumenophthalmus*) and robins (*Decapterus spp.*) on the Grenada and St. Vincent shelves, and field-based validation of growth rates. Working Paper presented at CFRAMP's Small Coastal Pelagics and Flyingfish Sub-Project Specification Workshop, 11-13 September, 1996, Grenada. 20 pp.

F. APPENDICES

APPENDIX 1

AGENDA

A. GENERAL PLENARY SESSIONS

i. Registration.
1. Opening ceremony.
2. Selection of Chairpersons and Rapporteurs.
3. Adoption of Agenda and Procedural Arrangements.
4. Introduction of country representatives, and invited resource persons.

B. MEETING OF THE LPWG

5. ICCAT - Brief Review of Status of Stocks and Management Update.
6. Fulfillment of ICCAT Contracting Party and Co-operating Party Obligations
7. ArgoNet, the VMS integrated solution.
8. Case studies.
9. Review of first FAO TCP workshop report and recommendations
10. Expansion of existing data collection systems to capture social and economic data for fisheries management and decision-making.
11. Ad hoc working groups to: (a) improve management of large pelagic commercial and recreational fisheries; and (b) improve management of reef and slope and small coastal pelagic fisheries
12. Ad Hoc working groups to examine, prepare and commence assessment analyses of available pelagic fish species.
13. Reports of Ad Hoc Working Groups on data preparation and analyses.
14. Age and Growth Studies of the Wahoo, *Acanthocybium solandri* (Curvier 1830) from the Southern Caribbean.
15. Proposal for extended operation of the Regional Fish Age and Growth.
16. Review of report of Ad Hoc Working Group to Improve Management of Large Pelagic Commercial and Recreational Fisheries

C. MEETING OF THE SCPWG

17. Review and finalisation of SCPWG Terms of Reference.
18. Proposal to determine the distribution and movement patterns of selected small coastal pelagic species.
19. Review of report of Ad Hoc Working Group to Improve Management of Reef and Small Coastal Pelagic Fisheries – Small Coastal Pelagic Fisheries Report.

D. MEETING OF THE RSWG

20. Review and finalisation of RSWG Terms of Reference.
21. A preliminary marine ecosystem model for the EEZ of a small island state: A case study for Grenada and the Grenadines.

22. Quantifying the impacts of fishing on marine resources by analysis of reconstructed fisheries time series data: A case study for Grenada and the Grenadines.
23. Estimating potential yield from habitat mapping data – An Example.
24. Review of historical fisheries data from The Bahamas.
25. Survey of the red hind fishery in St. Vincent and the Grenadines.
26. Review of available data on red hind fishery in St. Vincent and the Grenadines, and updated analyses.
27. Using statistics to analyse and interpret commercial fisheries data.
28. Review of Report of Ad Hoc Working Group to Improve Management of Reef and Small Coastal Pelagic Fisheries – Reef and Slope Fisheries Report.

A. GENERAL PLENARY SESSIONS (CONTINUED)

29. Other Business.
30. Review of draft report.
31. Adjournment.

APPENDIX 2

ANNOTATED AGENDA

A. GENERAL PLENARY SESSIONS

Monday 25th November 2002

i. Registration (*0830 - 0900h).*

1. Opening ceremony (*0900 - 0930h*).

2. Selection of Chairpersons and Rapporteurs (*0930 - 0935h).*

3. Adoption of Agenda and Procedural Arrangements (*0935 - 0940h).*

4. Introduction of country representatives, and invited resource persons (*0940 - 0950h).*

B. MEETING OF THE LPWG

5. ICCAT - Brief Review of Status of Stocks and Management Update (*0950 - 1030h*). [*Presenter: S. Singh-Renton*]
   - Status and Management of Stocks of Atlantic Tuna and Billfishes
   - Revision of ICCAT Catch Allocation Criteria

***Coffee/Tea Break** (1030 - 1045h).*

5. Continued (*1045-1100h*).

6. Fulfillment of ICCAT Contracting Party and Co-operating Party Obligations (*1100 - 1130h*). [*Presenter: S. Singh-Renton*]
   - Statistical reporting obligations.
     - Data recording (Task I and II data).
     - ICCAT reporting forms.
   - Research obligations.
     - Observer programmes.
     - Participation in ICCAT species programmes.
   - Management obligations
     - Implementation of ICCAT statistical document programmes.
     - Monitoring, including vessel monitoring systems.
     - Control and surveillance.
     - Legislation and regulations.
     - Policy.

7. ArgoNet, the VMS integrated solution (1130-1200h). [*Presenter: C. Villaran*]

8. Case studies (*1200 - 1230h*). [*Presenters: R. Ryan, S. Singh-Renton, C. Isaac, L. Martin*]
   - St. Vincent and the Grenadines (ICCAT Non-Contracting Party).
   - Belize (ICCAT Non-Contracting Party).

- Grenada (ICCAT Non-Contracting Party).
- Trinidad and Tobago (ICCAT Contracting Party).

Lunch *(1230-1330h).*

8. Continued (*1330-1415h*).

9. Review of first FAO TCP workshop report and recommendations *(1415 – 1500h*). [*Presenter: R. Walters*]
   - Summary presentation.
   - Review and discussion.
   - Develop recommendations for presentation to CRFM Forum.

10. Expansion of existing data collection systems to capture social and economic data for fisheries management and decision-making (*1500-1530h*). [*Presenter: T Phillips*]

Coffee/Tea Break (*1530-1545h*)

11. Ad hoc working groups to: (a) improve management of large pelagic commercial and recreational fisheries, and; (b) improve management of reef and slope and small coastal pelagic fisheries (*1545 - 1700h*). [*Introduced by S. Singh-Renton*]

Tuesday 26th November 2002

11. Continued (*0830 - 1030h*).

Coffee/Tea Break (*1030h - 1045h*).

12. Continued (*1045 - 1130h*).

13. Ad Hoc Working Groups to examine, prepare and commence assessment analyses of available pelagic fish species (*1130-1230h*). [*Introduced by S. Singh-Renton*]

Lunch (*1230 - 1330h*).

12. Continued (*1330 - 1530h*).

Coffee/Tea Break (*1530 - 1545h*)

12. Continued (*1545 - 1700h*).

Wednesday 27th November 2002

14. Reports of Ad Hoc Working Groups on data preparation and analyses (*0830–1000h*) *[Presenters: Working Group Rapporteurs]*.
    - Data preparation
    - Analyses
15. Discussion and further recommendations.

14. Age and Growth Studies of the Wahoo, *Acanthocybium solandri* (Curvier 1830) from the Southern Caribbean (*1000 – 1030h*). [*Presenter: R. Kishore*]

Coffee/Tea Break (*1030 - 1045h*).

15. Proposal for extended operation of the Regional Fish Age and Growth Laboratory (*1045-1130h*). [*Presenter: R. Kishore*]
    - Proposal review
    - Recommendations to CRFM Forum.

16. Review of report of Ad Hoc Working Group to Improve Management of Large Pelagic Commercial and Recreational Fisheries (*1130 -1230h*). [*Presenter: Working Group Rapporteur*]
    - Policy, FMPs, and legislation
    - Statistics and data forms
    - Working with ICCAT (Co-operating or Contracting Party status)?
    - Developing an active fisheries management cycle
    - Required improvements and practical approaches for CRFM States (Recommendations).
    - LPWG Inter-sessional work plan (ICCAT, statistics, research, management).

Lunch (*1230 - 1330h*).

16. Continued (*1330-1630h*).
    - Develop and finalise remaining country inter-sessional plans

C. MEETING OF THE SCPWG

Thursday 28th November 2002

17. Review and finalisation of SCPWG Terms of Reference (*0830 - 0930h*). [*Presenter: S. Singh-Renton*]

18. Proposal to determine the distribution and movement patterns of selected small coastal pelagic species (*0930 -1000h*). [*Presenter: S. Constantine*]

19. Review of report of Ad Hoc Working Group to Improve Management of Reef and Small Coastal Pelagic Fisheries – Small Coastal Pelagic Fisheries Report (*1000 - 1030h*). [*Presenter: Working Group Rapporteur*]
    - Policy, FMPs, and legislation
    - Statistics and data forms
    - Developing an active fisheries management cycle
    - Required improvements and practical approaches for CRFM States (Recommendations).
    - SCPWG Inter-sessional work plan (statistics, research, management).

Coffee/Tea Break (*1030 - 1045h*).

19. Continued (*1045-1230h*).

- Develop and finalise remaining country inter-sessional plans

Lunch *(1230 - 1330h).*

D. MEETING OF THE RSWG

20. Review and finalisation of RSWG Terms of Reference (*1330 - 1415h*). [*Presenter: S. Singh-Renton*]

21. A preliminary marine ecosystem model for the EEZ of a small island state: A case study for Grenada and the Grenadines (*1415 - 1500h*). [*Presenter: E. Mohammed*]

22. Quantifying the impacts of fishing on marine resources by analysis of reconstructed fisheries time series data: A case study for Grenada and the Grenadines (*1500 - 1530h*). [*Presenter: E. Mohammed*]

Coffee/Tea Break (*1530 - 1545h*).

23. Estimating potential yield from habitat mapping data – An Example (*1545-1615h*). [*Presenter: L. Straker and S. Constantine*]

24. Review of historical fisheries data from The Bahamas (*1615 - 1645h*). [*Presenter: S. Constantine*]

Friday 29th November 2002

25. Survey of the red hind fishery in St. Vincent and The Grenadines (*0830-0910h*). [*Presenter: S. Constantine and L. Straker*]

26. Review of available data on red hind fishery in St. Vincent and the Grenadines, and updated analyses (*0910 - 0950h*). [*Presenter: S. Singh-Renton*]
    - Data preparation and analyses.
    - Discussion and recommendations.

27. Using statistics to analyse and interpret commercial fisheries data (*0950-1030h*). [*Presenter: B. Lauckner*]
    - Cleaning and preparing data for statistical analyses.
    - The importance of basic analyses and their interpretations.
    - Standardisation of catch rates (e.g. using GLMs, GAMs, and regression trees) and Bayesian methods.

Coffee/Tea Break (*1030 -1045h*).

28. Review of Report of Ad Hoc Working Group to Improve Management of Reef and Small Coastal Pelagic Fisheries – Reef and Slope Fisheries Report (*1045 -1230h*). [*Presenter: Working Group Rapporteur*]
    - Policy, FMPs, and legislation
    - Statistics and data forms
    - Developing an active fisheries management cycle

- Required improvements and practical approaches for CRFM States (Recommendations).
- RSWG Inter-sessional work plan (statistics, research, management).
- Develop and finalise remaining country inter-sessional plans.

Lunch *(1230 - 1330h).*

A. GENERAL PLENARY SESSIONS (CONTINUED)

29. Other Business (*1330-1345h*).

30. Review of draft report (*1345-1430h*).

31. Adjournment (*1430h*).

APPENDIX 3

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APPENDIX 4

AD HOC WORKING GROUP TO IMPROVE MANAGEMENT OF LARGE PELAGIC COMMERCIAL AND RECREATIONAL FISHERIES

(a) Terms of Reference

1. Compile consolidated list of policy objectives (separate by type of fishery).
2. Are identified policy objectives adequately reflected in national fisheries management plans in terms of fisheries management goals and objectives?
3. Identify and list statistics required to monitor and measure achievement of identified policy objectives. Note rationale.
4. Identify and list additional statistics required to fulfill national reporting obligations under international fisheries instruments, e.g. FAO, and reporting to

regional and international fisheries management organizations such as ICCAT. Note rationale.

5. Identify and list additional statistics required to contribute to national, regional, and international fisheries assessment, research, conservation and management initiatives, e.g. MACC, GECAFS, CRFM. Note rationale.
6. Review sample data forms and provide comments on suitability for adoption by all countries, and further refinements needed. Consider (i) the availability of financial resources, and (ii) different field situations, especially with regard to:
    - The number and quality of data collectors;
    - Supervision of data collectors and quality control;
    - Promoting fisher-data collector-fisheries manager relations;
    - Characteristics (support for data recording, time and nature of fishing operations) and distribution of landing sites.
7. Give status of each country's fisheries statistical information system with respect to 3, 4, and 5 (identify, list and then evaluate the status of each component of the statistical information system, e.g. data collection, data review, reporting).
8. How can each country improve statistical data collection and be sure of adequate sampling coverage?
9. How can each country improve statistical recording and reporting tasks? Consider data storage, analysis and reporting needs (national, regional and international).
10. How do countries acquire Co-operating Party Status at ICCAT? Propose improvements in national contributions in statistics, research, monitoring, control, and surveillance (Task I data; Task II catch and effort and size frequency data; Species programs e.g. billfish biological data collection and tagging; observer programs; port or landing site inspection schemes; legislation and enforcement).
11. What basic rules can we follow to achieve a successful active fisheries management cycle in CARICOM/CRFM countries?
    i. Address needed linkages among various stakeholders (i.e. mechanisms for effective consultation), public education and awareness, legislation and enforcement
    ii. Identify and list the Parties that contribute to the various components of the fisheries management cycle.
12. Will present national fisheries work plans and budgets facilitate 6, 7, and 8, and if not, how and when can the necessary adjustments be made?
13. Develop inter-sessional plan for each country present: (i) to undertake activities to improve statistics, research, and management, and; (ii) to acquire Co-operating Party Status at ICCAT. Identify common areas of concern that could be addressed through regional projects.

(b) Report of The Ad Hoc Working Group to Improve Management of Large Pelagic Commercial and Recreational Fisheries

Prepared by L. Martin

This report follows the format of the working document used by the Ad Hoc Working Group to Improve Management of Large Pelagic Commercial and Recreational Fisheries at the 2002 Joint Meeting of the CRFM Large Pelagic, Reef and Slope and

Small Coastal Pelagic Fisheries Working Groups. The Ad Hoc Group's proposals are recorded, based on the working document's itemised instructions and questions. The report also reflects views expressed during the plenary discussion of the Group's proposals.

Working Group participants:

Crofton J. Isaac, Chairman (Grenada)
Jean Robert Badio (Haiti)
Rosemarie Kishore (IMA)
Louanna Martin, Rapporteur (Trinidad & Tobago)
Ingrid Peters (Guyana)
Susan Singh-Renton (CARICOM Fisheries Unit)
Leslie Straker (St Vincent and the Grenadines)
Randolph Walters (FAO)
Mario Yspol (Suriname)

Results of Working Group and Plenary discussions:

1. The group identified the following policy objectives for large pelagic fisheries (including recreational fisheries):
    - Maximise economic benefits through sustainable use of fisheries
    - Earn foreign exchange
    - Food security
    - Promote/maintain social, economic / cultural stability
    - Rural community development
    - Employment generation
    - Co-management

2. Various national management goals/objectives were identified:
    - Co-operate with ICCAT and Caribbean States for management
    - Promote sustainable and co-ordinated development of large pelagic commercial and sport fisheries through collaboration with regional and international organisations for shared resources
    - Sustainable use of resources
    - Preservation of biodiversity
    - Effective monitoring and enforcement
    - Promotion of / movement towards a co-management or rights-based approach
    - Earn foreign exchange through development of the industry
    - Generate income through development of the industry
    - Registration of recreational fishers

    Objectives should be measurable and should be reviewed by Fisheries Divisions.

3.& 4. The group identified these statistics as required for monitoring and measuring achievement of the management objectives identified in item 2. above and for fulfilling national reporting obligations under international fisheries management organisations such as ICCAT:

- Related to the first and second bullets:
  1. Catch and effort statistics by species, gear, area (EEZ, grids)
  2. Biological statistics: size frequency for certain species
  3. Social statistics: number of persons employed full-time and part-time, opportunity for alternative employment, household size, number of dependents of direct stakeholders, numbers achieving various educational levels, sex and age demographics and number of persons in various occupations within the industry
  4. Economic statistics: values of exports and imports, cost of fishery operations, revenue generated by the fishery, value of investment in the fishery
  5. Local/traditional knowledge of stakeholders

  The statistics identified under 3. and 4. are mentioned with reference to their importance in catch share negotiations.

- Related to the third bullet of item 2:
  1. Area specific catch rates and trends
  2. Gear specific catch rates and trends

- Related to the fourth bullet of item 2:
  1. Species composition in catch (includes bycatch and discards)
  2. Size composition in catch
  3. Effective effort
  4. Stock identification
  5. Stomach contents of species in catch
  6. Fisheries independent data (surveys and studies)
  7. Indicator species information

- Related to the fifth bullet of item 2:
  The implementation of effective monitoring and enforcement measures involves evaluation and analysis of all statistics.

- Related to the sixth bullet of item 2:
  1. Local/traditional knowledge of stakeholders

5. Additional statistics required to contribute to national, regional and international initiatives for fisheries management, e.g. MACC, GECAFS, CRFM include environmental statistics such as:
   - Sea surface temperature
   - Sea level rise
   - Rainfall
   - Storm frequency
   - Salinity
   - Availability of bait

With respect to adaptation to climate change statistics relating to alternative employment and pollution indicators are important. Agencies where pollution indicator information may be available include

- Institute of Marine Affairs (IMA)
- Food and Agriculture Organisation of the United Nations (FAO)
- United Nations Environment Programme (UNEP)
- The University of the West Indies (UWI)
- National Oceanic and Atmospheric Administration (NOAA)
- National agencies responsible for water and sewerage
- Caribbean Environmental Health Institute (CEHI)
- Ministries of Health
- Ministries of Environment

Item 6. was not discussed in the interest of time. Related information may be gleaned, however, from the information presented under item 7.

7. The table immediately following shows the status of national fisheries statistical information systems with respect to items 3, 4 and 5. In the top row of each of the sections (Data Collection, Data Review and Reporting) accomplishments are presented. In the corresponding bottom rows aspects requiring improvement are indicated. Actions required in addressing shortfalls in the information systems are presented in the third row of each section. Note that where there were similarities in national information systems and situations the information is combined for the countries.

Country		Data Collection	Data Review	Reporting
St. Vincent & The Grenadines, and Grenada	Accomplishments	SVG: Good coverage of fish landings at landing sites throughout the state Adequate and experienced data collection personnel Some catch and effort data collected Biological data collected for some species Grenada: Fisheries Division receives all data generated during the annual billfish fishing tournament Data collection system captures close to 100% of pelagics landed	SVG: Participate actively in the updating of the regional LRS and TIP programmes Some quality control checks are done at different stages of the data collection programme Grenada:	SVG: Analyses relating to biological parameters and stock abundance have been done for some species Frequent reports on landings, exports and value are prepared Reports to ICCAT, FAO, CFRAMP and other international, regional and local bodies Grenada: Provided over 2000 data items (data on individual fish) to ICCAT for close to 10 years (1989-1999) for the Enhanced Billfish Research Programme

Country		Data Collection	Data Review	Reporting
	Aspects of information programmes that require improvement	Economic and Social Biological Catch Area specific	Additional quality control mechanisms to deal with the data elements identified	Additional and more frequent reporting required Reporting constrained by lack of resources, which affects data entry/input into databases
	Actions required in addressing shortfalls	More focused programme Feedback		Feedback Stakeholder advocacy through involvement
	Accomplishments			
Guyana and Suriname	Aspects of information programmes that require improvement	Economic Local knowledge Sea surface temperature Area (Suriname)	Returns and accuracy in completion Improvement in quality control. There is no rigorous system in place (Suriname)	No data input capability presently in Guyana
Guyana and Suriname	Actions required in addressing shortfalls	Identify sources of environmental data. Feedback EOs should be regularised (Guyana)		Feedback Stakeholder advocacy through involvement
	Accomplishments			

Country		Data Collection	Data Review	Reporting
Haiti and Dominican Republic	Aspects of information programmes that require improvement	Catch and effort coverage Minimum biological data collection still required	Quality control must be improved	Lack of human resource to deliver data to Fisheries Department and to computerise data
	Actions required in addressing shortfalls	More Data Collectors Feedback		Feedback Stakeholder advocacy through involvement
Trinidad and Tobago	Accomplishments	On-going catch and effort data collection for the artisanal fleet. Greater than 3 years of biological data collected for several species including 2 species of mackerel and 5 species of sharks. Collection of catch and effort data for the recreational fisheries sub-sector from fishing tournaments. Implementation of a trip reporting system for semi-industrial longliners (precursor to a logbook programme).	Data review system in place for the on-going catch and effort data collection programme (artisanal fleet).	Published preliminary stock assessment report for *Scomberomorus brasiliensis*. Several reports published on various aspects of the artisanal, gillnet and pelagic handline, fishery. Publication of awareness materials for the general public.

Country		Data Collection	Data Review	Reporting
Trinidad and Tobago	Aspects of information programmes that require improvement	Coverage of the recreational, semi-industrial and industrial fleets Ongoing social and economic data Use of local/traditional knowledge	Consultation with semi-industrial fleet stakeholders. Verification of data collected through the trip report system for semi-industrial longliners.	More in-depth analyses, e.g. stock assessments Constrained by other priorities of resource persons
	Actions required in addressing shortfalls	Feedback Additional staff	Feedback Establishment of an Observer Programme	Feedback Additional staff Stakeholder advocacy through involvement

8. The required improvements are implicit in the identified weaknesses listed in item 7. Data collection programmes must be improved in their entireties, e.g. improvements should not focus on a single species.

9. The group indicated that it was important to report to management and stakeholders. Each target audience requires a different report, e.g. if the issue of confidentiality is involved.

   Backup of data and information and understudy are important with respect to maintaining basic capabilities and skills, e.g. in the computerisation of data.

10. The participant from Grenada indicated that the country will seek ICCAT Cooperating Party status and will submit billfish data to ICCAT.

    Guyana intends to submit catch and effort and biological data on Serra Spanish mackerel and King mackerel to ICCAT. Assistance is required to identify sharks.

    The group noted that billfish tag and release data should be required from fishers so that it can be reported to ICCAT. In the past these data have gone in some instances to organisations such as the Billfish Foundation and have not been recognised by ICCAT as data contributions from the CARICOM countries concerned.

11. The group identified organisation of information and consultation among all stakeholders as a major consideration that would assist in the fisheries management cycle. To establish an effective consultative mechanism a legislative framework is required.

12. It is recommended that activities identified under items 6, 7, and 8 are addressed in subsequent budgets.

13. Improvement in management requires:
    - Feedback to stakeholders
    - Consultation
    - Innovative presentation of information, e.g. area specific (fishery related) social and economic information in addition to resource and ecological information
    - Feedback within Fisheries Departments, e.g. seminars.

APPENDIX 5

AD HOC WORKING GROUP TO IMPROVE MANAGEMENT OF REEF, SLOPE AND SMALL COASTAL PELAGIC FISHERIES

(a) Terms of Reference

1. Compile consolidated list of policy objectives (separate by type of fishery).
2. Are identified policy objectives adequately reflected in national fisheries management plans in terms of fisheries management goals and objectives?
3. Identify and list statistics required to monitor and measure achievement of identified policy objectives. Note rationale.
4. Identify and list additional statistics required to fulfill national reporting obligations under international fisheries instruments, e.g. FAO. Note rationale.
5. Identify and list additional statistics required to contribute to national, regional, and international fisheries assessment, research, conservation and management initiatives, e.g. ICRI, MACC, GECAFS, CRFM. Note rationale.
6. Review sample data forms and provide comments on suitability for adoption by all countries, and further refinements needed. Consider (i) the availability of financial resources, and (ii) different field situations, especially with regard to:
    - The number and quality of data collectors;
    - Supervision of data collectors and quality control;
    - Promoting fisher-data collector-fisheries manager relations;
    - Characteristics (support for data recording, time and nature of fishing operations) and distribution of landing sites.
7. Give status of each country's fisheries statistical information system with respect to 3, 4, and 5 (identify, list and then evaluate the status of each component of the statistical information system, e.g. data collection, data review, reporting).
8. How can each country improve statistical data collection, and be sure of adequate sampling coverage?
9. How can each country improve statistical recording and reporting tasks? Consider data storage, analysis and reporting needs (national, regional and international).
10. What basic rules can we follow to achieve a successful active fisheries management cycle in CARICOM/CRFM countries?
    i. Address needed linkages among various stakeholders (i.e. mechanisms for effective consultation), public education and awareness, legislation and enforcement
    ii. Identify and list the Parties which contribute to the various components of the fisheries management cycle.
11. Will present national fisheries work plans and budgets facilitate 6 and 7, and if not, how and when can the necessary adjustments be made?
12. Develop inter-sessional plan for each country present to undertake activities to improve statistics, research and management. Identify common areas of concern that could be addressed through regional projects.

(b) Report of The Ad Hoc Working Group to Improve Management of Reef, Slope and Small Coastal Pelagic Fisheries

Prepared by S. Constantine

There were seven persons in the group: Albion Llewellyn (British Virgin Islands), Derrick Thoephille (Dominica), Melissa O'Garro (Montserrat), Samuel Heyliger (St. Kitts and Nevis), Williana Joseph (St. Lucia), Cheryl Jardine (St. Vincent and the Grenadines) and Terrence Phillips and Sherry Constantine (CARICOM Fisheries Unit). The discussions of the Working Group focused on the tasks assigned and on any other issues pertinent to the production of the desired outputs.

I. Policy Objectives

From the National reports submitted prior to the workshop and the experience and knowledge of the members of the working group, the following list of policy objectives common to all countries and fisheries was compiled.

- Promotion of self sufficiency
- Improve nutrition, food security
- Increased employment and income in the industry
- Increased foreign exchange earnings
- Increased awareness of fishers role in the community
- Use of more appropriate fishing technology

In addition to these, some countries had other policy objectives that were exclusive to them while other objectives were specific to a particular fishery. These objectives are listed below.

Small Coastal Pelagic Fisheries

Resource
- Exploit at maximum sustainable level – St. Lucia

Social
- Discourage beach seining and gill netting – St. Kitts and Nevis
- Encourage co-management/Support appropriate Traditional Use Rights in Fisheries (TURF) – St. Lucia
- Maintain artisinal nature of fishery – St. Vincent and the Grenadines

Economic
- Promote fishery development – St. Kitts and Nevis

Environment
- Maintain fish habitat – St. Kitts and Nevis
- Minimize land-based sources of marine pollution – St. Lucia

Reef and Slope Fisheries

Resource
- Promote stock recovery
- Ensure sustainable resource use
- Control fishing effort at or less than present level – Guyana
- Maximize catches within limits of potential yield – St. Vincent and the Grenadines

Social and Economic

- Limited entry

II. Fisheries management plans

Most of the countries that comprised the working group had Fisheries Management Plans. However, their species and fisheries specific objectives were vague and challenging to measure and monitor. Therefore, the group suggested that each country should review and revise its management plan to clearly define species and fishery specific management objectives, so as to facilitate measurement and monitoring.

III. Statistics

Statistics required to monitor and measure achievement of management objectives

The group found that there was poor linkage between the management objectives and the data collected. Additionally, there were large gaps in economic, social and environmental data collection systems. However, they did note that there was little need to collect environmental information if it was already being collected by another agency. Therefore, the recommendation was made that Fisheries Divisions should identify agencies that are responsible for collecting these data and form linkages with them. Although limited finances and personnel posed a challenge to collecting social and economic information, it was agreed by all, that the Fisheries Divisions should still take on the responsibility of collecting these vital data.

The following statistics and information were identified as requirements for effective monitoring and measurement of management objectives.

- Resource – stock status (catch, effort and biological – length; age; maturity; timing of spawning) by area
- Economic – costs and earnings
- Social – age, education, alternative employment, fishing status, length of time in industry, qualifications, other roles in the industry, civil status and number of dependents
- Environment – temperature, salinity, turbidity, rainfall, river run-off, natural disasters, etc.
- Local knowledge (ecological and other), which will assist with the determination of the possible reasons behind the trends seen
- The social and economic implications of restricting gear
- Exploratory and experimental fishing (from exploitation to marketing)
- Activities, both land and sea based, that impact on fish communities. This includes tourism, fisheries and agriculture.

Statistics required to fulfill national reporting obligations under regional and international fisheries instruments

The country representatives in the working group indicated that for small coastal pelagic and reef and slope fish species, there were no binding regional or international country obligations for reporting under any conventions or agreements. However, they did point out that their countries are members of the (UN) FAO and party to international biodiversity conventions to whom they supply data on their fisheries. Most country representatives did not know all the international agreements their country is party to. Therefore, the group recommended that countries should identify all international agreements to which they are party and note their responsibilities under each agreement. Additionally, the group suggested that CRFM should be provided with updated catch and effort statistics from all member countries to facilitate reporting and project development purposes.

Statistics required to fulfill national reporting obligations

Table 1 shows the types of information reported to national agencies for each country.

IV. Review of the data collection system

Table 2 shows the types of data collected, the quality control systems in place and the reporting capabilities of each country.

The working group discussed some of the factors affecting the data information systems of each country. These discussions focused mainly the issues affecting the types and quality of data collected by data collectors.

- Quality of the data collectors- Working group members expressed that there was a high turnover of data collectors in most countries, which resulted in the loss of trained, experienced people. Additionally, the most qualified people were not interested in the position due to their negative perceptions of the job. The Montserrat representative gave the example that funds were available to hire a data collector in her country but no one was interested in the position because they perceived it to be a job of low status.
- Motivation of data collectors – This was viewed as a very important task that Fisheries Divisions need to undertake. This is especially important because the job of a data collector is monotonous, they are paid low wages, they reap few benefits, most of them are hired on a temporary basis and there is a lack of career opportunity and advancement.
- Development of feed back mechanism between data collectors and stake holders – The group felt that the data collected should be analysed and put into a form that data collectors can take back to the fishers. This will thus allow for the development of an appreciation of how the information they provide is used.
- Value and importance of data collectors; change perceptions of Fisheries Divisions staff regarding data collectors; make data collectors feel part of fisheries management team. – The country representatives liked the suggestion of a newsletter, which is currently being done in St. Lucia to keep data collectors informed about the on-going activities in the division and to help them understand that most activities within the Division depend on their outputs.

The working group made the following recommendations to the CRFM on ways to improve data collection systems in member countries.

- Training modules developed for data collectors – Due to the high turnover of data collectors resulting in the Fisheries Divisions always having to train new persons, the working group felt that the CRFM should produce a CD that could be used to train newly employed data collectors and as a refresher course for other data collectors.
- Technical Cooperation Among Developing Countries (TCDC) arrangements between countries for training, conducting analyses and producing reports – The working group recognized that within the Fisheries Divisions in the region,

there are persons who are very knowledgeable and versed about certain issues and have the technical skills lacking in other Divisions. Therefore, the recommendation was made that this knowledge base should be put to good use by sending trained persons to assist countries in areas where they require support.

- Several persons trained in analysis; on-going analyses – It was suggested that there should be a regional workshop focused specifically on the analysis of fisheries data.
- Simple templates developed for basic data analysis - The working group noted that these simple templates should be easy to follow, thus enabling countries, especially those who do not have persons trained in data analysis to produce simple reports on the data collected.
- Translate technical information into a form that can be easily understood – The working group noted that because of the technical jargon used in writing reports, most stakeholders could not form an appreciation for or an understanding of the reports produced. They therefore suggested, that the CRFM should translate the technical information into a form that can be easily understood by all stakeholders.
- Specific studies - The group felt that there were certain studies that should be undertaken to facilitate increased knowledge, appreciation and understanding of the value and effects of particular fisheries. Some of the suggested studies included a) The impacts of beach seining on fish populations and the environment and b) The extent of the use of small coastal pelagics as bait in the large pelagic fishery.

V. Fisheries management cycle

What basic rules could be followed to achieve a successful active fisheries management cycle (e.g. Caddy, 2001) in CARICOM countries was one of the questions put before the working group. There were several different interpretations of the cycle (see Caddy, 2001). Much of the discussions of the group focused on the appropriate starting point of the cycle and the issue of stakeholder involvement verses co-management.

Although the working group could not come to a consensus on the basic rules that should be followed, it did recommended that each country should consider how their current decision making process fits into the fisheries management cycle.

References

Caddy, J. F. (2001). Review of the CFRAMP Project: Progress and achievements of the CFRAMP project and some perspectives for the future in fisheries management for CARICOM/CARIFORUM countries under a common Caribbean Fisheries Mechanism. CARICOM Fisheries Document: Consultancy Report. 75 pp.

Table 1. National reporting obligations

Country	Agency	Information Reported
St. Vincent and the Grenadines	• Government Statistics Bureau • Ministry of Agriculture; Agricultural planning	• Export data and value • Landings by species and value • Information on fishers,

	statistics • Educational; Investors	vessels and gear
St. Lucia	• Ministry of Finance • Donor Funding Agencies both national, regional and international (e.g. JICA and EU)	• Production by quantity and value • Effort; number of vessels, fuel consumption, number of trips, number of fishers
British Virgin Islands	• Ministry of Finance	• Production by quantity and value
St. Kitts and Nevis	• All above plus Eastern Caribbean Central Bank	• Production by landing site
Montserrat	• All above plus Ministry of Trade	• Production; total monthly production and value • Effort; number of trips and vessels • Import statistics
Dominica	• Statistics Bureau • Donor Agencies	• Production by landing sites and species

Table 2. Review of the data collection system within each country that had a representative in the working group.

Country	Data Collection	Quality Control	Reporting/Needs	Future plans
St. Lucia	• Sampling coverage not adequate for all areas and species; for small coastal pelagics two major sites not sampled • Data on effort e.g. gear quantity, hours fished, area information, not consistently collected • No biological data collected	• Quality control is adequate • Since there are large quantities of data visual estimation is the most common method used	• Adequate but can be improved; more and frequent • In-depth analysis of data needed • Capacity building required	• Plans to revise frame survey for non sampled sites in 2003
St. Vincent and the Grenadines	• Sampling coverage not adequate for small coastal pelagics • Data on effort e.g. gear quantity, hours fished, area information, not consistently collected • Biological data collection inadequate	• Quality control is adequate • Supervision of data collectors needs to be strengthened; incomplete data forms • Under recording of catches of small coastal pelagics (landings recorded only) • Since the landings of small coastal pelagics are so large weight is determined using visual estimation	• Adequate but can be improved; more and frequent • Capacity building required	• Plans to revise sampling plan in 2003

Dominica	• Sampling coverage adequate for all areas and species • Data on effort e.g. gear quantity, hours fished, area information, not consistently collected • Incomplete data collection forms • No biological data collected • Fabrication of data by some data collectors	• Quality control is inadequate • Supervision of data collectors is needed • Too lengthy lag in data entry • Assessing data is challenging	• Inadequate • Capacity building required urgently; training of data collectors and other Fisheries Division staff in data manageme nt	
St. Kitts and Nevis	• In St. Kitts, census coverage not adequate; one sample per site per week • In St. Kitts, data on effort e.g. gear quantity, hours fished, area information, not consistently collected • In Nevis, data collection system not adequate; data collectors employed but no data collected • No biological data collection; funds required to purchase fish	• Quality control is adequate • Supervision of data collectors needs to be strengthened; incomplete data forms • Since the landings of small coastal pelagics are so large weight is determined using visual estimation	• Adequate but can be improved; more and frequent • In-depth analysis of data needed • Capacity building required; training in data analysis required	
British	• Sampling coverage	• Quality control is	• Adequate	

Virgin Islands	adequate for all areas and species • Data on effort e.g. gear quantity, hours fished, area information, collected • Biological data collection adequate • Legislation - 50% of catch has to be landed at Fisheries Complex • Must fill log book to get license	adequate • Supervision of data collectors needs to be strengthened	but can be improved; more and frequent • Capacity building required • Biological data collection can be improved • Require additional data collectors • Training in depth analysis needed	
Montserrat	• Sampling coverage is good • One landing site; census of mostly catch and effort information e.g. gear quantity, hours fished, area • No biological data collection	• Supervision of data collector needs to be strengthened; one data collector employed • Back log of data to be entered • Funds available to recruit additional data collector but difficulty with filling the position	• Basic reporting done • Staff trained in data analysis needed • Training and capacity building essential	

APPENDIX 6

AD HOC WORKING GROUPS TO EXAMINE, PREPARE AND COMMENCE ASSESSMENT ANALYSES OF AVAILABLE DATA ON PELAGIC & REEF FISH SPECIES

(a) Data Analysis Guide Sheet

Your report should describe your methods, explain your results, and provide interpretations suitable for the development of management advice.

1. Prepare and clean species dataset.
2. Conduct exploratory analyses to determine mean values, the nature of sample distributions, and general relationships among variables. In particular, explore the relationships between 'catch' or 'landings' and other variables (descriptive analyses, frequencies, cross-tabulations, correlations, box plots, using SPSS 'explore' option).
3. Plot annual total catch versus year. Calculate average annual total catch for period examined. Could this be used as a suitable approximation of MSY?
4. Examine variations in catch by area/ country.
5. Estimate Grainger-Garcia index: $\{Yield_t – (1/3 (Yield_{t-1} + Yield_{t-2} + Yield_{t-3}))\}/ (1/3 (Yield_{t-1} + Yield_{t-2} + Yield_{t-3})$, where t is year. Plot G-G index versus year. What is the usefulness of this index?
6. Estimate mean size of fish in catch, by year and by area/country. Plot relationships. Conduct SPSS ANOVA using 'fish length' as the dependent variable, and landing site, country, area fished, and year as factors.
7. Estimate the ratio: mean size in catch/ size at 50% maturity. Plot relationship with time (year and month) and area/ country. How is this index useful?
8. Estimate the ratio: Kg catch/ litre of fuel consumed. Plot relationship with time and area/ country. How is this index useful?
9. Examine the change in number of area units visited/ fished through time (year and month). How is this a useful index? Is total trip time directly correlated with search time, fishing time, or both, and hence, number of area units visited?
10. Examine the change in number of fishing days with time (year and month). Has nominal effort increased over time?
11. Plot annual total catch versus annual total fishing effort, even if nominal effort.
12. Estimate $Y_t = Yt\text{-}1 * \{1+ g (B_{t-1} – B_{t-2})/B_{t-2}\}$, where Y is catch and B is biomass (or commercial CPUE index) in year t, and g is the 'feedback gain' index that reflects the degree of proportionality between changes in biomass observed between the last and current year, and hence the extent to which it will be reflected in the current year's quota (Caddy, 1998). Explore the results of this relationship with different values of g ranging from 1 to 3.
13. Estimate the total mortality coefficient, Z. Determine if

    $$Z < K (L_\infty - L_m)/ (L_m – L_c),$$

    Where K is the growth curvature parameter, L_∞ is the asymptotic length, L_m is the mean size at maturity, and L_c is the length at first capture. This inequality is important to ensure that an individual fish has a 50% chance of spawning at least once during its lifetime.

14. Determine a reasonable index of abundance (CPUE), and develop a time series of standardized CPUE values.

(b) Data Analysis - Group II Report

Review of historical fisheries data from The Bahamas

Group Members: L. Straker, S. Constantine, S. Heyliger, C. Jardine, and M. O'Garro

Introduction

The historical commercial data on the fisheries of The Bahamas examined by the working group had already been cleaned and prepared for basic statistical analyses in SPSS. A set of tasks was assigned to the working group with respect to the analyses of these data. The working group then attempted to carry out as many of the exercises listed as the time allowed.

Total recorded landings for all species

A stacked bar graph showing total recorded landings in metric tones by year for all species was plotted (Figure II-1). This showed that crawfish tails, conch fresh and Nassau grouper respectively, made the greatest contributions to the annual landings in The Bahamas. As a result, these three species were selected for all subsequent analyses. These analyses do not however reflect the totals for any one of these species since each species was represented in the data set by various categories of processing. For instance, crawfish landings were divided into crawfish tails and crawfish whole but only the data on crawfish tails was analysed. The Nassau grouper data was divided into Nassau grouper, which was selected for analysis and Nassau grouper filet. Conch was divided into conch fresh and conch dry but since the landings of conch fresh were greater than that of conch dry this category was selected.

Seasonality of the fishery

To determine if the data showed any seasonal trends in landings of the three selected species, total recorded landings for the period 1988-2000 was plotted against months. This showed that for crawfish (Figure II-2a) there were no landings for the months April to July, possibly indicating a closed season. Maximum landings were recorded in August, which was the first month in the new open season. It is expected that a comparison of the seasonality of the fishery to the monthly CPUE trends should show that during the months of April to July CPUE is zero. This plot however was not done and should be attempted at a later date. A look at the changes in prices of crawfish with month should also provide valuable information on how a closed season affects prices.

For Nassau grouper (Figure II-2b) the highest catches were recorded from December to February with catches for the other months of the year remaining fairly constant.

There was a steady increase in the landings for conch (Figure II-2c) from January to May however, from June onwards there was a general decrease in catches. It is notable that the highest landings of conch occurred during the closed season for lobster. It could indicate a shift in effort from one fishery to the other. An analysis of CPUE by month may highlight this. After the significant decline in the conch landings from June to July there was very little change in the catches until the increase from December to January.

Changes in price

Changes in the price of each species as time progressed were investigated by plotting the mean price for crawfish, conch and Nassau grouper against time.

Generally there were great fluctuations in the price of crawfish (Figure II-3a). The greatest price was recorded in 2000 with 1991 having the next highest price. The lowest recorded prices occurred in the years 1988, 1993 and 1996, with 1993 and 1996 showing noticeable drops in price from the previous years. From 1992 to 1993 there was a drop in price of approximately $5.00 per kg but the price went back up by $3.35 in 1994. In 1996 there was a drop in price of approximately $3.25 from 1995 but the price went back up in 1997 by $4.00 per kg.

There was a general decreasing trend in price per kg of Nassau grouper (Figure II-3b) from 1988 to 1997 with 1997 showing the lowest price on record. However, this trend was reversed in 1998 when there was an increase in price from $5.50 per kg in 1997 to $10.00 per kg in 1998. After 1998 the price began to fall again.

The prices for conch (Figure II-3c) generally fluctuated during the period under review. Conch was sold for approximately $13.80 per kg in 1998, which is the highest recorded price, whilst the lowest recorded price was $8.40 kg and occurred in 1995.

Although the plots of price with time revealed interesting results, one cannot proceed to make any broad conclusions without prior knowledge of certain aspects of the fishery. For instance, it would be useful to acquire additional information about the market conditions existing in each year.

Total catch per unit effort

For the three selected species the total catch per unit effort was investigated using three different units of effort namely, number of men on the trip, number of boats used on the fishing trip and the number of days spent fishing.

Looking at CPUE using the number of boats (Figure II-4a) one can see that this bar graph followed the same general pattern as the bar graph showing the total recorded landings (Figure II-1) by species per year. The greatest CPUE was recorded in 1996 with that year also recording the highest landings of crawfish. In addition, the lowest CPUE was recorded in 1989, the year, which also recorded the lowest landings of crawfish. The other years showed great similarities but a plot of total recorded landings by year separately for crawfish would allow for a more comprehensive review of the similarities between these two graphs. The other two CPUE graphs (number of days spent fishing (Figure II-4b) and number of men fishing (Figure II-4c)) both show similar results to the graph of the CPUE using the number of boats used on the fishing trip. All three graphs had similar shapes signifying that the general pattern observed with the total CPUE with years for crawfish, may be the actual CPUE trend. Therefore any one of these CPUE indices can be used as a reasonable CPUE index in subsequent analyses.

The same general patterns observed for crawfish were also observed for Nassau grouper. Not only did the shape of the recorded landings graph (Figure II-1) reflect the shape of the CPUE graphs but also all the CPUE graphs had the same general shape with one exception. There was an increase in both the CPUE using the number of boats (Figure II-5a) and in the CPUE using the number of men fishing (Figure II-5c) from 1988 to 1989. However, the plot CPUE using the number of days spent fishing (Figure II-5b) showed a decrease for those years.

For conch, the graph showing CPUE using the number of days spent fishing (Figure II-6b) had a slightly different shape to the other two graphs. For this graph there is an increase in CPUE in 1995 over 1994 but the graphs showing CPUE using number of boats (Figure II-6a) and the number of men (Figure II-6c) showed a decrease. Also, in 2000 there was a decrease from 1999 but the other two graphs showed an increase. The graph showing the total recorded landings from 1988 to 2000 for conch (Figure II.1) did not have the general shape of the CPUE graphs as was seen for crawfish and Nassau grouper. For certain years when the recorded landings increased the CPUE decreased and vice versa.

There seems to be an apparent direct relationship between landings and effort for both crawfish and Nassau grouper. However, this is not likely to be the case with conch since the recorded landings and CPUE graphs did not reflect similar trends. For both crawfish and Nassau grouper, landings may be used as an indicator of effort but this is not the case for conch.

Fishing grounds

Pie charts were drawn to highlight the distribution of fishing at the different fishing grounds for the different species. It was found that for crawfish (Figure II-7a) the most popular fishing ground was Andros North then Abaco, for Nassau grouper (Figure II-7b) Eleuthera and The Berry Islands were first and second respectively and for conch (Figure II-7c) Grand Bahama then The Berry islands were visited most frequently. A chart showing the distribution for fishing at all fishing grounds (Figure II-7d) showed that the most common fishing grounds in order of preference were Andros North, Abaco, Andros South, The Berry Islands, Grand Bahama, and Eleuthera.

Change in fishing grounds

Cross tabulations were used to investigate how the fishing grounds for the selected species changed as the years progressed. Some notable results were found.

For crawfish there was very little fishing at Andros North from 1988 to 1993. In 1994 however, the value went up to 16 recorded visits, 1740 in 1995, 3374 in 1996 and 1528 in 1997. From 1997 to 2000 there was a decreasing trend in the number of visits recorded.

There was no significant number of visits recorded at Grand Bahama for conch until 1996 when 189 fishing trips were reported to have taken place in this area. The figure increased to 690 in 1997 and there was a further increase to 759 in 1998, however, from 1999 to 2000 there was a drop in the number of recorded visits to 438.

These results may indicate a movement in fishing activity with time. It is possible as new fishing areas are discovered, fishermen move into these areas but when a reduction in the CPUE is realized, fishers move on to other areas. Investigation of recorded landings and CPUE by area with time may lend support to this hypothesis.

Grainger-Garcia Index

From the early 1990's to late 1994 the G-G Index indicated that the crawfish fishery (Figure II-8a) in The Bahamas was possibly in a healthy state. However, from late 1995 onwards the index fell below zero and stayed there until 1999 possibly indicating a decline in the health of the fishery. In late 1999, the index rose above zero indicating that there may have been an improvement in the health of the fishery.

The Grainger-Garcia Index for conch (Figure II-8b) showed a less definitive pattern than that of crawfish.
Without additional knowledge about the fishery, no conclusive statements could be made about the health of the crawfish or conch fisheries.

Additional group recommendations

1) A plot of mean CPUE in addition to total CPUE across species, fishing areas, months and years may provide insightful results.
2) There needs to be inclusion of the different levels of processing for each species into all analyses before any definitive conclusions can be made.
3) General information about, and factors affecting the fishery over the years needs to be in cooperated into the interpretation of the results.

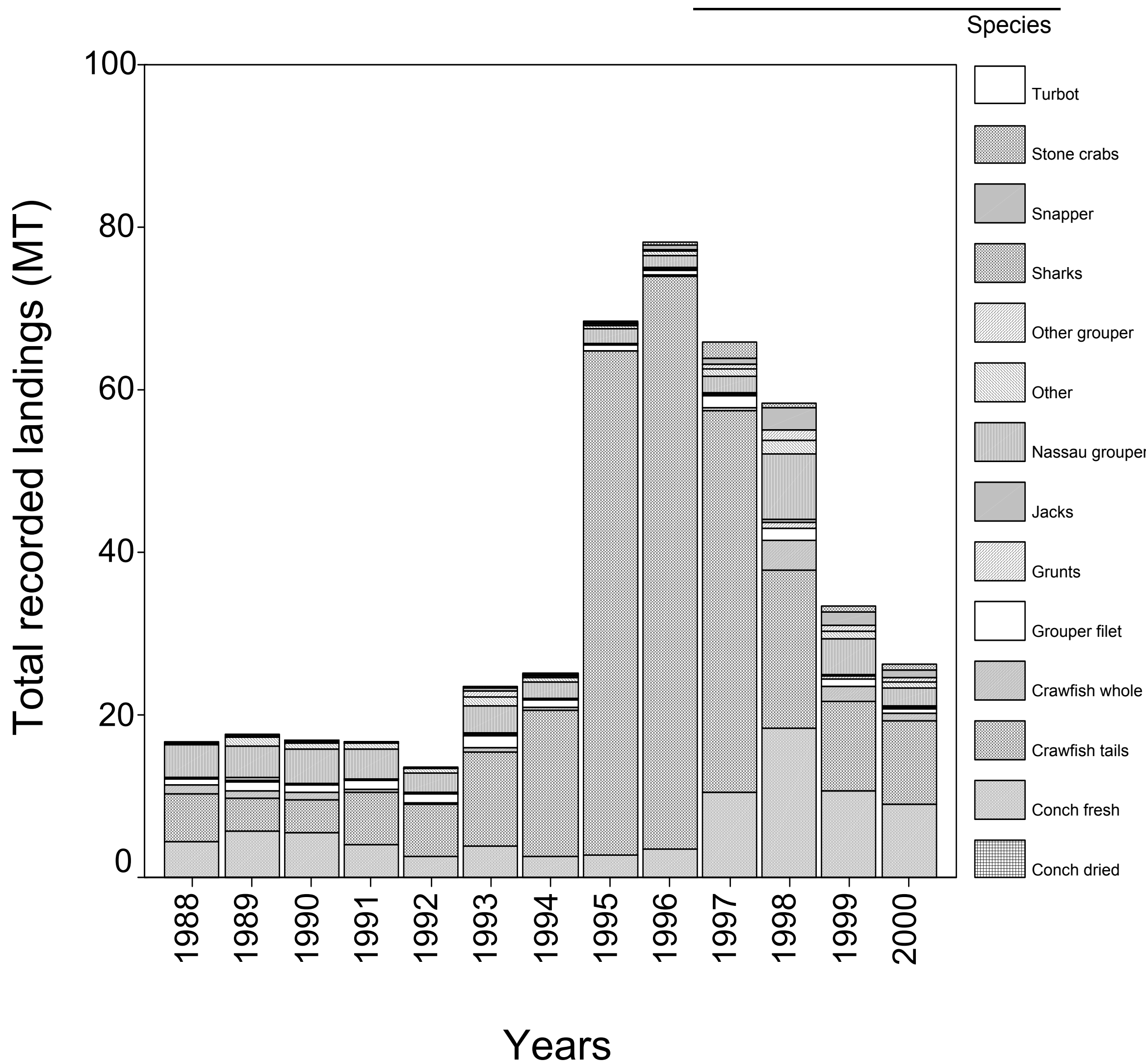
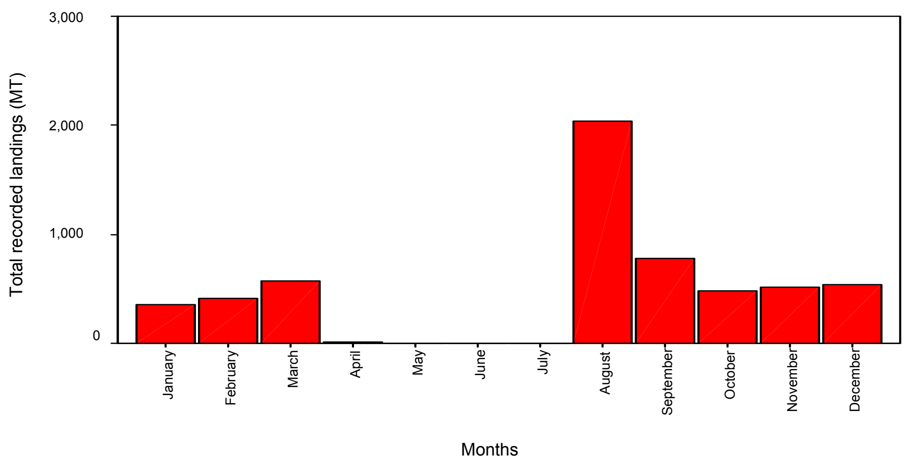
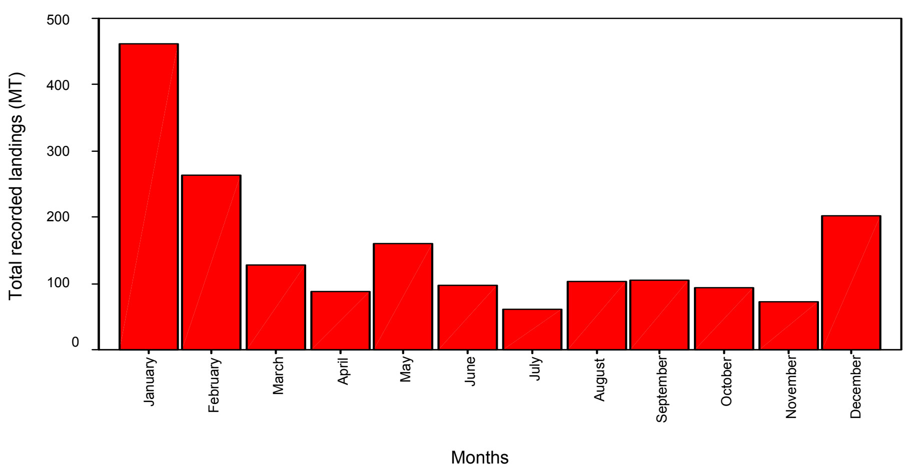


Figure II-1. Total recorded landings (MT) for the years 1988-2000 by species.

a)


Total recorded landings (MT)
3,000
2,000
1,000
0
January
February
March
April
May
June
July
August
September
October
November
December
Months

b)


Total recorded landings (MT)
500
400
300
200
100
0
January
February
March
April
May
June
July
August
September
October
November
December
Months

c)

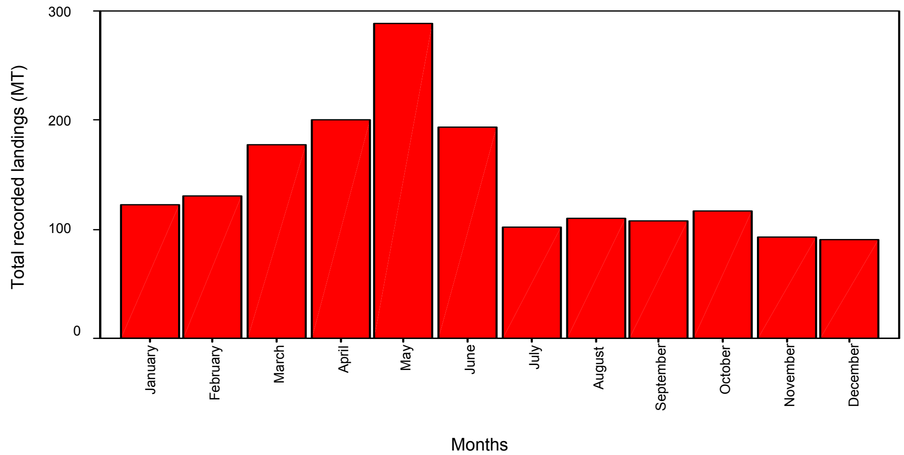
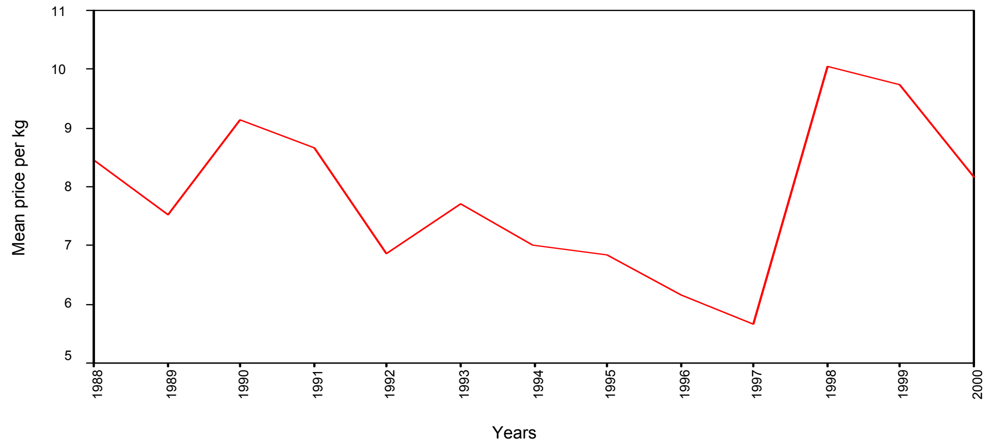


Figure II-2. Seasonality of landings a) crawfish, b) Nassau grouper and c) conch.

a)

b)



c)

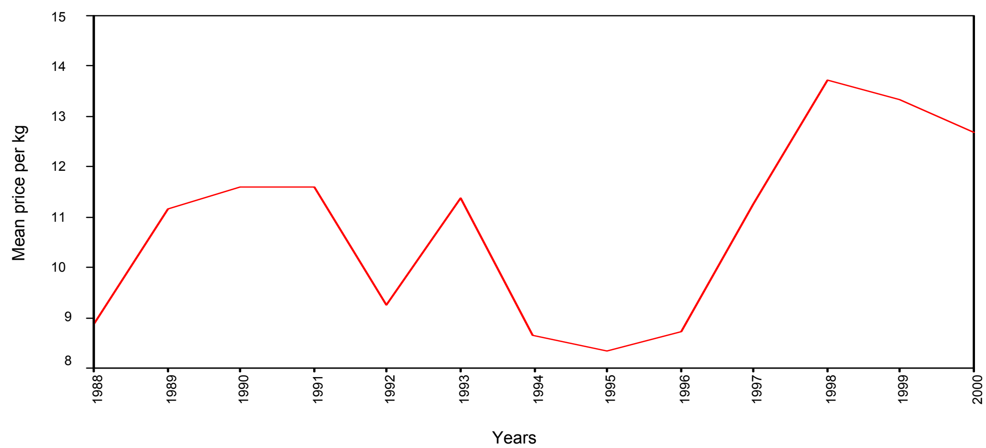
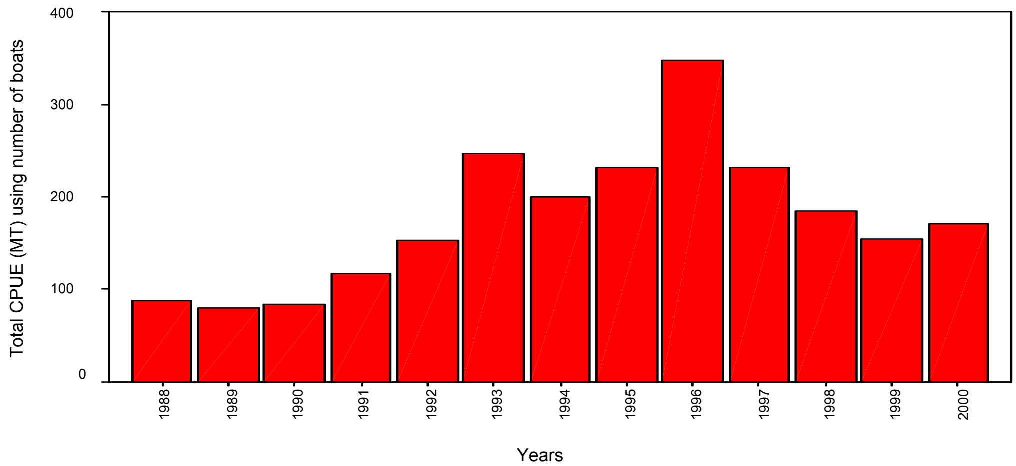
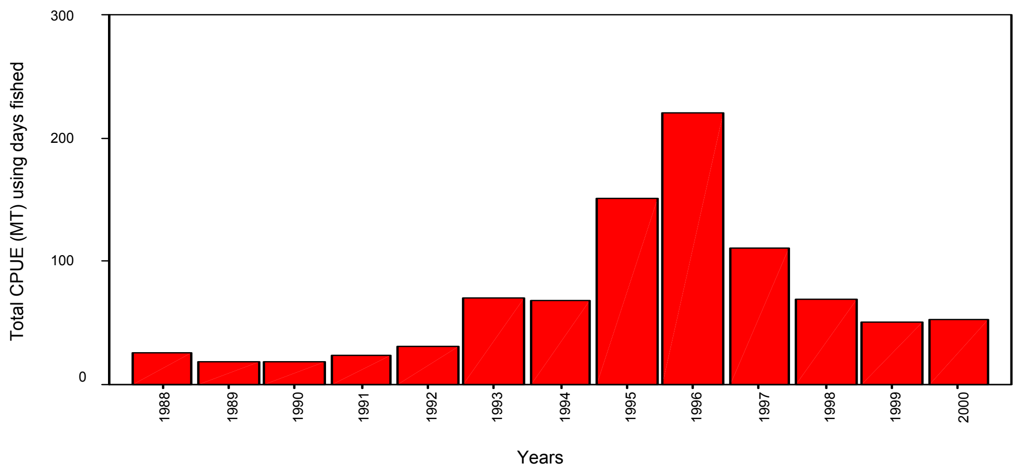


Figure II-3. Mean price per kg of a) crawfish, b) Nassau grouper and c) conch.

a)


Total CPUE (MT) using number of boats
400
300
200
100
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Years

b)


Total CPUE (MT) using days fished
300
200
100
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Years

c)

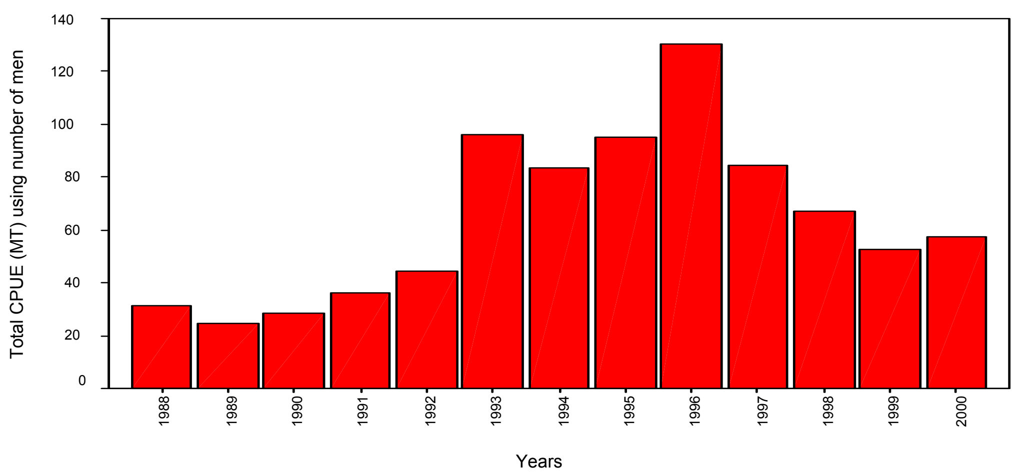
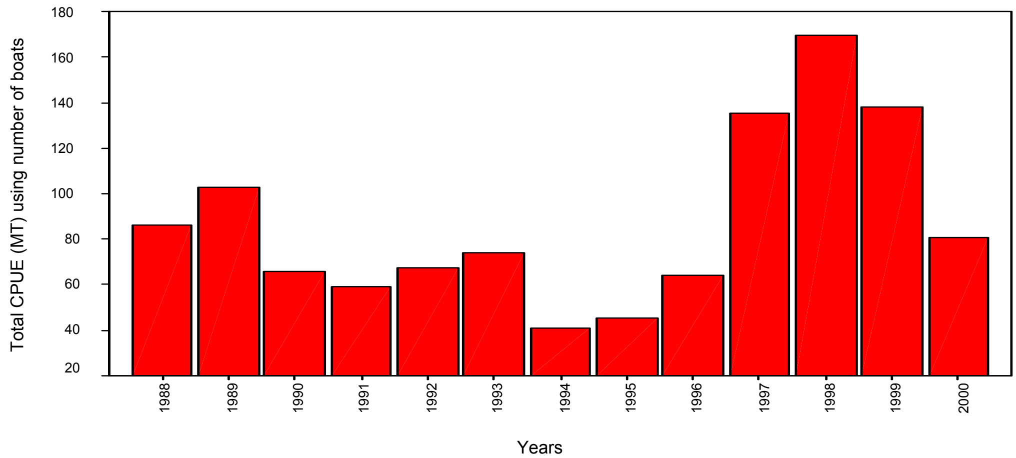
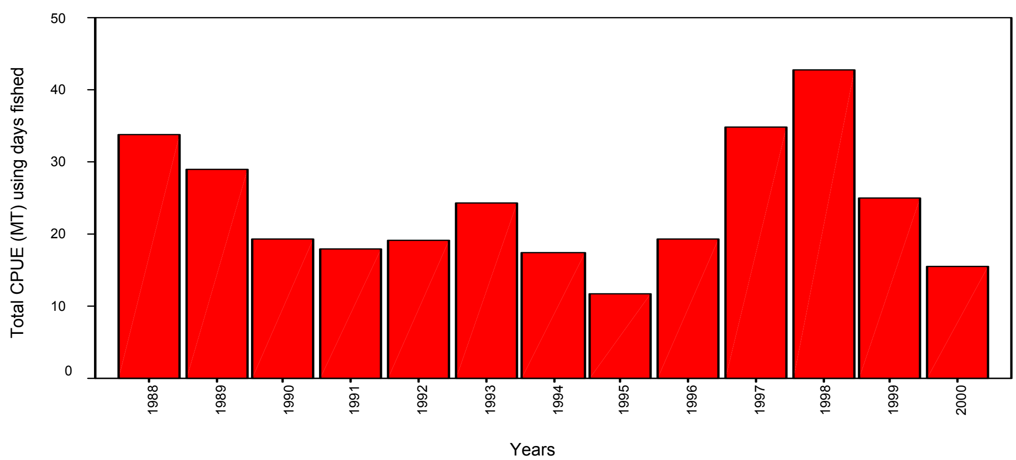

Total CPUE (MT) using number of men
140
120
100
80
60
40
20
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Years

Figure II-4. Total CPUE (MT) with time for crawfish using a) the number of boats used on the trip, b) the number of days fished and c) the number of men fishing.

a)



b)



c)

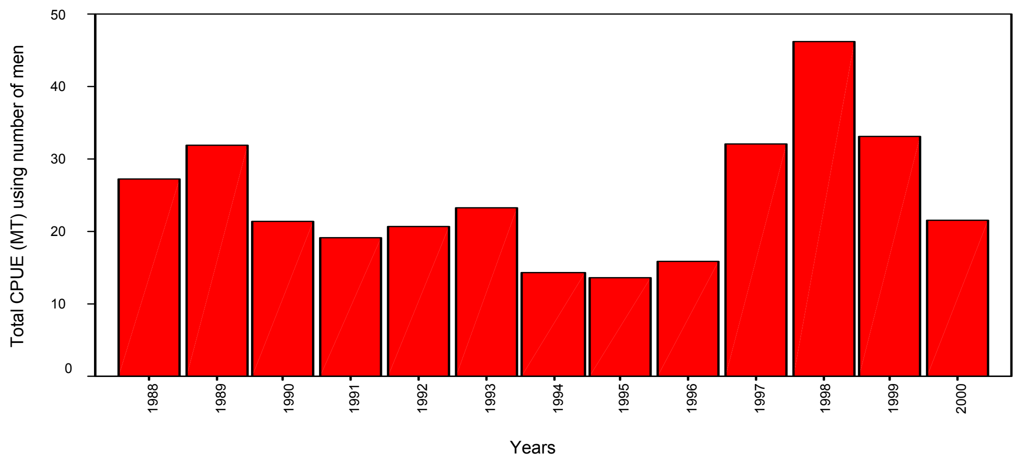
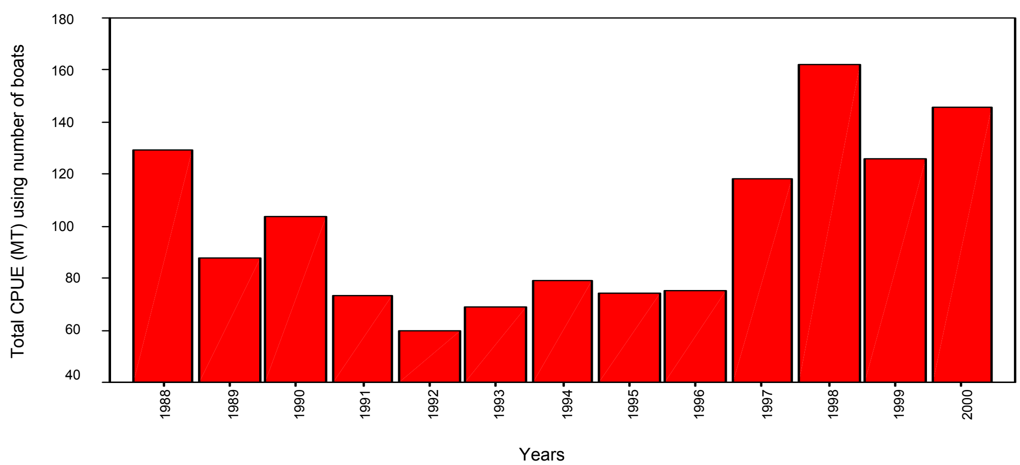
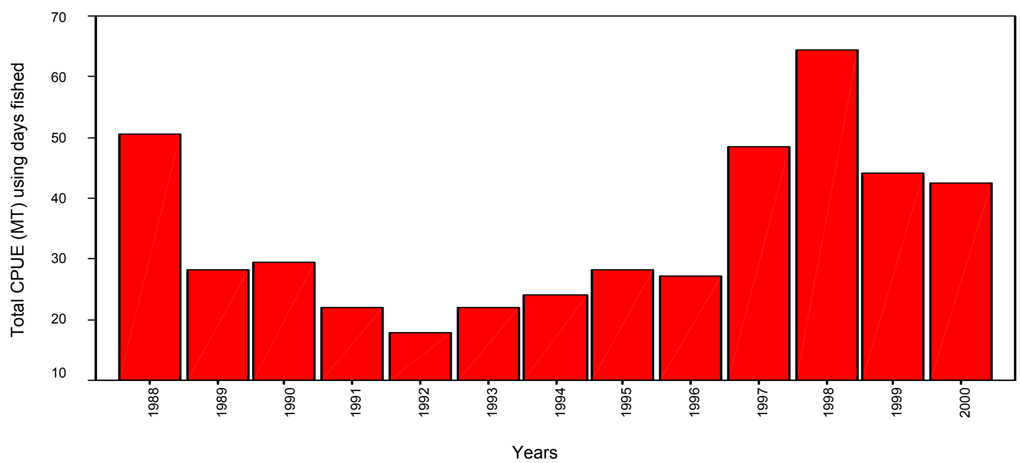


Figure II-5. Total CPUE (MT) with time for Nassau grouper using a) the number of boats used on the trip, b) the number of days fished and c) the number of men fishing.

a)



b)



c)

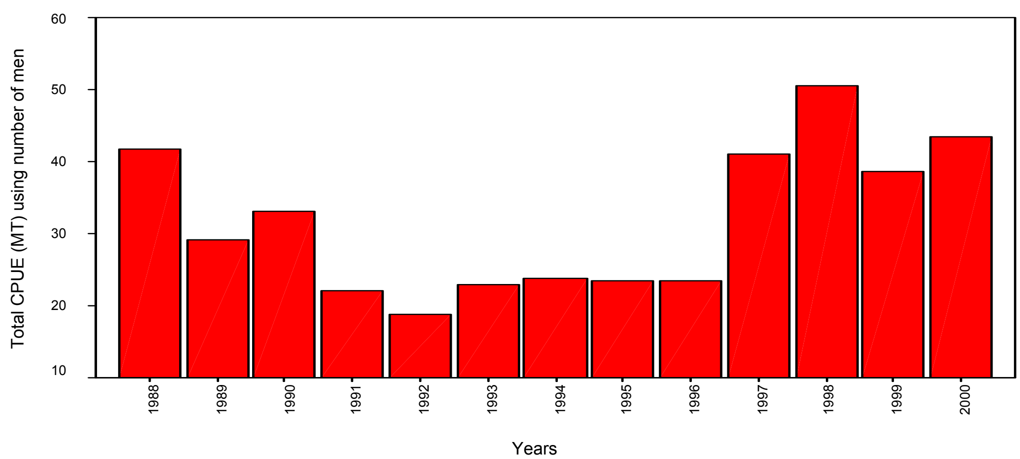
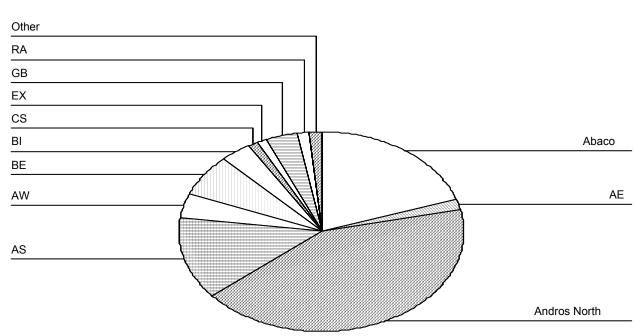
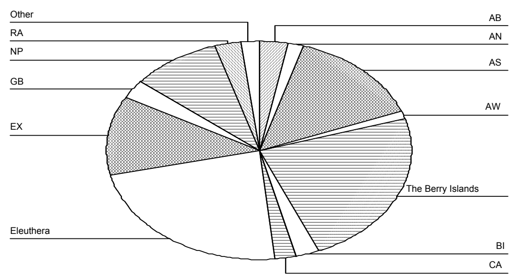


Figure II-6. Total CPUE (MT) with time for conch using a) the number of boats used on the trip, b) the number of days fished and c) the number of men fishing.

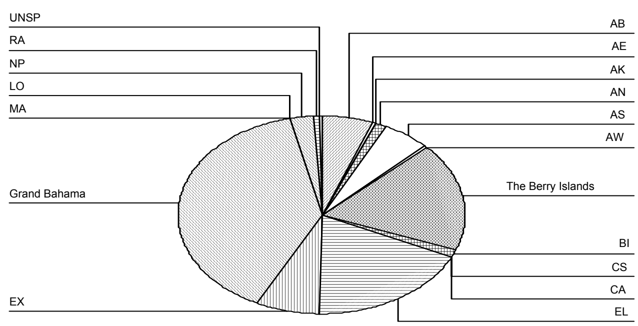
a)



b)



c)



d)

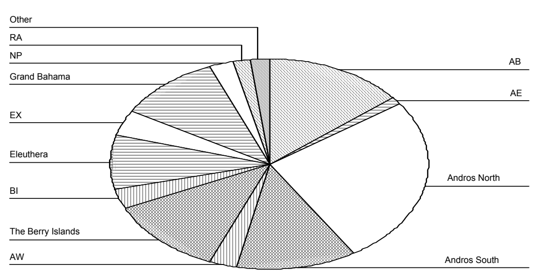
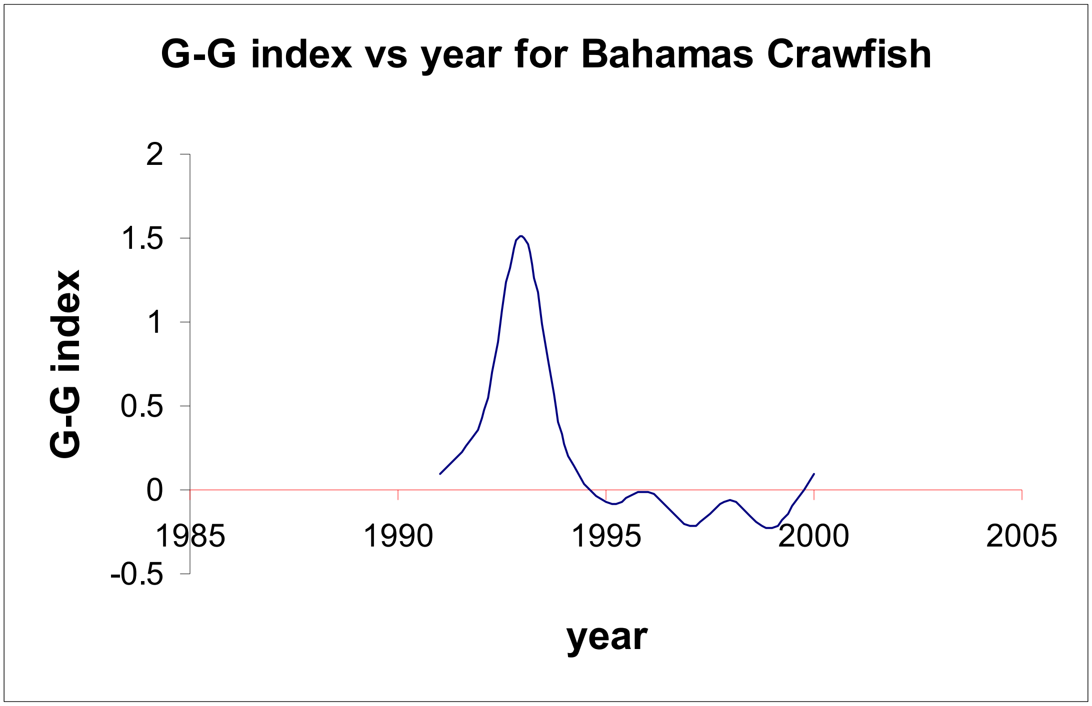


Figure II-7. Distribution of fishing for different species at the fishing grounds a) crawfish, b) Nassau grouper, c) conch, d) all species.
a)



b)

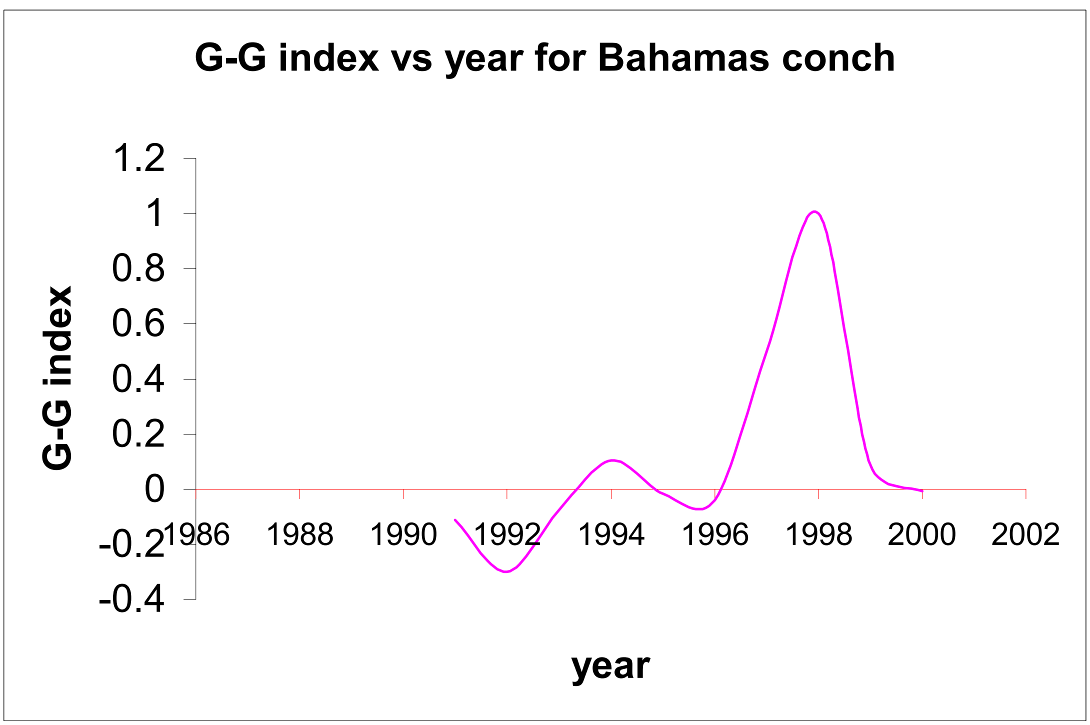


Figure II-8. Grainger-Garcia Index for a) crawfish and b) conch.

(c) <u>Data Analysis - Group III Report</u>

Some analyses trials of available commercial fisheries data on red hind (*Epinephelus guttatus*) caught in St. Vincent and the Grenadines.

Group members: A. Llewellyn, S. Singh-Renton, and D. Theophille

Introduction

In St. Vincent and the Grenadines, red hind comprises approximately half of the demersal fish catch, and is caught with several different types of gear (see Constantine *et al.*, Part III of this report). A preliminary assessment of this fishery was conducted by Straker *et al.* (2001), using available commercial catch and effort data, as well as length frequency data, collected for the period 1994-1998. Although several fishing grounds are known to exist and to be exploited by a range of gears, specific data on area fished and effective effort were not recorded for all fishing trips. Hence, for the purpose of the preliminary assessment, Straker *et al.* (2001) combined data for all fishing areas and for all gears used. Since then, an additional three years of data, for the period 1999-2001, have become available. Sampling still does not capture individual fishing trip data on effective effort, but the areas fished are identified according to a sea area grid system developed by the government of St. Vincent and the Grenadines and used by the Fisheries Division to identify and record area fished (Figure III-1). In view of this, a fisher interview study was undertaken in 2002 by Constantine *et al*. (see Part III of this report), to document fishing habits and patterns of fishers targeting red hind, particularly regarding their use of gears and fishing areas. The results of this survey indicated that the commercial sample data were obtained primarily from fishers operating from the main island of St. Vincent and from the Grenadine island of Bequia. The survey data also showed that St. Vincent fishers tended to fish in an area near the Grenadines island of Canouan, while the Bequian fishers tended to fish for red hind around the island of Mustique.

Using the available length frequency data on red hind for 1996-2001, some descriptive analyses were completed prior to the Group's working session, and are included in the present report. Based on the fishing areas identified during the 2002 survey study, a cleaned dataset for the central Grenadines fishing area, was prepared for use by Group III. During the working group session, Group III attempted to correct the cleaned dataset on length frequency for biases resulting from gear selectivity. Group III also spent time preparing the same dataset in a format that could be imported into FISAT for estimation of growth parameters.

Data and Descriptive Analyses

A total 16091 red hind length samples were recorded during the period 1996-2001, with over 4500 length samples recorded in each of 1997 and 1999 (Figure III-2). Only 386 samples were recorded in 1996. Length samples were collected every month of the year, with the least number of samples recorded during the months of October and March, and the highest number recorded during the month of September (Figure III-3).

Within the dataset, the fishing grids recorded were grouped into five specific red hind fishing areas identified by fishers during the 2002 red hind interview survey, and coded as follows for the purpose of the present analysis: ESVG – East coast of St. Vincent;

MGREN – central Grenadines fishing area; NGREN – channel between Bequia and St. Vincent; NSVG – north coast of St. Vincent; SGREN - southern Grenadines. In cases where area fished was not specified, these records were coded 'UNSP'. The frequency of red hind length samples was highest for the central Grenadines fishing area, 'MGREN' (Figure III-4). This is not surprising given that this area was utilized more frequently by fishers targeting red hind (Constantine *et al.*, 2002). The sampled red hind were taken with several different gears: most of the recorded lengths came from catches taken with 'palangue' or longline gear and handlines. 'Palangue' length samples were frequent in most areas, but in the central Grenadines area (MGREN), more length samples were recorded from catches taken with handline gear (Figure III-5).

Analysis of variance (ANOVA) tests were conducted to compare mean fish length (i) among fishing areas, and (ii) among years. The mean values estimated by the ANOVAs, together with the 95% confidence intervals, were plotted. The smallest mean fish length was estimated to be 34 cm (total length-TL) and was observed in the MGREN area (Figure III-6). The next lowest mean fish length was 35.7 cm TL, observed for the UNSP area category. The highest mean fish length was 40.8 cm TL, obtained in the NSVG area. In the SGREN area that is adjacent to the MGREN area, mean fish length was estimated to be 39.5 cm TL; this value was the second highest estimated mean. These observations suggest that several local distinct stocks of red hind could exist, and/or that fishing pressure has negatively impacted the resource in some areas. Certainly, the majority of red hind length samples came from the MGREN area, implying that this area was the most intensively fished. When we examined the change in mean fish length in the MGREN area during the period 1997-2001, the mean decreased from 38.1 cm TL in 1997 to 31.5 cm TL in 2000 (Figure III-7). An increase in mean length, 34.3 cm TL, was observed in 2001. The total level of sampling coverage in the MGREN area varied each year, and this might have introduced some bias in the yearly mean estimates obtained. Nonetheless, it appears likely that the mean fish size decreased in this area as a direct result of fishing pressure. To determine if this is so, analyses of changes in fishing effort, and comparison with trends observed in other areas should be conducted. However, the Group did not attempt these additional analyses during the available working sessions.

Gear Selectivity

Given that the largest set of length samples were recorded from catches taken in the MGREN area, and also the difference in mean fish sizes observed among fishing areas, the Group decided to treat the MGREN area as having a distinct red hind stock, and attempted to correct the MGREN length frequency data for biases due to gear selectivity. All gears were combined for the present investigation of gear selectivity in the MGREN area. Gear selectivity was estimated by applying a linearised catch curve method using an initial estimate of L_∞, and setting the curvature parameter k equal to 1(Sparre and Venema, 1998). The Powell-Wetherall method was used to generate the initial estimate of L_∞ (Figure III-8). This gave a value of 65.2 cm TL for L_∞, recognizing that the choice of values to be included in the regression analysis was subjective and hence was a likely source of error in the estimation.

Assuming a L_∞ of 65.2 cm TL, K=1, and t_0 = 0, the observed and estimated selectivity patterns obtained by the linearised catch curve method are shown in Figure III-9. The length at which 50% of the fish are retained, $L_{50\%}$, was estimated to be 30 cm TL. To test the efficacy of the method, the estimated selectivity correction was then applied to the 1997 sample of length frequencies. The observed and corrected length frequencies for 1997 are shown in Figures III-10 and III-11 respectively. The corrected 1997 length frequencies, particularly those for the smaller size intervals, did not appear to be realistic. Hook and line ('palangue' and handline) is the predominant type of gear used in the MGREN area. For the present analysis, it was assumed that a range of hook sizes is used, and so a sigmoid pattern of selectivity would have been appropriate. This assumption might have been incorrect. A bell-shaped selectivity pattern should be investigated in future analyses.

Estimation of Growth Parameters

The Group spent considerable time preparing a length frequency dataset in a format that would allow the data to be imported directly into FISAT for estimation of growth parameters. The dataset was successfully imported into FISAT, but there was no additional time for conducting this analysis.

Conclusions and Recommendations

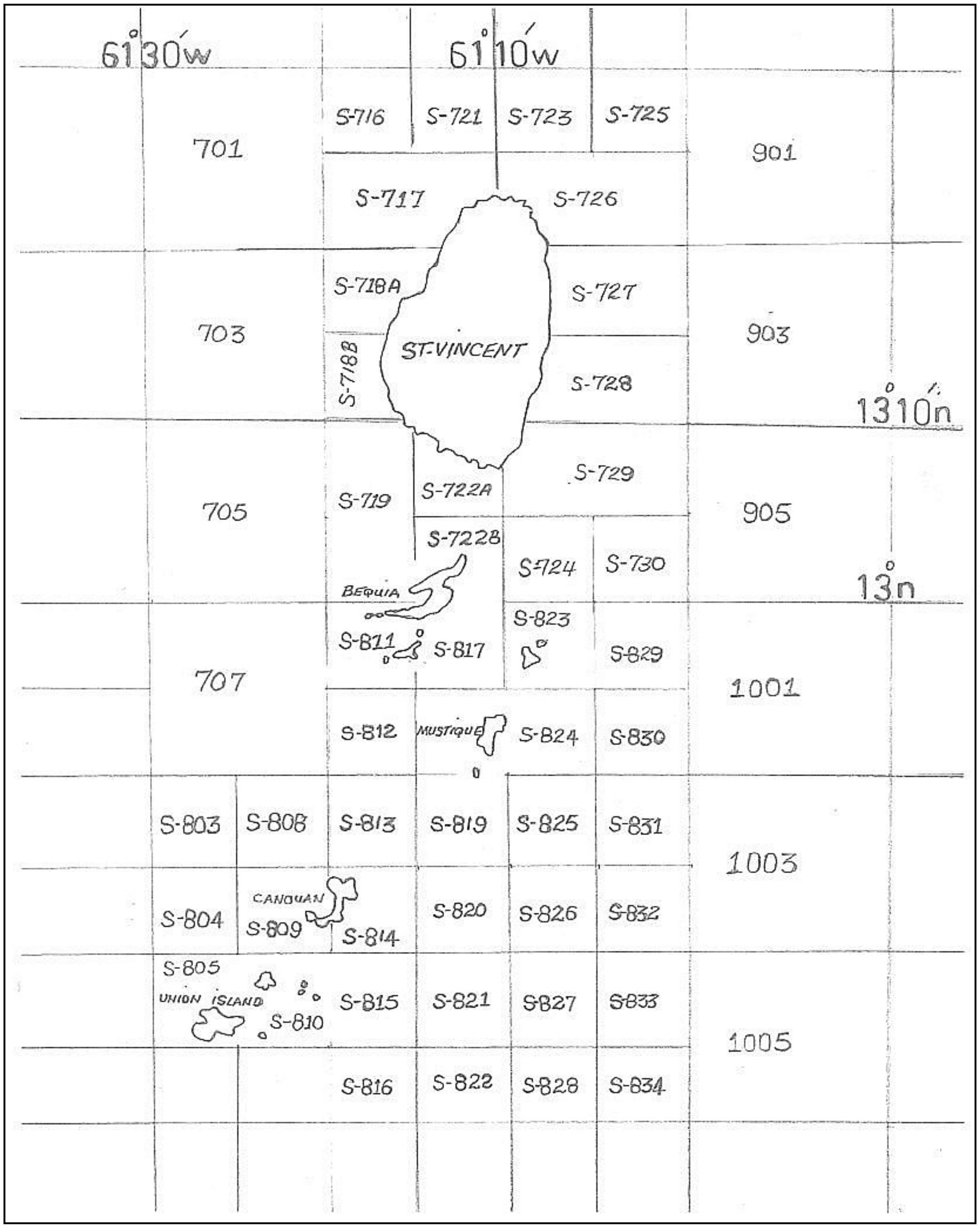
There were distinct differences in mean length of red hind among the fishing areas studied. The smallest red hind were observed in the MGREN fishing area where almost 50% of the length samples were recorded. This implies that fishing pressure may be negatively impacting the stock in this area. Additional statistical analyses should be conducted to compare annual changes in mean fish length among fishing areas. The present analyses are incomplete, and a more detailed complete analysis and assessment of the red hind fishery is needed in the near future.

References

Constantine, S., S. Singh-Renton, and L. Straker. See Part III of this Report. The Red Hind Fishery of St. Vincent and the Grenadines – An Interview Study.

Sparre, P. and S. C. Venema. 1998. Introduction to tropical fish stock assessment Part I; Manual. FAO Fisheries Technical paper 306/1 Rev. 2. FAO: Rome. 407 pp.

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


61°30'W
61°10'W
S-716
S-721
S-723
S-725
701
901
S-717
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S-718A
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703
ST. VINCENT
903
S-718B
S-728
13°10'N
S-729
705
S-719
S-722A
905
S-722B
S-724
S-730
13°N
BEQUIA
S-823
S-811
S-817
S-829
707
1001
S-812
MUSTIQUE
S-824
S-830
S-803
S-808
S-813
S-819
S-825
S-831
1003
CANOUAN
S-804
S-809
S-814
S-820
S-826
S-832
S-805
UNION ISLAND
S-815
S-821
S-827
S-833
S-810
1005
S-816
S-822
S-828
S-834

Figure III-1. Chart of St. Vincent and The Grenadines, showing the fishing grid system utilized by the Fisheries Division to identify and record fishing areas: NSVG – north coast St. Vincent (squares S-717 & S-726); ESVG – east coast of St. Vincent (squares S-727, S-728, & S-729); NGREN – channel between Bequia and St. Vincent (S-719, S-722a, S-722b, S-724, & S-730); MGREN – central Grenadines (squares S-811, S-812, S-817, S-818, S-823, S-824, S-829, and S-830); SGREN – southern Grenadines (squares S-813, S-814, S-819, S-825, S-831).

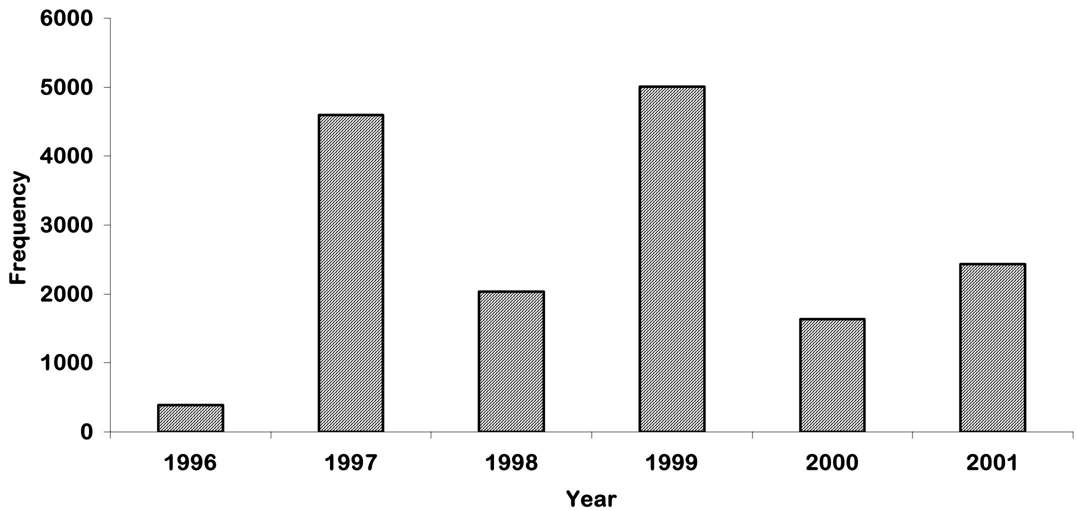


Figure III-2. Numbers of red hind length measurements taken each year during the period 1996-2001.

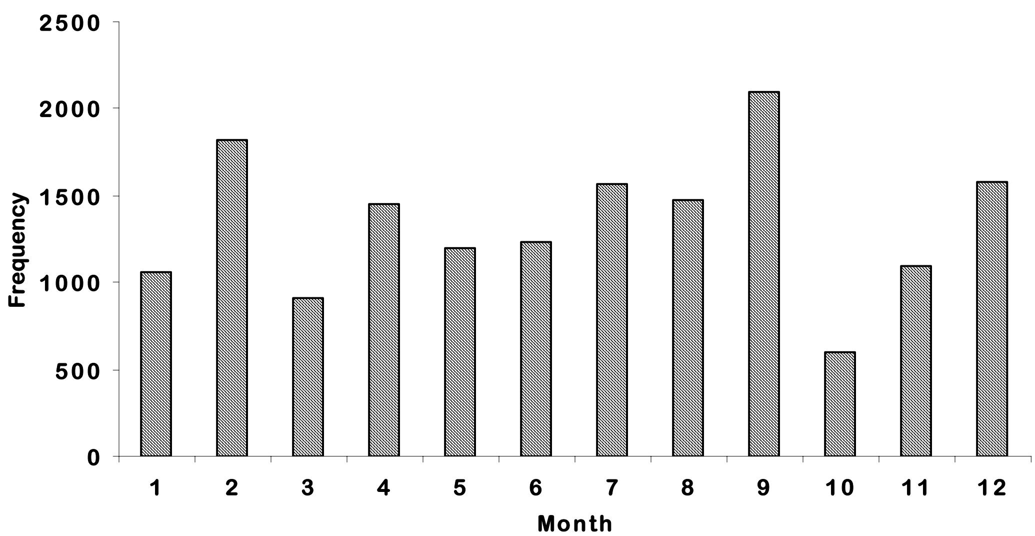


Figure III-3. Numbers of red hind length measurements taken during each month for the period 1996-2001.

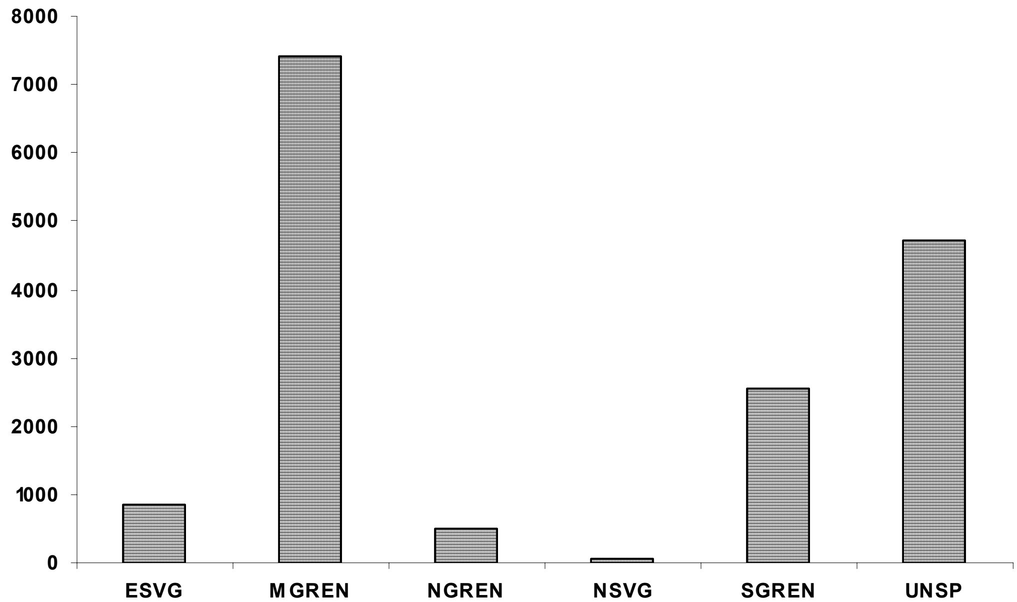


Figure III-4. Numbers of red hind length measurements taken in each fishing area {ESVG – East coast of St. Vincent; MGREN – central Grenadines; NGREN – channel between Bequia and St. Vincent; NSVG – north coast of St. Vincent; SGREN southern Grenadines; UNSP – area not specified}.

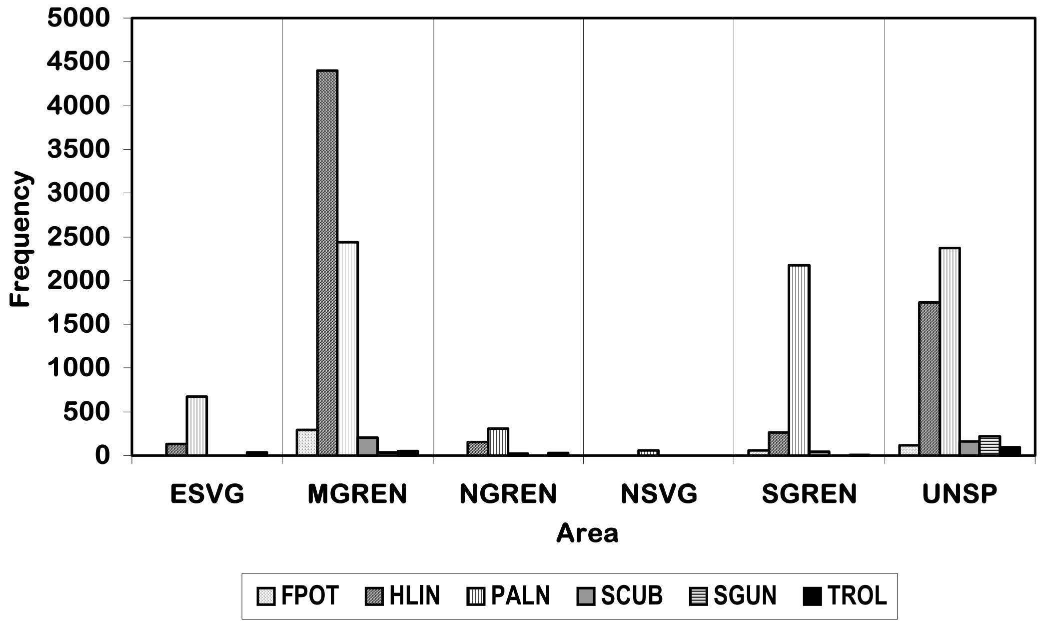


Figure III-5. Number of red hind length measurements recorded by area and by gear during the period 1996-2001.

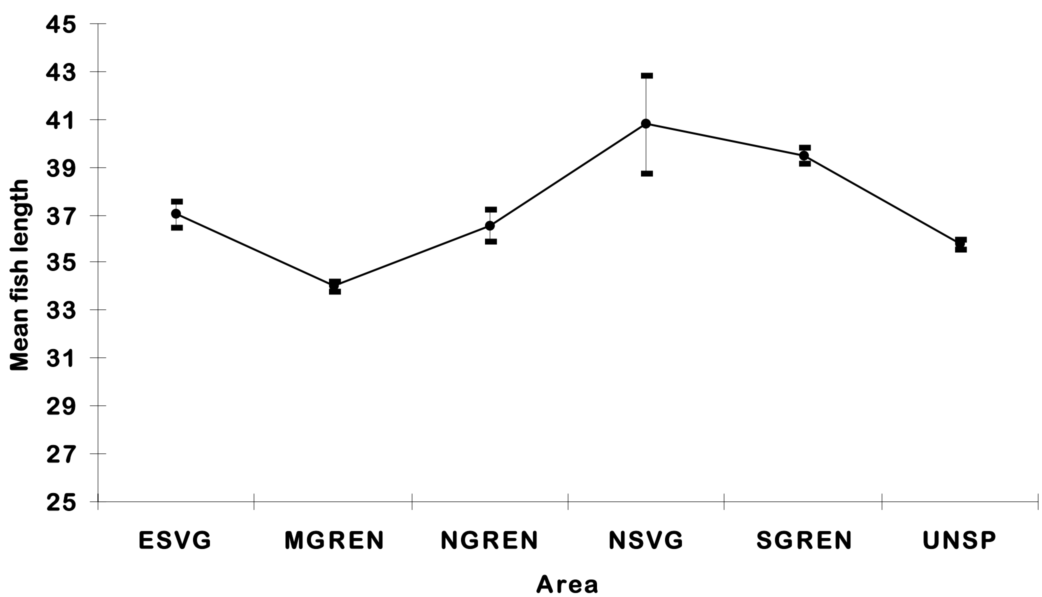


Figure III-6. Mean size (length) of red hind caught in each fishing area. Limits of 95% confidence interval are also shown.

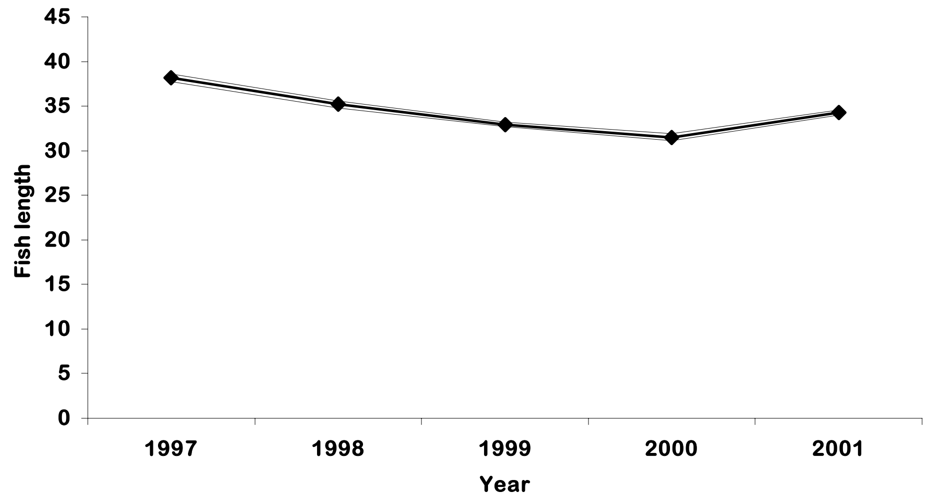


Figure III-7. Estimated annual trend in mean size (length) of red hind caught in the central Grenadines (MGREN) fishing area during the period 1997-2001. 95% Confidence Interval range is shown.

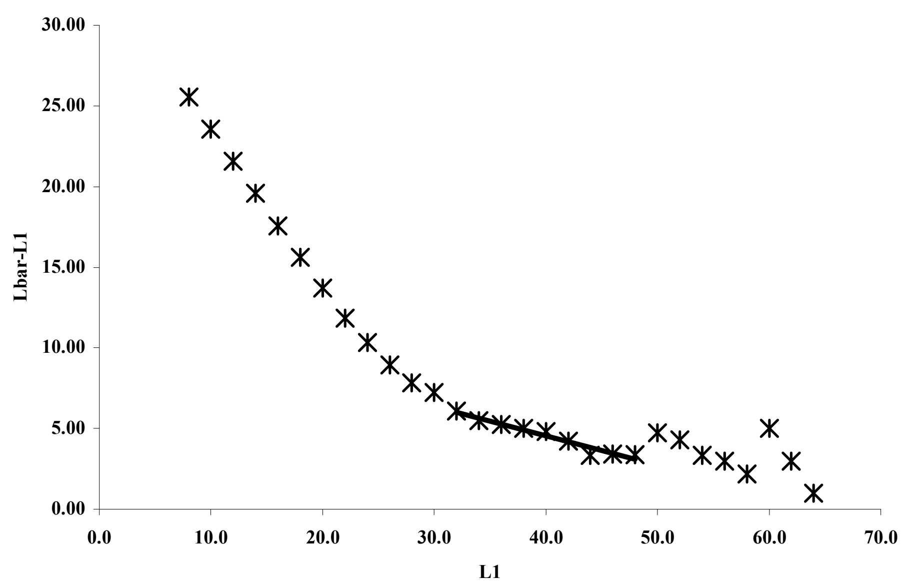


Figure III-8. Powell-Wetherall plot for red hind sample in the central Grenadines fishing area (MGREN area).

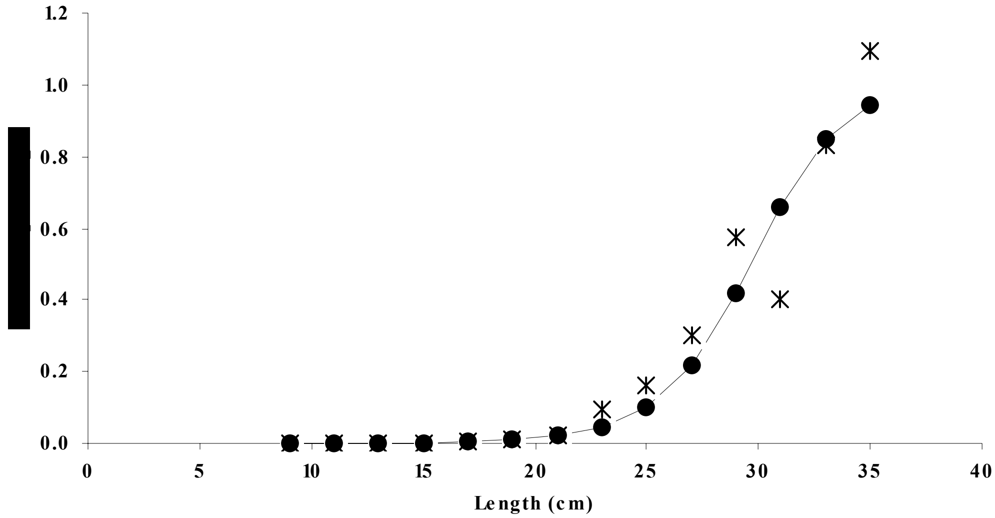


Figure III-9. Observed and estimated selectivity of red hind in central Grenadines fishing area.

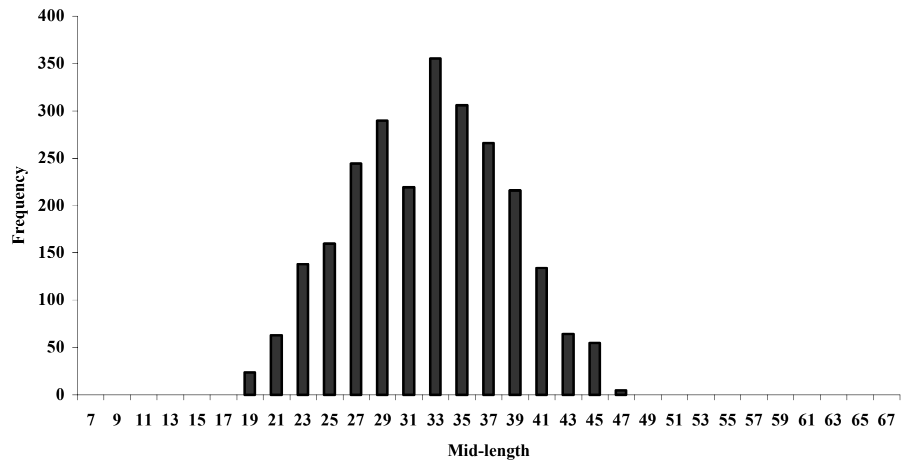


Figure III-10. Length frequency sample observed in 1997.

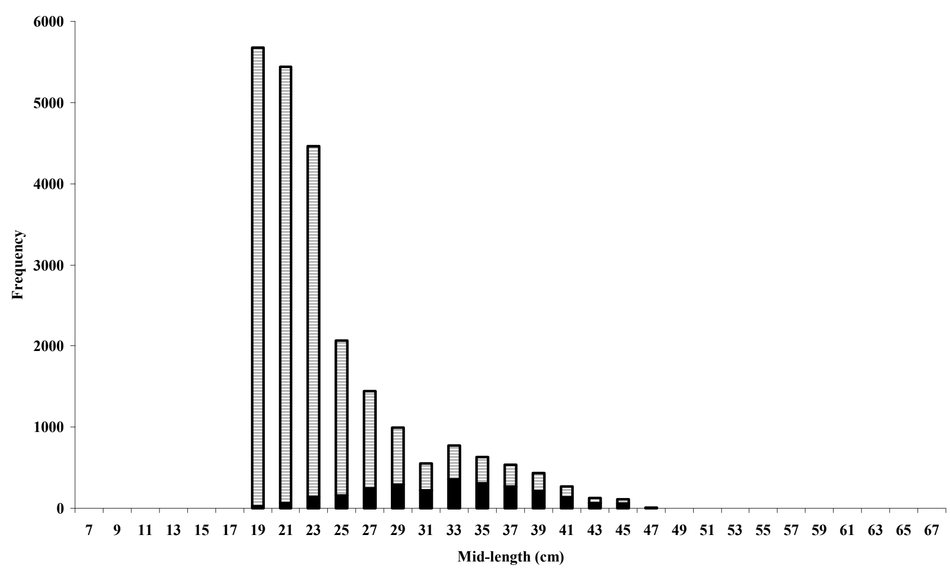


Figure III-11. 1997 length frequency sample corrected for selectivity.

APPENDIX 7

Proposed Continued Operations of the Regional Fish Age and Growth Laboratory at the Institute of Marine Affairs (IMA)

Prepared by R. Kishore

Background

The CARICOM Fisheries Resource Assessment and Management Program (CFRAMP) and the Institute of Marine Affairs (IMA) signed a Letter of Agreement in January 1995 for the development of a Regional Fish Age and Growth Laboratory at the IMA in Trinidad. The CFU agreed to provide financial resources for the strengthening and operation of the laboratory and the IMA to supply the necessary facilities, expertise and personnel.

Under the CFRAMP Subproject "Large Pelagics, Deep-Slope and Reef Fishes Resource Assessment", the capabilities for fish age and growth studies were enhanced at the IMA through the recruitment of staff, the procurement of equipment and a training consultancy.

Research Aims

The knowledge of age and growth is fundamental to fishery science (Jones 1992) and in adult fish populations, knowledge of their age and rate of growth is used to understand life history events, determine the size of fish to be targeted which will maximise yield while ensuring the future of the resource. In 1994, CFRAMP participating countries identified a total of 16 species for ageing using hard-parts by the Fish Age and Growth Laboratory. Since then, other species have been added to the list, Table 1. The function of the Laboratory is to produce age determination of those species as well as produce corresponding growth curves and growth parameter estimates.

Evaluation of Laboratory

In 1996 Dr. Steven Campana from the Marine Fish Division, Bedford Institute of Oceanography, Canada was contracted for a nineteen-day period by CFRAMP to assess and improve the operational capabilities of the Age and Growth Laboratory. Training in laboratory management, large scale sample processing, quality control procedures, image analysis, otolith microstructure examination, age validation, preparation of reference collections and data processing was provided. Infrastructure associated with the Age and Growth Laboratory was found to be sound and of above-average quality. The Laboratory was found to have the skilled personnel required for sample preparation and age interpretation. A number of recommendations were made by Dr. Campana to increase efficiency, improve productivity and enhance the reliability of age estimations.

Dr. Maxwell Sturm did a second assessment of the Laboratory in 2001. This assessment found that many of the recommendations made by Dr. Campana had been successfully implemented. Recommendations for further improvements in the Laboratory include:

1. Ensuring that adequate and proper samples are sent to the Laboratory from the relevant countries.

2. Purchase of equipment to develop a comprehensive digital reference collection. Reference collections are an important component in the training of laboratory staff, quality control evaluations and the exchange with other laboratories to enable consensus readings.
3. Strengthening of communication between the Laboratory and Fisheries Officers in the CFRAMP/CRFM countries. Fisheries Officers should visit the Laboratory to acquaint themselves with its workings and Laboratory staff should reciprocate visits to the countries to familiarise themselves with the fisheries and the sampling problems.
4. Closer collaborations between Laboratory staff and Fisheries Officers from the relevant countries in fitting the growth parameters to yield models for fishery management purposes.
5. Increase in staff development through attendance and participation at CFRAMP/CFRM workshops, and regional and international conferences. Laboratory staff should also be encouraged to study for higher degrees.

Statement of Work and Services

The Laboratory needs to continue and complete age and growth research commenced for species identified during the CFRAMP Programme. Recently, several regional resource working groups (CRFM Large Pelagic Fisheries Working Group, the CRFM Reef and Slope Fisheries Working Group and the CFRM Small Coastal Pelagic Fisheries Working Group) have been established to coordinate statistics, research, assessment and management of specific fisheries. The Laboratory has provided input data for resource working groups such as the CRFM Large Pelagic Fisheries Working Group and the CRFM Reef and Slope Fisheries Working Group, and will be expected to continue to contribute to these working groups' activities. For the duration of this Agreement, the Laboratory will also be expected to age new species that may be identified during other CFU projects such as the Integrated Caribbean Regional Agriculture and Fisheries Development Programme (ICRAFD), and those recommended by the regional resource working groups.

Equipment Procurement

Execution of the Letter of Agreement by CFU and the IMA will initiate procurement of selected new equipment by CFU through the Belize office, in consultation with the Pelagic, Reef and Slope Resource Assessment Unit and the IMA. The procurement of selected Laboratory equipment will be used to augment existing ageing equipment at the IMA.

Staff Recruitment and Training

At present the laboratory is staffed by two officers and a part-time technician. The IMA is responsible for the salaries and expenses of the staff. The IMA has additionally hired a researcher (M.Phil) for one year as well as on a part-time basis another officer at the IMA, to assist in the Laboratory to advance the age and growth research. With the introduction of additional species, the IMA may have to consider recruiting additional staff from time to time with the anticipated increase in workload.

Assessment Framework for Age and Growth Studies using Hard-parts

Figure 1 highlights a framework by which the selection of species to be aged can be made and the approaches available to the Laboratory for search image development, age determination, quality control and validation as well as the production of growth curves and growth parameters.

Choice of Species

The species to be chosen will be determined by the member countries. Several criteria can be applied such as the commercial importance as well as the absence of any previous age and growth studies for a particularly species. Notice should also be taken of the need to repeat age and growth studies of commercial species periodically (every 5 years is usually recommended) because of changes in fish stocks. Based on suggestions from CFU and the IMA (based on status of age and growth activities, Appendix 1) a provisional list of 11 species has been suggested, Table 2, for the proposed continuation of the Laboratory. Some of these species are a continuation of previous activities as well as suggested new species. Given the resources of both the Laboratory and the member countries, it is suggested that only one or in some cases two species per country be chosen. Also this should be done on a phased basis to maximise the use of resources of both member countries and the Laboratory.

Evaluation of hard parts and search image development

For each new species being investigated, the Laboratory should first conduct a literature review to determine the current status of age and growth research. An appraisal of the utility of various hard parts based on suitable criteria such as those developed by Neilson *et al*. (1993) for blackfin tuna should be performed. For medium to long lived species the usual choice of hard-part is the sagitta or vertebrae or set of largest spines to determine annular growth patterns. In short-lived species such as small coastal pelagics or for species for which the suspected life span is about 2 years, it is recommended that age determination be done based on microstructure analysis (daily rings or increments). The Laboratory is expected to collaborate with other fish ageing laboratories within the region, e.g. in Brazil and Venezuela and Florida, on all aspects of age and growth research and particularly so for age validation studies.

Sample Collection

The original intention under the Biological Data Collection Program of CFRAMP was to collect 300 individuals per species per year over a two-year period for the originally selected 16 species. The major hindrance to the generation of growth curves and growth parameters, and in some instances search images, was the lack of adequate samples across the entire size range. This would necessitate samples from males and females, all gear types as well as commercial and non-commercial sources. This has been recommended by two separate evaluations of the Laboratory Campana (1996) and Sturm (2001). The reduction of species ages per country would allow more resources to be devoted to the collection of samples, which would be more representative of the target fish population. Data Collectors in the field should be informed of work progress on a regular basis, so that field collection efforts can continue to be refined and optimised. Hard-parts to be collected should be paired sagittae and lapilli and several samples of vertebrae and spines.

Quality Control

To ensure quality control, several techniques will be employed as recommended by Campana (1996) and Sturm (2001). These will include the assignment of a secondary reader, the use of age bias plots, development of annotated and non-annotated reference collections for training/bi-annual checks of age readers and otolith exchange programs with other Fish Age and Growth Laboratories in the region or those laboratories that are ageing similar species.

Validation

Many marks exist in the otolith, however only some of them can be interpreted as growth rings/bands or annuli. To confirm accuracy of annular interpretation, validation is required, that is, the confirmation of the temporal nature of these presumed annuli.

The simplest technique available to the IMA is marginal increment analysis, which requires monthly samples (approx. n= 25) collected over at least one year. Campana (1996) had expressed some concerns over this method but given the present circumstances Sturm (2000) recommended its use, which is also well documented in the literature including those by Neilson *et al.* (1993), McPherson and Squire (1992) and Manooch *et al*. (1987). Such appraisals should be done in conjunction with the length-frequency analyses (conducted by CFU, regional resource working groups, and the national investigators) as recommended by Campana (1996) to corroborate the length–at-age of the first few age groups.

Microstructure analysis is a much more robust means of validation and is more recognised internationally. The type of analysis available to the Laboratory is the validation of the position of the first annulus. This requires the collection of 100- 150 samples of paired lapilli of young of the year (YOY) and year I fish.

Microstructure analysis is particularly important because of the difficulty of identifying the position of the first annulus on sagittae for many of the species currently aged by the Laboratory. Inherent in such studies are experiments using chemical markers to validate the daily rings, however this is beyond the resources available of the Age and Growth Laboratory for 2002 – 2005 and could be entertained at a later time.

Peer collaboration

CFU and IMA will continue to pursue linkages with other laboratories and fisheries divisions and departments within the region, that undertake similar fish ageing studies of tropical species.

Work details and scheduling

The Laboratory will be responsible for management of fish age and growth data. It is recognised that this is a time-consuming exercise, involving organisation and archiving of processed hard part samples, as well as computerised data and digital images. The Laboratory is about to undertake some changes with respect to storage of otoliths suggested by an evaluating team from the Smithsonian Institution on IMA biological reference collections (Hawks and Palmer 2002).

Laboratory management will continue to include several tasks: development of a Laboratory operations manual (in progress); reports, etc.; acquisition and compilation of relevant literature; and development and prioritising of work plan and schedule. Future Laboratory management should include compilation of reference collections and corresponding descriptive profiles. In general, the necessary hard part to be collected is the paired sagittae. In some instances, other hard parts such as vertebrae and/or spines may be required. Laboratory staff will therefore be responsible for developing a set of guidelines to address additional sampling requirements for existing incomplete reference collections, as well as future approaches.

The Laboratory can develop and conduct training and refresher courses for field sampling supervisors and data collectors with financial support from CFU. These courses should not only provide training in hard part extraction procedures, but be used to nurture full appreciation for fish age and growth studies through exposure to other aspects of fish age and growth research, including laboratory procedures, and generation and utilisation of outputs. The Laboratory will provide regular feedback on research progress through publication of reports and information circulars.

Considering all tasks to be carried out, the Laboratory will generate at least 1-2 sets of age and growth parameters per year for input into ongoing annual fishery

assessments. Previously generated age and growth parameter estimates would continue to be refined alongside the newly introduced investigations.
During March 2002- December 2003, the Laboratory will advance ongoing studies on the following species with the aim to produce primary publications on the completed studies.

- *Acanthocybium solandri*, wahoo,
- *Scomberomorus cavalla*, king mackerel,
- *Scomberomorus brasiliensis*, Spanish mackerel and
- *Caranx hippos*, the crevalle jack
- *Epinephelus guttatus*, red hind
- *Lutjanus synagris*, lane snapper

During 2003-2005, the Laboratory will aim to complete those age and growth investigations recommended by the various regional resource working groups, of the following species;

- *Lutjanus purpureus* (southern red snapper),
- *Macrodon ancylodon* (king weakfish or bangamary),
- *Arius parkeri* (gillbacker sea catfish),
- *Micropogonias furnieri* (yellow mouth croaker)
- *Cynoscion jamaicensis* (Jamaican weakfish).

Although age and growth studies for these species will be initiated by the Laboratory from 2003, sample collection must begin prior as suggested in the methodology and assessment framework.

Outputs

i. Continued provision of age estimates. The age data are subject to quality control (including the components of consistency, accuracy and precision), as determined through otolith exchanges with other laboratories and determining the precision of ages provided by a given reader. In the provision of these outputs it is recognised that some species may not have interpretable age marks.
ii. Continued refinement and development of age-length relationships for the species investigated, and provision of age and growth parameters suitable for use in stock assessments. In instances where there are known to be differences in growth rate between the sexes, separate growth curves should be provided for each sex.
iii. Validation of ages for those species using marginal increment analysis as outlined by McPherson and Squire (1992) and Manooch *et al*. (1987) and microstructure analysis to validate the position of the first annulus. Validation should be provided for as many species as is reasonably possible.
iv. Advanced training of Laboratory staff in fish age and growth investigations, including validation and related quality control methods.
v. Continued development and training of field sampling supervisors and data collectors in countries participating in the CFU/ICRAFD programme.

Budget

The CFU budget for the period 2002-2005 is approximately USD 44, 000.00. During a CFU-IMA meeting convened in August 2001, it was agreed that the CFU funds would be used for equipment procurement, staff training and short-term attachments. Please note that the estimated budget is only for equipment and materials and does not include training attachments of Laboratory personnel, training of field data collectors and otolith exchanges with other Laboratories. The IMA will provide Laboratory and office space and storage, electricity, air-conditioning, water, phone and e-mail service, printing and graphic facilities and the use of other IMA equipment (e.g. oven, freezers, compound microscopes), and consumable items such as resins, chemicals slides, gloves, ink cartridges, envelopes, CDs, and photocopying as an In-Kind Contribution. IMA will also pay Laboratory staff salaries.

It is important to note that IMA has continued to show commitment to regional fish age and growth research and collaboration with regional fisheries agencies by its continued activities in age and growth research inclusive of sample collection such as the wahoo, purchase of computer and image software system and continued support through payment of salaries and services. This research has also been given priority for the next 5 years in its Strategic Plan 2002 – 2006 as well as its commitment to an Age and Growth Laboratory and related facilities in its proposed new buildings.

Fisheries Division and Department Inputs

Fisheries Division staff of countries participating in CFU projects will be expected to supervise field sampling of fish hard parts, and ensure timely delivery of good quality samples to the Laboratory. The estimate of supervision time required is about 5 – 10 person-days each year as determined by CFU, for each participating country. Those fisheries divisions that are engaged in independent fish age and growth research should collaborate closely with the Laboratory, to avoid duplication of research effort and to exchange ideas regarding research procedures, achievements and other developments.

References

Campana, S. E. 1996. Assessment, training and recommendations pertaining to the operational capabilities of the Institute of Marine Affairs Ageing Laboratory in Trinidad.

Hawks, C. and Palmer, L. 2002. General Conservation Assessment. Institute of Marine Affairs. Sponsored by the Ocean Conservancy and the Bay Foundation.

Jones, C. M. 1992. Development and applications of the otolith increment technique, p. 1–11. In D. K. Stevenson & S. E. Campana (eds.). Otolith microstructure examination and analysis. Canadian Special Publication of Fisheries and Aquatic Sciences 117. Department of Fisheries and Oceans, Ottawa.

McPherson, G. R. and L. Squire. 1992. Age and growth of three dominant Lutjanus species of the great Barrier Reef Inter-Reef fishery. Asian Fisheries Science 5:25-36.

Manooch, C. S, III, Naughton, S. P., Grimes, C.N. and L. Trent. 1987. Age and growth of king mackerel (Scomberinirus cavalla) from the U.S. Gulf of Mexico. Mar.Fish.Rev. 49: 102-108.

Neilson, J.D., Manickchand-Heileman, S. and S. Singh-Renton. 1993. Assessment of hard parts of blackfin tuna (Thunnus atlanticus) for determining age and growth. ICCAT SCRS/93/98, 17p.

Sturm, M. 2001. Assessment and Long term Development of the CFRAMP Age and Growth Laboratory at the Institute of Marine Affairs, Trinidad, W.I. Part 1 and Part II.

Table 1. List of species to be aged (Large pelagics, Reef, Deep Slope species) by the Regional Age and Growth Laboratory.

SPECIES	COUNTRY REQUESTING AGEING													
	Antigua Barbud a	Barbado s	Beliz e	Dominica	Grenad a	Guyan a	St. Vincent	Grenadine s	Jamaic a	Alice Shoal	Montserrat	St. Kitts/ Nevis	St. Lucia	Trinidad & Tobago
Acanthocybium solandri		X											X	
Scombermorus cavalla												X		X
Thunnus atlanticus		X					X		X					
Caranx hippos												X		X
Sparisoma viride	X							X						
Holocentrus				X				X		XXX				
Holocentru rufus				XX										
Balistes vetula			X					X			X			
Haemulon	X							X						
Haemulon										XXX				
Haemulon parrai										XXX				
Haemulon plumieri										XXX				
Acanthurus				X				X			X			
Etelis oculatus	X	X			X							X	X	
Lutjanus synagris			XX	X						XXX				
Lutjanus jocu														X
Lutjanus vivanus	X	X								XXX				
Lutjanus analis	X													
Lutjansu bucanella				XX						XXX				
Lutjanus mahogoni			X	X				X						
Pristopoimoides										XXX				
Epinephelus cruentatus				XX										
Epinephelus fulvus				X						XXX		X		
Epinephelus	X		X		X					XXX				
Macrodon ancylodon						XX								
Ocyurus chrysurus			XX											

X –CFRAMP species from original 1995 Letter of Agreement XX – Species added to original list XXX - Non-CFRAMP Species

Table 2. Proposed species list for age and growth studies for the period 2002 – 2005.

Fish Group	Species	Common Name	Status
Large Pelagics	*Acanthocybium solandri*	Wahoo	Approximately 85% completed
	Scomberomorus cavalla	Kingfish	Approximately 20% completed
	Scomberomorus brasiliensis	Spanish mackerel or carite	Approximately 75% completed
Small Coastal Pelagics	*Caranx hippos*	Crevelle jack or cavali	Approximately 40% completed
Reef and Slope Species	*Lutjanus synagris*	Lane snapper or red fish	Approximately 30% completed
	Lutjanus purpureus	Southern red snapper	New species
	Epinephelus guttatus	Red hind	Approximately 40% completed
Demersals	*Macrodon ancylodon*	King weakfish	New species
	Arius parkeri		New species
	Micropogonias furnieri		New species
	Cynoscion jamaicensis	Jamaican weakfish	New species
Status refers collectively to the completion of literature review, sample processing, age determination, data analysis, growth curve and generation of growth parameters.			

Table 3 - Proposed budget for the Age And Growth Laboratory for equipment and materials to be funded by CFU for the period 2002 – 2005.

ITEM	Unit Cost $US	Quantity	Total $US

Isomet Low Speed Saw	$3,850	1	$3,850
Low Viscosity "Spurr" Kit	$100	6	$600
Gelatin Capsules	$20	5	$100
Diamond Wafering Blade	$ 270	5	$1350
6" Lapidary Machine	$270	2	$540
CD Burner 19″Flat Screen Monitor	$3000	1	$3000
Stereomicroscope	$10 000	1	$10 000
Digital Camera	$10 000	1	$10 000
Embedding Molds	$400		$400
Carbimet Discs – PSA 8″ PSA Backed Grit 400 30-5118-400-100 Grit 600 30-5118-600-100 Grit 800 30-5528-800-100	$150 $150 $200	2 box 4 box 10 box	$300 $600 $2000
Dissecting Equipment & Storage trays	$1000		$1000
Storage Cabinet for Chemicals	$675	2	$1350
Plexi Glass	$200	5 sheets	$ 1000
Micromounts	$700	5 boxes	$ 3500
Lacquer	$10	20 bottles	$ 200
Total			**39 790**
Total + 10% Contingency			**$43 769**
The above costs is for equipment and material **only** and does not cost for training attachments, training of field data collectors and otolith exchanges with other Laboratories			

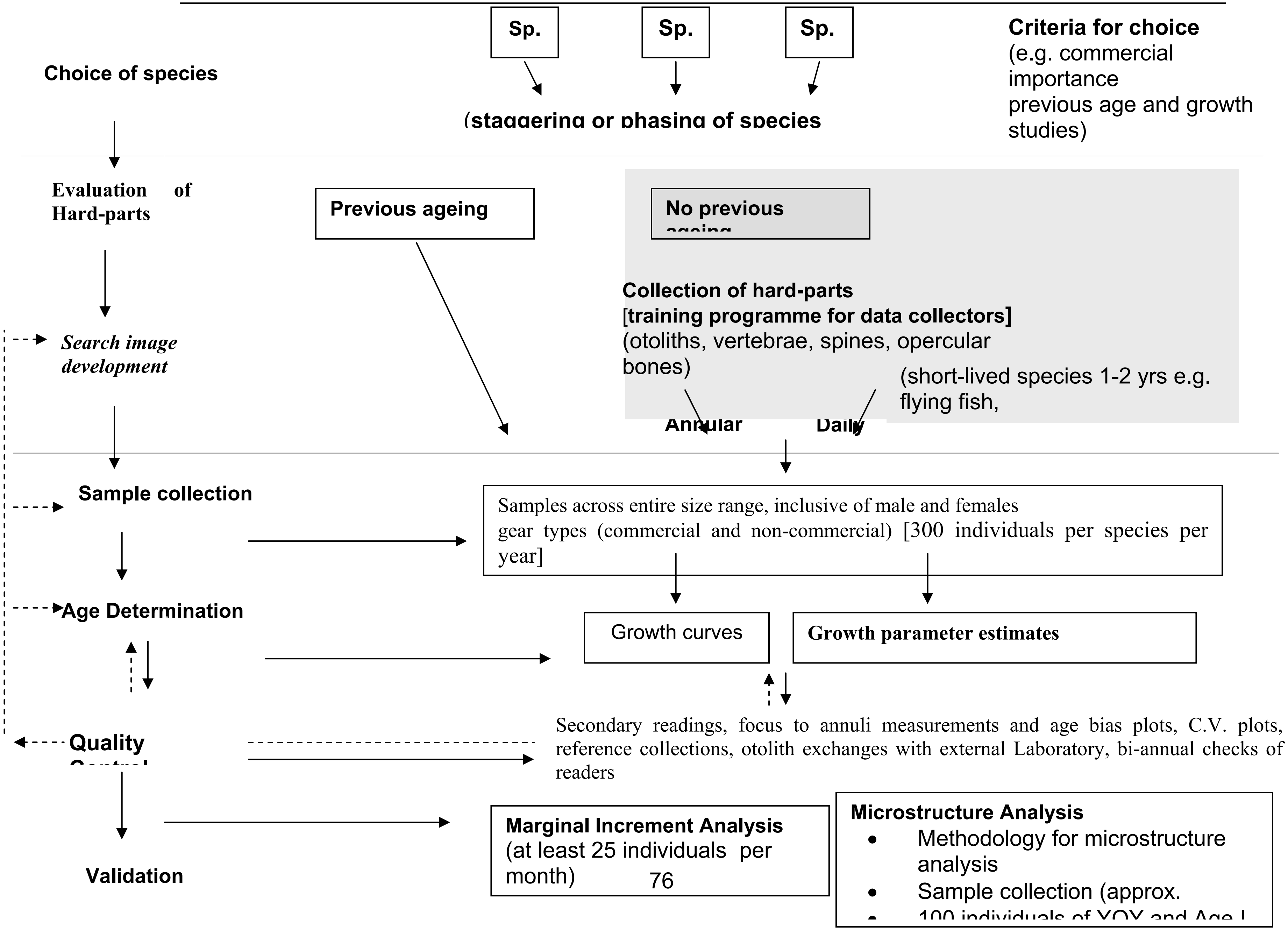


Figure 1: Methodology and Assessment Framework for Age and Growth Studies using Hard-parts

Addendum to Appendix 7

Status of Activities of the Age and Growth Laboratory at the Institute of Marine Affairs.

There was considerable re-organising of the laboratory's protocol for receiving, processing and ageing of hard-parts. Primary and secondary readings and data analysis were completed for several species and preliminary growth parameters and growth curves were developed.

Digital Reference Collections of otoliths is being developed for fish species which have a range of length and age data. Literature material on age and growth studies is continually being sourced and an author/subject index system was established to catalogue all the reference material in the Age and Growth Laboratory.

Several reports have been prepared as well as the research has presented at various research symposia, scientific meetings and workshop for peer review. These include:

1) Paper presented at IMA 1997 Research Symposium
"Preliminary Age Determination of Silk Snapper, *Lutjanus vivanus,* from Dominica, West Indies by A. Ricahardson-Drakes, R. Kishore and H. Guiste,

2) Two poster presentations were displayed at the Second International Symposium – Fish Otolith Research and Application, Bergen Norway 2—25 June 1998. They were entitled

(a) **"Preliminary age Determinations of Tropical Fish species from the Caribbean"** by R. Kishore, A. Richardson-Drakes and H. Ramsundar.

(b) **"Age and Growth studies of the Spanish Mackerel, *Scomberomorus brasiliensis"*** (Family: Scombridae) in coastal waters of Trinidad by R. Kishore and L. Martin.

3) **"Age and Growth Determination of the Lane Snapper, *Lutjanus synagris* from Belize and Jamaica"** - Draft Report – by R. Kishore.

4) **"Age and Growth Determination of the red hind, *Epinephelus guttatus* from Grenada, coney, *Cephalopholis fulva* from Dominica and graysby, *Cephalopholis cruentata* from Dominica"** by X. Chin.

5) Two CFRAMP workshops were attended in St Lucia and Barbados in 2000 to give presentations on the work of the Age and Growth Laboratory. Papers were entitled:

(a) **"Age and Growth Studies at The CFRAMP/IMA Regional Age And Growth Laboratory – Progress of Work Done and Future Approaches"** by R. Kishore and X. Chin.

(b) "**Age and Growth Studies at the CFRAMP/IMA Regional Age and Growth Laboratory. The importance of collecting otolith information in fish stock assessment – Suggestions for a way forward**" by R. Kishore and X. Chin.

6) Paper presented at the Scientific Meeting of the Association of Marine Laboratories of the Caribbean attended in June 2001. Paper entitled **"The Use of Hard-parts in Fisheries Assessments in the Caribbean"** by R. Kishore and X. Chin.

APPENDIX 8

Proposal To Establish A Caribbean Regional Fisheries Mechanism Small Coastal Pelagic Fish Resource Working Group (CRFM SCPWG)

Prepared by S. Singh-Renton

Background and Rationale

Small coastal pelagic fish resources support substantial fisheries throughout the Caribbean region, sometimes accounting for 40% or more of the total reported national fish landings (e.g. Wilkins and Barrett, 1996; Guiste, 1996; Ryan, 1996). Important bait fisheries also operate in some countries (Kelly, 1996; Mohammed, 1996). Small coastal pelagic fishing operations are conducted usually close to or from the seashore, often using small open vessels. Some operations are diver-assisted and the popular gears are the seines, gill nets and cast nets; given the variable resident times of fish schools, fishers prepare to deploy their gears at any time of day. The labour of setting and hauling of a single seine, as well as the catch, is often shared by a team of persons. The small coastal pelagic fisheries can employ large numbers of the populations in some small island and coastal states, and hence are of paramount importance in contributing to the social and economic stability of the countries involved. Considering the extensive coastlines in CRFM States and the nature and changeable timing of fishing operations, it is easy to appreciate the complexity of the small coastal pelagic fisheries in these countries, and the difficulty this complexity poses for both fisheries statistical coverage and management.

Management of these fisheries is currently limited by lack of adequate data and information for quantitative assessment of the resources concerned (Nakashima, 1996). Notwithstanding, small coastal fishers in some Caribbean territories have developed a set of rules for determining fishing opportunities (see Finlay, 1995, 1996).

The movement and distribution of stocks of small coastal pelagic fish resources within the Caribbean are not well understood, although it is very likely that islands sharing a common shelf are fishing the same stocks. In instances of shared stocks, the States concerned will need to collaborate for management purposes. Given the limited human and financial resources available to many CRFM countries for resource assessment and management, and the diverse and complex network of small coastal pelagic fishing operations in most CRFM States, the establishment of a regional working group on small coastal pelagic fish resources would facilitate a collective effort to address common issues pertaining to statistics, research, stock assessment methods and development of management advice.

Terms of Reference

Noting the significant contribution of small coastal pelagic fish resources to the social and economic well-being of many Caribbean States,

Recognising the need to develop adequate data information systems, and the benefits of inter-state collaboration aimed at improving knowledge on and understanding of the biology and ecology of small coastal pelagic fish resources,

Acknowledging the role and mandate of the CRFM in providing a regional arrangement for the coordination of statistics, research, assessment, and management of shared fish resources within the Caribbean region,

A CRFM Small Coastal Pelagic Fish Resource Working Group (CRFM SCPWG) should be established with a mandate to promote the sustainable utilization of small coastal pelagic fish resources in CRFM countries.

The CRFM SCPWG should operate within the following Terms of Reference.

1) To provide a forum for review of fisheries statistical and sampling procedures, and for advising on improvements in recording and reporting of small coastal pelagic fisheries data;
2) To provide a forum for review and analyses of the best available scientific information for determining the status of exploitation of small coastal pelagic fish stocks within CRFM States;
3) To provide a forum for developing multidisciplinary approaches to fishery assessment, including the consideration of social, economic, and environmental data, and local knowledge;
4) To provide a forum for review and discussion of the biology and ecology of small coastal pelagic fish resources;
5) To provide a forum for promoting sustainable development and management of small coastal pelagic fisheries;
6) To provide a forum for the development and coordination of statistical and research programmes on small coastal pelagic fisheries;
7) To identify and recommend funding requirements in support of small coastal pelagic resource research programmes;
8) To archive a written record of the proceedings of the Working Group including the scientific basis for conclusions reached and suggested management actions;
9) To ensure the timely publications of research documents and other Working Group reports.

Mode of Operation

CRFM Member countries are members of the SCPWG and will be responsible for ensuring implementation of agreed Working Group recommendations at the national levels. The CRFM Secretariat will be responsible for coordinating the activities of the Working Group, including development of harmonized data information systems where necessary, preparation and submission of project proposals for external funding, and development and implementation of regional research programmes.

The Working Group, through the CRFM, should work closely with staff of national and regional institutions such as IMA and UWI respectively, and of regional organizations such as FAO (WECAFC) and OECS, in order to make full use of available technical expertise and any related project opportunities. The Working Group, through the CRFM, should also collaborate closely with FAO WECAFC on related activities that may also involve neighbouring non-CRFM countries.

Working Group Meetings

It is recommended that each CRFM country designate a representative for serving on the CRFM SCPWG. A representative of the CRFM/IMA regional age and growth laboratory should also serve on the Working Group. The designated country representative should be involved in aspects of statistics, research, and management of small coastal pelagic fisheries in his/her respective country. Fisheries staff in territories adjacent to CRFM Member countries, fisheries staff of regional organizations such as FAO, and OECS, and fisheries staff of research institutes such as UWI, will be invited at their own expense, to participate in meetings of the Working Group. Depending on the need for their participation, independent consultants may also be invited to participate in meetings. Working Group meetings can take place given the presence of at least six different country representatives. The election of a Chairman, Vice-Chairman, and Rapporteur should take place on a rotational basis.

Budget

An on-site meeting of the CRFM SCPWG should be convened at least once every two years, and could be scheduled to take place immediately before or after other regional meetings, thus reducing airfare and other travel costs. It is recommended that the accommodation and per diem costs for on-site meetings be covered under the appropriate CRFM budget item. Other CRFM SCPWG meetings may be convened electronically.

References

Finlay, J. 1995. Community-level sea use management in the Grenada beach seine fishery: current practices and management recommendations. MSc thesis. UWI, Barbados. 113pp.

Finlay, J. 1996. Conditions and Practices in coastal pelagic fisheries within the OECS with a design for data collection and to facilitate management. Working Paper No. 15, 25pp., presented at CFRAMP Small Coastal Pelagics and Flyingfish Subproject Specification Workshop.

Guiste, H. 1996. Small coastal pelagic fisheries in Dominica. National Report. Working Paper No. 5, 4pp., presented at CFRAMP Small Coastal Pelagics and Flyingfish Subproject Specification Workshop.

Kelly, R. 1996. Small coastal pelagic fisheries in Jamaica. National Report. Working Paper No. 8, 9pp., presented at CFRAMP Small Coastal Pelagics and Flyingfish Subproject Specification Workshop.

Mohammed, E. 1996. Small coastal pelagics and flyingfish fisheries in Trinidad and Tobago. National Report. Working Paper No. 13, 17pp., presented at CFRAMP Small Coastal Pelagics and Flyingfish Subproject Specification Workshop.

Nakashima, B. 1996. Report of the scoping mission for the small coastal pelagics and flyingfish sub-projects. Working Paper No. 14. 67pp., presented at the CFRAMP Small Coastal Pelagics and Flyingfish Subproject Specification Workshop.

Ryan, R. 1996. Small coastal pelagic fisheries in St. Vincent and the Grenadines. National Report. Working Paper No. 12, 10pp., presented at CFRAMP Small Coastal Pelagics and Flyingfish Subproject Specification Workshop.

Wilkins, R. and A. Barrett. 1996. Small coastal pelagic fisheries in Saint Kitts and Nevis. National Report. Working Paper No. 10, 7pp., presented at CFRAMP Small Coastal Pelagics and Flyingfish Subproject Specification Workshop.

APPENDIX 9

Proposal To Establish A Caribbean Regional Fisheries Mechanism Reef and Slope Fish Resource Working Group (CRFM RSWG)

Prepared by S. Singh-Renton

Background and Rationale

For the purpose of this document, reef fish resources refer to those resources which spend most of their lives on island shelves while deep slope fish resources refer to those resources which spend most of their lives on the deep slopes and submerged banks that occur further offshore. In the Caribbean region, reef and slope fisheries are multi-gear, multi-species fisheries and are relatively diverse and complex. Fishing operations are generally small-scale. At present, several reef fish resources in CRFM States are believed to be fully or over-exploited, based on evidence indicating changes in species composition (disappearance of larger species from the catch), decreasing mean fish size caught and trends in abundance (e.g. FAO, 1993). Additionally, Mahon (1990) indicated limited potential for expansion of deep slope fisheries within the Lesser Antilles region.

During 1992-1998, the CARICOM Fisheries Resource Assessment and Management Program (CFRAMP) provided funding and technical support for the overall enhancement of fisheries data information systems in several CARICOM countries. The 2000 Caribbean Pelagic and Reef Fisheries Assessment and Management Workshop reviewed and analysed some of the reef fish data collected by CARICOM countries (CFRAMP, 2001). CFRAMP (2001) also emphasized the need for countries to continue efforts to improve their data information systems, to facilitate the refinement of statistical and assessment analyses of their fisheries data and hence minimize errors in the provision of management advice.

It is generally assumed that reef and slope fish resources do not undergo large-scale movements, and can be managed at the local or country level. However, islands sharing a common shelf may also be sharing the same reef and slope fish stocks. In such instances, the States concerned will need to collaborate for management purposes. Given the limited human and financial resources available to many CRFM countries for resource assessment and management, the establishment of a regional working group on reef and slope fish resources would facilitate a collective effort to address shared issues pertaining to statistics, research, stock assessment methods and development of management advice.

Terms of Reference

Noting that most CRFM States experience similar challenges pertaining to development, monitoring and management of their reef and slope fisheries,

Recognising the need to continue improving statistics on these fisheries, and the benefits of inter-state collaboration aimed at improving knowledge on and understanding of the biology and ecology of reef and slope fish resources,

Acknowledging also the role and mandate of the CRFM in providing a regional arrangement for the coordination and harmonization of statistics, and coordinating development of approaches to research, assessment, and management of fish resources within the Caribbean region, A CRFM Reef and Slope Fish Resource Working Group (CRFM RSWG) should be established with a mandate to promote the sustainable utilization of reef and slope fish resources in CRFM countries.

The CRFM RSWG should operate within the following Terms of Reference.

10) To provide a forum for review of fisheries statistical and sampling procedures, and for advising on improvements in recording and reporting of reef and slope fisheries data;
11) To provide a forum for review and analysis of the best available scientific information for determining the status of exploitation of reef and slope fish stocks within CRFM States;
12) To provide a forum for developing multidisciplinary approaches to fishery assessment, including the consideration of social, economic, and environmental data, and local knowledge;
13) To provide a forum for review and discussion of the biology and ecology of reef and slope fish resources;
14) To provide a forum for promotion of sustainable development and management of reef and slope fisheries;
15) To provide a forum for the development and coordination of statistical and research programmes on reef and slope fisheries;
16) To identify and recommend funding requirements in support of reef and slope resource research programmes;
17) To archive a written record of the proceedings of the Working Group including the scientific basis for conclusions reached and suggested management actions;
18) To ensure the timely publications of research documents and other Working Group reports.

Mode of Operation

CRFM Member countries are members of the Working Group and will be responsible for ensuring implementation of agreed Working Group recommendations at the national levels. The CRFM Secretariat will be responsible for coordinating the activities of the Working Group, including development of harmonized data information systems where necessary, preparation and submission of project proposals for external funding, and development and implementation of regional research programmes.

The Working Group, through the CRFM, should work closely with staff of national and regional institutions such as IMA and UWI respectively, and of regional organizations such as FAO (WECAFC) and OECS, in order to make full use of available technical expertise and any related project opportunities. The Working Group, through the CRFM, should also collaborate closely with FAO WECAFC on related activities that may also involve neighbouring non-CRFM countries.

Working Group Meetings

It is recommended that each CRFM country designate a representative for serving on the CRFM RSWG. A representative of the CRFM/IMA regional age and growth laboratory should also serve on the Working Group. The designated country representative should be involved in aspects of statistics, research, and management of reef and slope fisheries in his/her respective country. Fisheries staff in territories adjacent to CRFM Member countries, fisheries staff of regional organizations such as FAO, and OECS, fisheries staff of research institutes such as UWI, will be invited, at their own expense, to participate in meetings of the Working Group. Depending on the need for their participation, independent consultants may also be invited to participate in meetings. Working Group meetings can take place given the presence of at least six different country representatives. The election of a Chairman, Vice-Chairman, and Rapporteur should take place on a rotational basis.

Budget

An on-site meeting of the CRFM RSWG should be convened at least once every two years, and could be scheduled to take place immediately before or after other regional meetings, thus reducing airfare and other travel costs. The accommodation and per diem costs should be covered under the appropriate CRFM budget item. Other CRFM RSWG meetings may be convened electronically.

References

CFRAMP, 2001. Report of the 2000 Caribbean pelagic and reef fisheries assessment and management workshop. CARICOM Fishery Report 9, 139 pp.

FAO, 1993. Marine fishery resources of the Antilles. FAO Fisheries Technical Paper 326, Rome: 235 pp.

Mahon, R. 1990. Fishery management options for Lesser Antilles countries. FAO Fisheries Technical Paper 313, Rome: 126 pp.

APPENDIX 10

Proposal for the investigation of the stock movements, distribution, and migration, validation of growth rates and unit stock determination for jacks (*Selar crumenophthalmus*) and robins (*Decapterus spp.*) on the Grenada, and St. Vincent and the Grenadines shelves.

(1996 CFRAMP proposal updated by S. Constantine)

Introduction

In the Caribbean the small coastal pelagics catch is composed of species from a variety of families including Carangidae, Scomberidae, Exocoetidae and small tunas and the young of large tunas such as yellowfin. These catches make up a significant portion of the total landings in these countries. In 1993, FAO reported that small coastal pelagics accounted for 40-50% of the total recorded landings in St. Vincent and the Grenadines, 20-25% in Grenada, 40-45% in Dominica, 40-50% in Montserrat and 15-20% in St. Lucia.

The principal types of gear employed in this fishery are gill nets, beach seines, ballyhoo nets, cast nets and trolling gear. The catch, which is sold primarily by fishermen and vendors at landing sites and markets, is primarily for consumption or used as bait in the longline, trolling and trap fisheries.

Despite the importance of small coastal pelagics to many CARICOM countries, there is no comprehensive management of the resource anywhere in the region although some countries have put in place *ad hoc* mesh size regulations for example a minimum mesh size for beach seines in Dominica. Other management measures include a community level, self-regulating Territorial Use Rights in Fisheries (TURFs) system, practiced by fishers in Grenada. Ten traditional rules are identified within the TURF system and these allocate fishing opportunity to beach-seine nets through the recognition of temporary exclusive ownership at hauls (Finlay, 1996). This TURF system however is threatened by inter fishery conflicts between beach seine fishers related to non-compliance with the TRUF rules.

There is anecdotal evidence from fishermen around the region, which suggests that stocks are declining, and that there is a high proportion of immature fish being landed (e.g. see Finlay, 1995) however, the status of most species of small pelagics is largely unknown. The general understanding of their status in the region is that they vary from under to fully-exploited (FAO, 1998).

In 1990, Mahon reported that there was a lack of information on the biology and ecology, seasonal distribution, scale of local movements and seasonal migration patterns and stock structure of small coastal pelagics, which today is still largely the case. This lack of information precludes the estimation of potential yield and other stock parameters with the result that no sensible management plans can be initiated for the conservation of this important resource.

A tagging study and a genetic study are proposed to allow for the collection of valuable information about small coastal pelagics. The results of the tagging study are expected to facilitate the determination of: (i) the geographical extent of the area in which a stock lives, (ii) the degree of overlap of adults among populations and (iii) the geographical location of the stock seasonally. The chemical marking of a sample of fish otoliths will facilitate the validation of the periodicity of growth checks in these species. The genetic study will allow for the determination of the stock structure of the species selected for investigation.

The information gained from these three studies will not only facilitate the development of appropriate management options to ensure the long-term survival of individual stocks and to ensure the attainment of sustainable harvests for the fishery but will also help determine the appropriate geographical scale of management of the fishery (Gomes and Oxenford, 1996).

Selection of study area for the tagging study

St. Vincent, Grenada and the Grenadines have been selected for the tagging study for the following reasons:

1) The small pelagics are generally considered to be national resources, and should be managed under national plans. However, there may be some countries where a common shelf exists between them, such as between Grenada and St. Vincent and the Grenadines and between St. Kitts and Nevis, Antigua and Barbuda and Montserrat, where cooperative management is required (WECAFC, 1999). The archipelagic system from Grenada to St. Vincent provides a continuous shelf from Grenada to the Grenadines, which is separated from the St. Vincent shelf by a narrow channel. This area will allow for the investigation of both inter and intra shelf movements for the selected small coastal pelagic species.
2) The presence of the CARICOM Fisheries Unit Office in St. Vincent will facilitate easy implementation of the study.

Selection of species

Since the selected area of study is St. Vincent, Grenada and the Grenadines, the two small coastal pelagic species most important to the landings of these countries will be investigated. In Grenada, the two species that were reported to make up approximately 83% of all seine fish landings in 2000 were the bigeye scad, *Selar crumenophthalmus* (locally known as “jacks”) which accounted for 65% of all seine fish landings and the round scad, *Decapterus punctatus* which, accounted for 18% of all seine fish landings (Grenada Fisheries Division Data Unit, 2000). In St. Vincent and the Grenadines, the mackerel scad, *Decapterus macarellus* (know locally as “robins”) accounted for approximately 21.4% and the bigeye scad, *Selar crumenophthalmus* (locally known as “jacks”) 11.6%, of the annual recorded landings for 2000 (St. Vincent and the Grenadines Fisheries Division Data Unit, 2001).

Participants

The tagging study is expected to be a collaborative effort among the CARICOM Fisheries Unit, the Grenada Fisheries Division, the St. Vincent and the Grenadines Fisheries Division, the Fisheries Divisions and fishers of the CARICOM countries where the tagging posters will be distributed and tag returns made, small coastal pelagic fishers from both Grenada and St. Vincent and the Grenadines whose catches will be used for the tagging event and the Institute of Marine Affairs.

The genetic study is expected to be a collaborative effort among the CARICOM Fisheries Unit, The Fisheries Divisions of all islands where the selected small coastal pelagic species will be sampled, the small coastal pelagic fishers whose catches the samples will be taken from and the University of the West Indies, Cave Hill.

Goals and objectives of the studies

This tagging study will assist with the determination of the movements, distribution and migration patterns of the three most important species in the seine fisheries of Grenada, St. Vincent and the Grenadines and to provide validation of growth rates for these species. The following tasks will be undertaken:

1) Measure, sex, tag and release a significant number of jacks and robins from landing sites selected around St. Vincent, Grenada and the Grenadines.
2) Mark the otoliths of a sub-sample of the fish tagged with a chemical dye before they are released.
3) Recapture and re-measure a significant number of the tagged fish.
4) Determine the movements and absolute growth of all recaptured fish.
5) Compare days at large with the number of otolith increments for all recaptured injected fish.

The goal of the genetic study is to obtain information on the genetic variation among populations of one or more of the three selected small coastal pelagic species in the Caribbean Region.

Methods

Tagging study

The study, which is expected to last for approximately two years (to allow for the maximum number of tag returns), is to be carried out at 12 sampling sites distributed throughout St. Vincent, Grenada and the Grenadines.

The breakdown of sites by island is as follows (see Figure 1):

St. Vincent	Clare Valley, Buccament and Chateaubelair
Grenada	Duquesne, Gouyave and St. George's
Bequia	Admirality and Friendship Bay
Union Island	Ashton and Chattam
Carriacou	Hillsborough and Grand Bay

The tagging event at each sampling site is predicted to last for 1 week, at which time a significant sample of jacks and robins will be marked and released. Based on the information provided by key informants the best times for sampling at each site will be determined. Since seine catches tend to take an entire, single-species school, it is recommended that between 100 and 200 fish of each species be tagged and released at each sampling site with a proportion of the school remaining unmarked. Of the 100 to 200 fish, it is recommended that 10% of the smallest, immature fish be marked with oxytetracycline before their release. Fishers operating at each site will be paid for the use of their catches.

The recommended tag type is a conventional spaghetti tag (FLOY T-Bar Extra Small Anchor FF-94) colour coded by site. A different number series should be used for each species to enable distinction of the species once the tag is recovered. Each tag should be treated with algaecide to reduce mortality in the released fish.

The oxytetracycline dose applied should be no more than 100mg OTC per kg body weight of the fish and should be dissolved in a minimum amount of saline water. The sex and fork length of the fish, the school size taken from and released with, and the tag colour and tag number series should be recorded for each released fish.

Advertising should be done in all the countries taking part in the aging study and all neighboring countries that have a fishery for small coastal pelagics including St. Lucia, Martinique, Trinidad and Tobago, Barbados and Dominica. Advertising should take the form of tag reward posters (at all beach seine fishing sites, fish markets, fishing complexes and fishery offices), flyers, newspaper articles and radio advertisements. The reward offered should be of an amount that will encourage fishers to turn in the entire marked fish.

Information on the attached tag as well as the accurate sex, fork length and species identification should be obtained from all recaptured fish. In addition all three pairs of otoliths (sagittae, asterisci and lapilli) should be removed, cleaned and properly stored. The sagittae should be stored dry while the two smaller pairs placed in glycerine, then shipped to IMA.

It is recommended that a trial mark and release effort be done at one of the selected landing sites to test the methodology and the feasibility of releasing large numbers of fish simultaneously. Additionally this will be needed to test the behaviour of the fish and the fishers immediately after release. This will enable the refinement of the methodology for the main tagging study.

Genetic Study

Sampling should be carried out in at least a sub-sample (Jamaica, Montserrat, Dominica, St. Lucia, Trinidad, St. Vincent and the Grenadines, and Grenada) of all islands, which have commercial fisheries for the selected species. Approximately 30 fish liver samples should be collected from fishers at every sampling site within the selected islands. These samples should be obtained from a variety of boats over a period of a few days so as to minimize the chance of sampling a single school.

At the landing site, crude liver tissue samples from spawning fish which were immediately iced after being caught should be removed with forceps and a scalpel and placed in preservative (NaCl and DMSO-EDTA solution) immediately after removal. These should be stored at room temperature.

The mitochondrial DNA should be extracted from the preserved liver samples, quantified, diluted to a concentration of 5 ng μl^{-1} and stored at -20^0C. The mtDNA D-loop region should be extracted from the stored genomic DNA by amplification. Subsequently, restriction enzymes should be used to cut the mtDNA D-loop region and the various products of the mtDNA D-loop should then be physically separated on a 2% agarose gel, stained with ethidium bromide. These separated products should be visualized under ultraviolet light and a photograph should be taken of each stained gel to permit analysis at later date. These photographs should be evaluated to determine the degree of genetic variation between samples and populations.

Expected outputs from the studies

This study will facilitate:

1) The determination of the movements and home ranges of jacks and robins in Grenada, St. Vincent and the Grenadines.
2) The determination of whether or not jacks and robins migrate and if possible the timing of those migrations
3) The determination the extent of resource sharing likely between Grenada, St. Vincent and the Grenadines and thus through the region.
4) The validation of the periodicity of otolith growth checks

5) The verification of length-based growth rate estimates through the measurement of absolute growth over known periods.
6) The determination of stock structure of one or more selected small coastal pelagic fish species in CARICOM countries.

Once completed, these studies are expected to improve the knowledge of the movements, distribution and migration patterns, age and growth and stock structure of jacks and robins and therefore allow for the development of informed management plans for this resource.

References

FAO, 1993. Marine fishery resources of the Antilles: Lesser Antilles, Puerto Rico and Hispaniola, Jamaica, Cuba. *FAO Fisheries Technical Paper* No. **326**. 235pp.

FAO, 1998. Report of the 7th session of the Working Party on the assessment of marine fishery resources. Belize City, Belize. 2-5 December 1997. *FAO Fish. Rep*. **576**. 39pp.

Finlay, J. 1995. Community-level sea use management in the Grenada beach seine fishery: current practices and management recommendations. M.SC. Thesis, University of the West Indies, Cave Hill, Barbados. 180pp.

Gomes, C. and H. Oxenford. 1996. The use of mitochondrial DNA markers towards stock discrimination of commercially important small coastal pelagic fish species in CARICOM countries. 13pp. Presented at a CFRAMP small coastal pelagics and flyingfish sub-project specification workshop, Grand Anse, Grenada. 11-13 September, 1996.

Grenada Fisheries Division Data Unit. 2000. Total fish landings; Grenada-2000. 2pp.

Mahon, R. 1990. Fishery management options for Lesser Antilles countries. FAO Fish. Tech. Pap. 313. 126pp.

Oxenford, H. 1996. Investigation of stock movements, distribution and migration of the primary seine fishery species, jacks (*Selar Crumenophthalmus*) and robins (*Decapterus spp.*) on the Grenada and St. Vincent shelves, and field-based validation of growth rates. 20 pp. Working paper presented at a CFRAMP small coastal pelagics and flyingfish sub-project specification workshop, Grand Anse, Grenada. 11-13 September, 1996.

St. Vincent and the Grenadines Fisheries Division Data Unit. 2001. Landings and exports from 1980-2000.

WECAFC, 1999. State of fishery resources in the WECAFC region. Report of the 6th Session WECAFC Lesser Antilles fisheries committee. Castries, St. Lucia. 27-30 September 1999. 13pp.

Preliminary Budget

Tagging Study

ACTIVITY	QUANTITY	TOTAL COST US$

Ferry Passages/ Airfare		
St. Vincent to Bequia	1	11
St. Vincent to Union Island	1	60
St. Vincent to Grenada	1	95
Grenada to Carriacou	1	26
Field Accommodation	5 weeks (5 nights per week)	1 250
Hire of Fishers Catches or Purchase of Released Fish	35 casts	1 750
Advertising Materials		
▪ Poster design	1	20
▪ Poster printing	250	575
▪ Poster distribution		
Marking Materials		
▪ FLOY tags with algaecide and lettering/numbering	3 000	1 500
▪ Fine fabric tagging gun	4	200
▪ Incidentals		75
Rewards for Return of Recaptured Fish	1 000	1 000
Storage and Return of Tagged Fish		
▪ Small plastic bags	1 000	40
TOTAL		6 602

Ageing Study

ACTIVITY	QUANTITY	TOTAL COST US$
Marking Materials		
▪ Medical grade OTC	200 g	100
▪ Syringes	300	54
▪ Incidentals		25
Otolith extraction and Preparation		
▪ *Fine forceps	2	
▪ Sharp knife	2	8
▪ *Storage tubes	400	
▪ Glycerine	1 000 ml	10
TOTAL		197

* Represents materials already owned by CRFM.

Stock Determination Study (one species)

ACTIVITY	QUANTITY	TOTAL COST US$
Field Sampling		
▪ Return airfares to sampling sites		
▪ Accomodation and meals		
▪ Purchase of samples	180	63
▪ Tissue preservative	1 litre	220
▪ Ice		10
Tissue Analysis		
▪ 1.5 ml microcentrifuge tubes	1 * 1000	45
▪ 5.0 ml microcentrifuge tubes	4 * 1000	264
▪ pipette tips	12 * 1000	350
▪ CTAB detergent	500 g	88
▪ Extraction buffer	200 ml	88
▪ Ethanol	500 ml	175
▪ Sarkosyl	200 ml	175
▪ Ammonium acetate	200 ml	175
▪ Isopropyl alcohol	200 ml	175
▪ TERNase	300 ml	350
DNA Amplification		
▪ Primers	2 * 1 ml	350
▪ DNA polymerase & buffer	3 * 10 tubes	4 730
▪ dNTPs	2 boxes	350
▪ Mineral oil	500 ml	88
Restriction Digest of mtDNA D-loop		
▪ Restriction enzyme & buffer	30 tubes	7 876
Gel Electrophoresis		
▪ Trizma base	2 kg	132
▪ Tracking dye	0.4 ml	132
▪ Ethidium bromide	100 ml	88
▪ Polaroid film	40 boxes	700
▪ PCR markers	2 * 250 ml	175
▪ Alcohol	11	88
▪ Gloves	10 boxes	45
▪ Paper towels/tissues		65
▪ Parafilm	1 roll	20
▪ Markers	1 pkg	10
TOTAL		17 029

Figure 1. Map of St. Vincent, the Grenadines and Grenada showing the sites where jacks and robins will be tagged during the main marking event (sites are marked with an x).


Soufriere
Chateaubelair
Saint Vincent
Georgetown
KINGSTOWN
Caribbean Sea
Bequia
Grenadines
Baliceaux Island
Mustique
Petit Mustique Island
Savan Island
Petit Canouar
Canouan
Mayreau
Tobago Cays
Union Island
Palm Island
Petit St. Vincent Is.
Petit Martinique
Hillsborough
Carriacou
Caribbean Sea
Grenadines
Ronde Island
North Atlantic Ocean
Grenville
SAINT GEORGE'S
Grenada

PART II:

NATIONAL REPORTS SUBMITTED

National Report of The Dominican Republic

Submitted by L. Sang

1. Fishery Type: Large Pelagic
2. Management objectives: Maintain the sustainability of the resource
3. Fishing vessel trends during 1990-2001: Small vessels (pirogue type) in the range 18-23 feet have been increasingly changed from wood to fiberglass or fiberglass reinforced. Outboards of low power (9.9-15 hp) are heavily used. The number of vessels exploiting this fishery has increased.
4. Gear trends during 1990-2001: The main method of trolling has been enhanced with a progressive use of FADs, although these are not used equally by fishers of the different landing beaches. On the South coast and scattered beaches along the North coast FADs have been adopted by pelagic fishers. Vertical drift lines with few hooks (called 'artefactos') are sometimes deployed while working the FADs.
5. Introduction of new fishing technologies (give description and dates) during 1999-2001: FADs were introduced from the beginning of the 90s mainly in localities of the central South coast (San Pedro de Macorís, Santo Domingo, Palmar de Ocoa), and later adopted in other places. Use of GPS receivers have increased, although not heavily.
6. Trends in catches or landings during 1990-2001: Available statistics for tuna-mackerel show a 50% (1,779.6 mt) increase in 1994 compared to the level of 1992-93 (1,188 and 1,151 mt) and a remarkable increase of 90% (3,348.2 mt) was recorded in 1995. From there a progressive decrease was recorded until 1999 when catches reached a lower level (871.2 mt) than at the beginning of the decade.
7. Collection of catch and effort statistics during 1999-2001 (indicate sampling coverage for each year, important landing sites, and current sampling issues): Only one Government center (Propescar Sur) located in the southwest collects landing data. The coverage is thus limited to landing sites of that area. In general there is a shortage, and inadequacy, of fishery personnel and means to collect catch statistics.
8. Research conducted during 1999-2001: None
9. Fisheries legislation and regulations in effect during 1999-2001: The Dominican Fishery Law (Law 5914) of 1962 The General Law of Environment and Natural Resources (Law 64-00) of 2000 Decree 1193-00 of 2000 on gillnet and small trawl net gear restrictions Decree 1111-01 of 2001 on export and import licensing and permits

1. Fishery Type: Reef and Slope
2. Management objectives: Maintain the sustainability of the resource
3. Fishing vessel trends during 1990-2001: Small vessels (pirogue type) in the range 18-23 feet have been increasingly changed from wood to fiberglass or fiberglass reinforced. Outboards of low power (9.9-15 hp) are heavily used. Number of vessels targeting these resources has decreased since the large pelagic fishery has attracted more fishers. A limited number of larger boats (40-60 feet) are used for long trips (2-4 weeks) to international grounds and the DR offshore banks to the north and northeast.
4. Gear trends during 1990-2001: Handlines are the more commonly used gear and in many places are used at night with lights. Spearfishing with compressors is heavily used for shallow water, with night diving with lights being used in recent years. Arrowhead traps have increased in some localities (e.g. Palmar de Ocoa, Manzanillo). Gillnets are common in some localities (e.g. Azua, Miches). Slope fish (mostly snappers) are caught mainly with multihook (6-15) handlines called 'calas'. In some places bottom longlines (100-500 hooks) are used, manually retrieved. A few larger boats that make long trips use electric reels with 'calas'. In the southwest (and few other localities) baited traps are used.
5. Introduction of new fishing technologies (give description and dates) during 1999-2001: In CEDEP, a Dominican-Japanese project located in the northeast, bottom longline with multihook vertical branches for slope fishing have been introduced since 1996, but so far this has not been adopted by local fishers due to high costs and unavailability of materials.
6. Trends in catches or landings during 1990-2001: Available year statistics for the deep and shallow water snapper (including yellowtail) group shows rather stable figures from 1992-1995 (1,106-963 mt), a great increase in 1996-97 (1,986-2,224 mt) and then a sharp decrease until 1999 (1,166 and 815 mt). Similar statistics for grouper in the years 1992-99 shows oscillation around a mean value of 593 mt, with peaks in 1993, 1995 and 1999 (809, 753 and 683 mt). A steady decrease from 753 mt in 1995 to the lowest figure of 390 mt in 1998 was recorded.
7. Collection of catch and effort statistics during 1999-2001 (indicate sampling coverage for each year, important landing sites, and current sampling issues): Only one Government center (Propescar Sur) located in the southwest collects landing data. The coverage is thus limited to landing sites of that area. In general there is a shortage, and inadequacy, of fishery personnel and means to collect catch statistics. Main landing sites: In Puerto Plata land most of the larger boats that carry out shallow reef fishing with compressors. Larger boats targeting slope fish land mainly in Manzanillo, Luperón, Río San Juan, Samaná, Pedernales. Reef and slope landings from small vessels occur all along the coast.
8. Research conducted during 1999-2001: Bottom longline with verticals used by CEDEP boat.
9. Fisheries legislation and regulations in effect during 1999-2001: The Dominican Fishery Law (Law 5914) of 1962 The General Law of Environment and Natural Resources (Law 64-00) of 2000 Decree 1193-00 of 2000 on gillnet and small trawl net gear restrictions Decree 1111-01 of 2001 on export and import licensing and permits

1. Fishery Type: Small Pelagic
2. Management objectives: Maintain the sustainability of the resource
3. Fishing vessel trends during 1990-2001: Small vessels (pirogue type) in the range 18-23 feet have been increasingly changed from wood to fiberglass or fiberglass reinforced. Outboards of low power (9.9-15 hp) are heavily used.
4. Gear trends during 1990-2001: The main methods of handline with light at night (mostly yellowtail snapper) and trolling for species such as bonito, jack, mackerel, barracuda and others, are replaced in some localities by gillnet and beach seine, which can catch more fish. Gillnets are even deployed on reefs and can get both bottom and pelagic species. Beach seines are mostly used opportunistically to catch passing schools.
5. Introduction of new fishing technologies (give description and dates) during 1999-2001: None
6. Trends in catches or landings during 1990-2001: Available year statistics for jacks shows oscillations from a high of 886 mt in 1992 decreasing to 473 mt in 1994, then an increase in 1995-97 from 565 to 636 mt, to end the period with a sharp decrease of 357 mt in 1998 to the lowest 106 mt in 1999. Probably only a small portion of the tuna-mackerel group statistics (discussed in the large pelagics) include small coastal mackerels.
7. Collection of catch and effort statistics during 1999-2001 (indicate sampling coverage for each year, important landing sites, and current sampling issues): Only one Government center (Propescar Sur) located in the southwest collects landing data. The coverage is thus limited to landing sites in that area. In general there is a shortage, and inadequacy, of fishery personnel and means to collect catch statistics. Main landing sites: Pedernales, Palmar de Ocoa, Salinas, Palenque, Miches, Sabana de la Mar, Sánchez, Los Cacaos, Cabrera, Monte Cristi, but also many others sites have landings of small coastal pelagics.
8. Research conducted during 1999-2001: None
9. Fisheries legislation and regulations in effect during 1999-2001: The Dominican Fishery Law (Law 5914) of 1962 The General Law of Environment and Natural Resources (Law 64-00) of 2000 Decree 1193-00 of 2000 on gillnet and small trawl net gear restrictions Decree 1111-01 of 2001 on export and import licensing and permits

National Report of Grenada

Submitted by C. Isaac

1. Fishery Type: Large pelagics - dolphinfish (*Coryphaena hippurus*)
2. Management Objectives: (i) Cooperate with ICCAT and members of Caribbean states. (ii) Promote the development of commercial and sport fishery
3. Fishing vessel trends during 1990 – 2001: EAST COAST **–** Still open pirogues but increased use of fiberglass hull or wood (marine ply) coated with fiberglass. Wooden hulls of cigarette design have also been introduced. WEST COAST - increase in the number and sizes of surface longliners.
4. Gear trends during 1990 – 2001: TROLLING – monofilament line (150lb – 400lb test) with double hooks (sizes #22 to #24). "Depth charge" using grades 18 – 21 tying wire. Both monofilament and wire attached to silky nylon cord #9. SURFACE LONGLINERS – using monofilament droplines (250lb – 300lb test) ranging from small (100 hooks) to large (> 400 hooks).
5. Introduction of new fishing technologies during 1999 – 2001: (i) VHS communications network . (ii) Rapid increase in the use of GPS. (iii) Compulsory safety items. (iv) Modification of open pirogues (to cigarette types) for enhanced capacity (load carrying), speed and fuel efficiency.
6. Trends in catches or landings during 1990 – 2001: Trends were not analysed.
7. Collection of Catch & Effort statistics 1999 – 2001: Data capture points at 6 sites – data collected are weight (by species), effort (hours fished), name of boat & owner, gear used and area fished. Attempts are made to capture total landings (i.e. not samples). Issues include inadequate sampling of *Secondary* landing sites and the absence of biological data collection (length frequency at least)
8. Research conducted during 1999 – 2001: None
9. Fisheries legislation and regulations in effect during 1999 - 2001: No new legislation/regulations relating to this fishery

1. **Fishery Type:** Large pelagics - wahoo (*Acanthocybum solandri*)
2. Management Objectives: (i) Cooperate with ICCAT and members of Caribbean states. (ii) Promote the development of commercial and sport fishery.
3. Fishing vessel trends during 1990 – 2001: EAST COAST – still open pirogues but increased use of fiberglass hulls or wood coated with fiberglass. Wooden hulls of the cigarette design have also been introduced. WEST COAST – increase in the number and sizes of surface longliners.
4. Gear trends during 1990 – 2001: TROLLING - monofilament line (150 – 400lb test) with double hooks (size #22 - #24). "Depth charge" using grades 18 – 21 tying wire. Both monofilament and wire attached to silky nylon cord #9. SURFACE LONGLINERS - using monofilament droplines ranging from small (100 hooks) to large (600 hooks).
5. Introduction of new fishing technologies during 1999 – 2001: (i) VHS

communications network. (ii) Rapid increase in the use of GPS. (iii) Compulsory safety items. (iv) Modification of open pirogues (to cigarette types) for enhanced capacity, speed and fuel efficiency.
6. Trends in catches or landings during 1990 – 2001: Trends were not analysed.
7. Collection of catch and effort statistics during 1999 – 2001: Data capture points at 6 sites – data collected are weight (by species), effort (hours fished), name of boat & owner, gear used and area fished. Attempts are made to capture total landings (i.e. not sample). Issues include inadequate sampling of *Secondary* landing sites and the absence of biological data collection (length frequency at least).
8. Research conducted during 1999 – 2001: None
9. Fisheries legislation and regulations in effect during 1999 – 2001: No new legislation/regulations relating to this fishery.

1. Fishery Type: Large pelagics - blackfin tuna (*Thunnus atlanticus*)
2. Management Objectives: (i) Cooperate with ICCAT and members of Caribbean states. (ii) Promote the development of the commercial and sport fishery
3. Fishing vessel trends during 1990 – 2001: EAST COAST - still open pirogues but increased use of fiberglass hulls or wood (marine ply) coated with fiberglass. Wooden hulls of the cigarette design have also been introduced. WEST COAST – increase in the number and sizes of surface longliners.
4. Gear trends during 1990 – 2001: TROLLING – monofilament line (150lb – 400lb test) with double hooks (size #22 - # 24). “Depth charge” using grade 18 – 21 tying wire. Both monofilament and wire are attached to silky nylon cord #9. Bait mostly artificial lures (squid or “scuchi”) or fresh round or big eye scad. SURFACE LONGLINERS using monofilament droplines from small (100 hooks) to large (>400 hooks). Bait fresh flying fish (bait of choice) or fresh round or bigeye scads.
5. Introduction of new fishing technologies during 1999 – 2001: (i) VHS communication network. (ii) Rapid increase in the use of GPS. (iii) Compulsory safety items. (iv) Modification of open pirogues (to cigarette type) for enhanced capacity (i.e. load carrying), speed and fuel efficiency.
6. Trends in catches or landings during 1990 – 2001: Trends were not analysed.
7. Collection of Catch & Effort statistics during 1999 – 2001: Data capture points at 6 sites - data collected are weight (by species), effort (hours fished), name of boat & owner, gear used and area fished. Attempts are made to capture total landings (i.e. not sample). Issues include inadequate samplings of *Secondary* landing sites and the absence of biological data collection (length frequency at least)
8. Research conducted during 1999 – 2001: None.
9. Fisheries legislation and regulations in effect during 1999 – 2001: No new legislation/regulations relating to this fishery.

National Report of Guyana

Submitted by I. Peters

Introduction

Guyana is on the northern coast of South America and is the only English speaking country on the South American continent. It has 83,000 sq miles (215,000 sq km) and is bordered by the Atlantic Ocean on the north, Brazil on the South, Venezuela on the west and Suriname on the east (Figure 1). Geographically, Guyana is a part of South America, but it is culturally and socially more affiliated to the Caribbean and it is an integral member of Caricom. Guyana has a population of approximately 750, 000 which represents one of the lowest population densities in the world. Most of the population lives on the coastal plain.

The country is divided physically into four regions: the Low Coastal Plain, the Hilly Sand and Clay Area, the Highland region and the Interior Savannahs. Administratively, the country is divided into ten regions (figure1). Marine fishing occurs in six of those regions, namely 1 to 6, with all of the industrial vessels having their operational base in region 4, and regions 4 and 6 having the largest number of artisanal vessels. Guyana has a 200-mile EEZ and territorial sea, with a sea limit of twelve miles from the shore.

The fishery sector is guided by Fisheries Act (1956) and Regulations (1957), which are primarily concerned with inland fisheries and fisheries within the 12 mile territorial sea of Guyana. It is also governed by the Maritime Boundaries Act (1977), which established the 200-mile EEZ. New fisheries legislation has been drafted for the fisheries of Guyana, and will soon be put into force.

The living resources being exploited within the EEZ are mainly the demersal resources and to a limited extent the pelagic fish resources over the continental shelf and the continental slope.

Fisheries and the national economy

The fishery sector is of critical importance to the economy and to the social well being in Guyana. The importance of the fisheries is evident in the five key areas set out below:

i) Fish is the major source of animal protein, with the capita consumption in 2001 being 60 kg.
ii) The Guyana Bureau of Statistics estimates that the primary sector of the fisheries contributed G$7.240 billion to the Gross Domestic Product (GDP).
iii) The total value of fish products in 2001 was G$18.6 billion of which domestically marketed finfish accounted for G$7.780 billion. Export earnings in 2001 were approximately G$10.8 billion.
iv) The fishing industry employs over 11,000 persons in harvest, post harvest and other related areas.
v) The fishery sector is a significant net contributor to the government revenues in Guyana, through licence fees and consumption taxes on imported fuel for boats.

Description of the fisheries

The Marine Fishery of Guyana is made up of an Offshore Industrial Trawl Fishery and an Inshore Artisanal Fishery.

The offshore fishery consists of 127 trawlers (Prawns 46 and Seabob 81).
The foreign trawlers mainly exploit prawns (Penaeus species) with fin-fish as by-catch while locally owned trawlers primarily exploit a smaller shrimp called seabob and fin-fish. These trawlers measure about 34 metres in depth over the seabed of mud, gravel or sand. Turtle Excluder Devices (TED's) are mandatory for the entire shrimp trawl fleet.

The Inshore Artisanal Fishery is made up of an estimated 1331 boats ranging in size from 6-18 metre and powered by sails, outboard, or inboard engines. All boats are made from wood and are manufactured locally. The fishing gear use include pin seines, Chinese seine/fyke nets, cadell lines, drift nets, gillnets, circle seine and handlines/snapper lines. The Inshore Artisanal Fishery is mainly demersal. The species caught include seabob and whitebelly shrimp, gillbacker, bangamary, sea trout, grey snapper, shark and red snapper. See Table 1 for the artisanal fishing fleet in Guyana.
The Marine Fishery is a demersal one, with pelagic species occurring as incidental catch in such gear as the gillnet, cadell and hooks and lines. The species on the ICCAT List that are being caught include *Scomberomous brasiliensis, Scomberomous cavalla,* Sharks and *Lutjanus purpureus*.

Management goals and objectives of the fisheries

The major goals and objectives for fisheries management are:

(i) The achievement of nutritional self-sufficiency and food security.
(ii) The maintenance in good working order and the optimal utilisation of assets related to production.
(iii) The generation of increased employment and incomes in the sub-sector.
(iv) The increase in net foreign exchange earnings.
(v) The promotion of the image of fishing as an occupation that is socially desirable and financially rewarding.
(vii) The incorporation into the national consciousness of an awareness of the need to apply appropriate technology to the fisheries production process.

Data collection programme

Data Collection Programme for the Inshore Artisanal and Offshore Industrial Fisheries

In 1998, Guyana, with assistance from CFRAMP, undertook a review of the data collection programmes in the Offshore Industrial and Inshore Artisanal Fisheries (Mahon 1998).
Based on the review and on the human and other resources available to the Fisheries Department, a random stratified sampling programme was devised for both Fisheries. Stratification was done by vessel/gear type. The landings, employment and value of the catch were important factors that led to this type of stratification. This determined the number of vessels to be sampled per month per gear type. For each region, the sites were divided into three categories namely: primary, secondary, and tertiary.

Method of sampling

At the beginning of each month, sampling schedules are prepared in the three regions for data collection. A total of 82 vessels are to be sampled for data. These vessels are

randomly selected from landing sites in the region. They include 20 chinese seine, 17 gillnet nylon. 4 caddel, 15 gillnet (outboard), 6 gillnet (inboard), 4 pinseine, 3 handlines and 2 traps for the artisanal fishery and 6 seabob and 5 prawns for the industrial fishery.
The vessels sampled in Region four are all industrial vessels and forty-two artisanal. In Regions six and two the number of vessels sampled are 14 and 13 respectively.
Sampling sites within each strata are chosen randomly. Sampling is done on three days per week, with at least two trips being scheduled per day. The number of vessels targeted per trip would depend on the landing site being targeted, the number of data collectors and the number of vessels at the site. Catch, effort and biological data are collected from the vessels selected randomly at the landing sites.

Estimation of Landings
For each Month, Landing Site, Vessel / Gear type: Estimated landings = Average CPUE x Expected Effort, Where: CPUE is the average catch per day for the month, vessel / gear type (for the entire country, or for Chinese seines, per fishing area); and where, Expected Effort is the number of boats per landing site x the potential number of fishing activity for the region (i.e. the proportion of those days on which fishers actually fished).

The approach to sampling length frequencies of the selected species is based on monthly target numbers of fish to be measured from the artisanal landings and from the industrial landings. The monthly targets are:

Pelagic 150 – 200 species per month

Demersal 150 – 200 species per month per fishing ground

In terms of quality control in the data management process, the supervisor normally reviews the data forms before they are handed over to the Data Input Clerk for inputting into the TIP programme. It should be noted that the TIP programme has not functioning for some time, but this problem was recently sorted with assistance from Ms. Cheryl Jardine, Data Manager, DOF-SVG.

During 2000 to 2001, the data collection programme was affected by the following constraints:

- Lack of transportation;
- Inadequate number of data supervisors and data collectors;

- Political tension in the country;

- Problems in species identification which led to some length frequency data being discarded; and
- Insufficient field equipment.

It is important to note that in 2002 there has been improvement with data collection as some of the constraints have been addressed.

In addition to the sampling programme for the Marine Fishery, a logbook programme and an observer programme are being implemented in the Offshore Industrial Fishery. And Logbook Programme.
Save for the collection of prices on fish at the landing sites and municipal markets, no other economic data is being collected at present.
Some of the data and information gathered from the data collection programmes are set out in the Tables 1 to 4 below.

References

Charles, R., Hackett, A., Maison, D., and Francis, S., - Shrimp and Groundfish Sub-specification Workshop Country Proposal – Data Acquisition and Monitoring System
Chakalall, B., and Drogovich, 1979. Artisanal Fishery of Guyana.
Guyana Fisheries Department, 1999 & 2000 Annual Report
Phillips, T., Aiken, K., and Mahon, R., Draft Marine Fishery Management Plan of Guyana.

Figure 1. Map of Guyana

Table 1. Characteristics of the artisanal fishing fleet of Guyana

Name of Vessels		**Method of Propulsions**	**Length of Vessels (m/ft)**	**Gear Type**	**Trip Length**	**Catch Compositions**	**Crew Size**	**Preservation method**	**Est. Annual Landings (1997) (MT)**	**Principal Fishing Area**
Frame Survey	**1997 Vessel Count Exercise**									
	35	Inboard Diesel	14/45	Hand liners, Fish Pots	12-24 days	Snapper, Grouper	8	Ice	700	Edge of continental shelf, rocky areas (areas between 10 and 20 fathoms
558	63	Inboard Diesel, Lister, Perkins 210 hp	12-15/40-50	Gillnet Polyethylene (inboard)	10-12 days	Grey snapper, sea-trout, gill backer, tarpon, Spanish-mackerel, croaker, snook, shark spp.	4-6	Ice	2175	Area between 10 and 20 fathoms.
	308	Outboard Engine 48 hp	8-11/35	Gillnet Polyethylene (cabin cruiser)	6 days	Grey snapper, sea trout, pagee, tarpon, croaker, gill backer, Spanish mackerel	4-6	Ice		Area between 10 and 20 fathoms
	441	Outboard Engine 25 hp	30 m	Gillnet Nylon	1 day	Banga mary, sea-trout, butterfish	4	Ice	14,707.13	Area between 10 and 15 fathoms.
	373	Sail, Outboard Engine 6 – 9 hp	6.40-12.19 m (21-40ft.)	Chinese Seine	6-12h	Whitebelly, seabob, immature fish, bangamary, butterfish, catfish.	2-4	Fresh	Finfish 2379.25 Seabob 575.5 Whitebelly 1717.13	Estuaries, river mouths and banks on the coast.
79	80	Outboard Engine 6 – 9 hp	6-9/15-30	Cadell	12h	Catfishes, sharks spp.	2-4	Fresh	2175.28	Areas between 5 and 10 fathoms
46	35	Sail, Outboard Engine	6-9/15-30	Pin Seine	12h	Mullet, snook, queriman, catfish, croaker, bangamary	2	Fresh	206.2	Intertidal zones.

Fisheries Census 1997

Table 2. Fishing vessels by gear type for 1997 and 2001

Gears	Vessels/1997	Vessel/2001
Caddell	61	80
Gillnet nylon	338	441
Gillnet (outboard)	236	308
Gillnet (inboard)	49	63
Red Snapper	7	46

Table 3. Landings (mt) by Species 1995 – 2001.

Species	1995	1996	1997	1998	1999	2000	2001
Scomberomorus brasiliensis	-	2011	572	625	1143	263	132
Scomberomorus cavalla	-	-	270	440	398	177	182
Lutjanus purpureus	Nil	163.2	Nil	351.0	273.0	510.0	524.0
Sharks	824	691	2194	2562	2175	903	666

Table 4. Length frequency achievements for species by gear type for 2001

Species	CAD	GNN	GNP cc	GNP inb	H/L	TRAPS	TOTAL
Blacktip Shark	-	-	-	-	-	-	**-**
Sharpnose Shark	-	-	-	-	-	-	**-**
Vermillion Snapper	-	-	-	-	246	79	**325**
Sth Red Snapper	-	-	-	-	399	835	**1234**
Lane Snapper	-	-	-	-	-	23	**23**
Spanish Mackerel	2	1	243	-	-	-	**246**
Kingfish	-	-	32	41	8	-	**81**
Total	**2**	**1**	**275**	**41**	**653**	**937**	**1,909**

National Report of Montserrat

Submitted by M. O'Garro

1. **Fishery Type:** Coastal Pelagics and Reef Fish

2. **Management objectives:**

   - To ensure the sustainable management of fish stocks
   - To improve skills in the fishing industry
   - To enhance marketing, hygiene and quality of fish

3. **Fishing vessel trends during 1990-2001:**

Open boats with outboard engines. No real change in type of boats used. However, boats have gotten larger with more engine power (approximate size 17ft – 28ft).

4. **Gear trends during 1990-2001:**

   No change in gear. Pots, Trammel nets and Beach Seine are used.

5. **Introduction of new fishing technologies (give description and dates) during 1999-2001:**
   - 2001 – training exercise carried out on improved pot building using biodegradable traps and longer lasting wire

6. **Trends in catches or landings during 1990-2001:**

   - Catch sizes decreased
   - Fish size decrease
   - Slight increase in the amounts of Gar caught as compared to other pelagics

7. **Collection of catch and effort statistics during 1999-2001 (indicate sampling coverage for each year, important landing sites, and current sampling issues):**

   - 1999 - 44,450lbs
   - 2000 - 52,107 lbs
   - 2001 – 68,104 lbs

   Sampling is complete as there is only one important landing site.

8. **Research conducted during 1999-2001:** None

9. **Fisheries legislation and regulations in effect during 1999-2001:**

   - Fisheries regulation in the process of development
   - National Fisheries Legislation 2001 in effect

1. Fishery Type: Deep Slope
2. Management objectives: ▪ To ensure the sustainable management of fish stocks ▪ To improve skills in the fishing industry ▪ To enhance the marketing, hygiene and quality of fish
3. Fishing vessel trends during 1990-2001: Open boats with outboard engines. No real change in type of boats used. However, boats have gotten larger with more engine power (approximate size 17ft – 28ft).
4. Gear trends during 1990-2001: ▪ Less pots are used ▪ No real change between 1990-2001 ▪ Rod and reel, hand line, trammel net and beach seine
5. Introduction of new fishing technologies (give description and dates) during 1999-2001: Refresher Long line training exercise carried out in 1999
6. Trends in catches or landings during 1990-2001: ▪ *Catch sizes decreased* ▪ *Fish sizes decreased* ▪ *Decreasing quantity of catch*
7. Collection of catch and effort statistics during 1999-2001 (indicate sampling coverage for each year, important landing sites, and current sampling issues): ▪ 1999 – 2,518 lbs ▪ 2000 - 1,416 lbs ▪ 2001 – 1,427 lbs Sampling is complete as there is only one important landing site.
8. Research conducted during 1999-2001: None
9. Fisheries legislation and regulations in effect during 1999-2001: ▪ Fisheries regulation in the process of development ▪ National Fisheries Legislation 2001 in effect

1. **Fishery Type:** Ocean Pelagics
2. Management objectives: ▪ To ensure the sustainable management of fish stock ▪ To improve skills in the fishing industry ▪ To enhance the marketing, hygiene and quality of fish
3. Fishing vessel trends during 1990-2001: Open boats and outboard engines. No real, change in boats. However, boats have gotten larger and more engine powered (approximate size 17ft – 28ft).
4. **Gear trends during 1990-2001:** Rod and reel. One or two hooks.
5. **Introduction of new fishing technologies (give description and dates) during 1999-2001:** Use of technology such as: ▪ Depth Sounder ▪ Lures (artificial squids) ▪ Ice for longer days
6. **Trends in catches or landings during 1990-2001:** ▪ Declining catch ▪ More Black fin and Bonito than Wahoo or Yellow Fin ▪ More fish in winter season than summer
7. **Collection of catch and effort statistics during 1999-2001 (indicate sampling coverage for each year, important landing sites, and current sampling issues):** ▪ 1999 – 390 lbs ▪ 2000 - 208 lbs ▪ 2001 – 108 lbs Sampling is complete as there is only one important landing site.
8. **Research conducted during 1999-2001:** None
9. **Fisheries legislation and regulations in effect during 1999-2001:** ▪ Fisheries Regulation in the process of development ▪ National Fisheries Legislation 2001 in effect

National Report of Nevis

Submitted by L. Pemberton

1. **Fishery Type:** Small Coastal Pelagic
2. **Management objectives:** ▪ Promote development of the fishery ▪ Maintain fish habitat ▪ Discourage additional beach seining and gill netting
3. **Fishing vessel trends during 1990-2001:** Unchanged; four vessels in net and beach seine fishery - open transat vessels.
4. **Gear trends during 1990-2001:** Beach Seine Net, Ballahoo Net, Gill Net
5. **Introduction of new fishing technologies (give description and dates) during 1999-2001:** No new fishing technology
6. **Trends in catches or landings during 1990-2001:** Yearly increase in landings over the period 1995 – 2002
7. **Collection of catch and effort statistics during 1999-2001 (indicate sampling coverage for each year, important landing sites, and current sampling issues):** No sampling was done so no effort data was collected
8. **Research conducted during 1999-2001:** No research was conducted
9. **Fisheries legislation and regulations in effect during 1999-2001:** ▪ The Fisheries Act of 1984 ▪ The Fisheries Regulation of 1995

1. **Fishery Type:** Reef and Slope

2. **Management objectives:**

- Promote stock recovery
- Maximize catches within the limits of the potential yield for slope fisheries

3. **Fishing vessel trends during 1990-2001:**

Open dories and pirogues 15 – 30 ft, An increase in the number of imported fiberglass boats

4. **Gear trends during 1990-2001:**

Fish pots, Scuba Gear, Pot Haulers, GPS

5. **Introduction of new fishing technologies (give description and dates) during 1999-2001:**

No new fishing technology

6. **Trends in catches or landings during 1990-2001:**

Yearly increase in landings over the period 1995 – 2002

7. **Collection of catch and effort statistics during 1999-2001 (indicate sampling coverage for each year, important landing sites, and current sampling issues):**

No sampling was done so no effort data was collected

8. **Research conducted during 1999-2001:**

Research on sea urchin by student of UWI. Results have not been submitted to the department.

9. **Fisheries legislation and regulations in effect during 1999-2001:**

- The Fisheries Act of 1984
- The Fisheries Regulation of 1995

1. **Fishery Type:** Large Pelagic
2. **Management objectives:** ▪ Cooperate with members of ICCAT particularly Caribbean states to access, protect and conserve the large pelagic resources ▪ Maintain and restore populations of marine species at levels that can produce the maximum sustainable yield ▪ Use of selective fishing gear to reduce by-catch
3. **Fishing vessel trends during 1990-2001:** Pirogues, Launches, Dories, Fiberglass Sport Fishing Vessels
4. **Gear trends during 1990-2001:** Hook and Line, Rod and Reel, FADS, GPS, Compass, Fish Finders, Depth Recorders
5. **Introduction of new fishing technologies (give description and dates) during 1999-2001:** Surface long lining
6. **Trends in catches or landings during 1990-2001:** Yearly increase in landings over the period 1995 – 2002
7. **Collection of catch and effort statistics during 1999-2001 (indicate sampling coverage for each year, important landing sites, and current sampling issues):** No sampling was done so no effort data was collected
8. **Research conducted during 1999-2001:** No research was conducted
9. **Fisheries legislation and regulations in effect during 1999-2001:** ▪ The Fisheries Act of 1984 ▪ The Fisheries Regulation of 1995

National Report of St. Lucia

Submitted by W. Joseph

Policy Statement

In the national interest, the Government of St Lucia recognizes the need to have an integrated policy relating to the marine space over which St Lucia exercises sovereign rights. In this regard, there is the binding obligatory policy to develop the marine resources present within the Exclusive Economic Zone (EEZ). This policy is pursued with consideration for the development of shipping or marine transportation, tourism and recreational aspects within the coastal waters, along with a sound program for coastal zone management and development. However, due consideration must be given to the traditional users (fishers) and their right to compensation for loss of traditional fishing areas.

Government enunciates that there is no free access to living resources. Foreign and local fishing licenses along with fisheries regulations and permit systems for spearfishing, scuba diving, snorkeling and marine research have been instituted.

Overall objectives of the fisheries sector

- To develop the fishing industry in terms of modernization of fisheries infrastructure and fishing vessels and use of improved fishing gear and methods.
- To promote self-sufficiency through increased production from capture fisheries and the aquaculture sector.
- To advance the social and economic welfare of fishermen and their families.
- To improve the nutrition of the nation through the provision of increased volumes of fish protein.

However, a number of constraints have arisen from attempts to accommodate the myriad of uses in the marine space:

The extent of the Exclusive Economic Zone of St Lucia is limited by the close proximity of St Vincent in the south, Martinique in the north, Barbados to the east and the Venezuelan territory to the west. This in turn limits the resources available to national users. Further, illegal fishing and the lack of adequate monitoring and surveillance capacity need to be addressed.

With the rapid development of the tourism industry, use of the marine space has expanded to include activities such as yachting, SCUBA diving, snorkeling, jet skiing, sunfish sailing and sportfishing. Thus, traditional users (artisanal fishermen and recreating locals) now compete for use of this limited marine space, a situation that has often resulted in conflict among users.

The construction of nearshore structures such as jetties and groynes has changed the natural dynamics of beaches and hampered traditional fishing activities. The problems that have resulted are erosion of beaches and displacement fishers, respectively.

Both land- and water-based activities continue to contribute to degradation of the marine environment. With regard to land-based activities, improper land use management within watershed and coastal areas has resulted in high levels of sediment being introduced into the marine environment. Poor management of solid and liquid wastes has also led to pollution of the marine area.

Objectives of National Fisheries Management and Development

- 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.

National Data Collection System

<u>Present catch and effort data systems for all fisheries</u>

The island fishery operates out of 22 landing sites, which are categorized as primary, secondary and tertiary based on the number of vessel operating out of the site and the level of fishing activity. However catch and effort data are only collected at eight landings sites based on a random stratified system (Table 1). The sites presently sampled include: Gros Islet, Castries, Soufriere, Laborie, Choiseul, Vieux Fort, Micoud, and Dennery.

<u>Sampling schedule</u>

At each of the primary sites being sampled, catch and effort data are collected for every other returning vessel fifteen days (randomly selected) monthly. Information such as area fished, species caught, gear used, hours fished, total vessels out, etc. are recorded and submitted monthly to the Data Section of the Department of Fisheries. The island's coastal waters are divided into two zones or fishing areas for pelagics and offshore pelagics, A and B and three zones for nearshore and bank species C, D and E. The Department personnel monitor data collectors regularly.

<u>Limitation and strengths of sampling plan</u>

Generally, the Department of Fisheries is satisfied with the current sampling system in term of the quantity, quality and regularity of the data collected. However, the limitations that have been recognized include: random days selected at not always adhered to by the collectors; the current system of estimating annual landing for sites not sampled needs to be regularly updated to include changes in the fishery and the number of vessels at these sites; collection of data for certain fisheries needs enhancing.

Vessels

Fishing in St. Lucia is still artisanal and multi-species in nature. Most vessels target all species, except for specialised fisheries such as conch and coastal pelagics. There has been a steady increase in the number of vessels registered with the Department as seen in Fig.1 since the implementation of the programme for registration of vessels.

References

Department of Fisheries, 2000 Fisheries Management Plan
Department of Fisheries, 1998 Report of buy back scheme of fillet nets in Soufriere.
Department of Fisheries, 2001 Annual statistics reports.

Table 1 Fish landing sites category 2002

Site	Category	Site	Category
Anse la Raye	T	Marigot	T
Banannes	T	Marisule	T
Canaries	T	Micoud	S/S
Castries	P/S	Monchy	T
Choiseul	P/S	Praslin	T
Cul De Sac	T	River Doree	T
Dennery	P/S	Roseau	T
Gros Islet	P/S	Savannes Bay	S
Laborie	P/S	Soufriere	P/S
		Vieux Fort	P/S

P = primary S = secondary T = tertiary /S = sites currently being sampled.

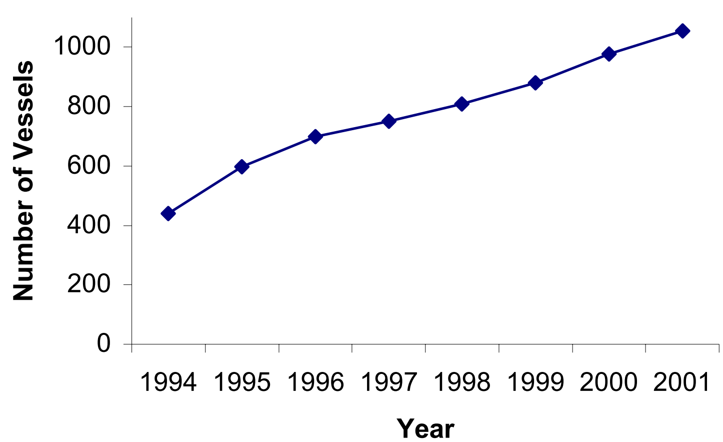


Figure 1. Number of fishing vessels during 1994-2001.

1. Fishery Type: Large Pelagic Fisheries

2. Management objectives: as articulated in the Fisheries Resources Management Plan

- Promote the sustainable development of the commercial and sport fisheries for large pelagic species.
  Cooperate with other Caribbean States to manage the large pelagic resources;
- Manage traditional cetacean fishery on a sustainable basis.

3. Fishing vessel trends during 1994-2001: Registration of fishing vessels commenced in the later half of 1993. See section 4 above.

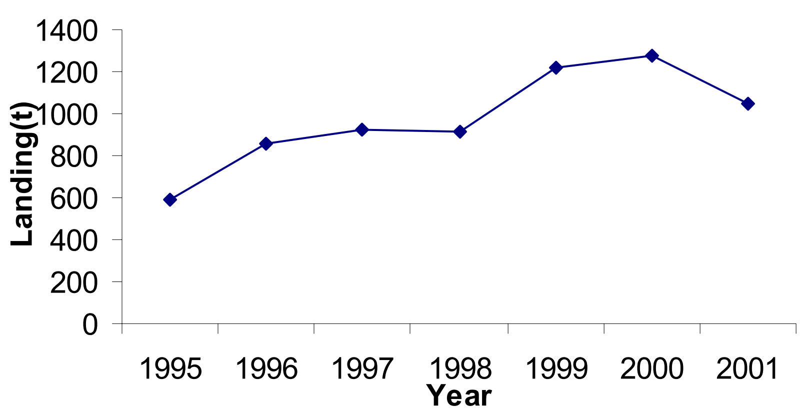
4. Gear trends during 1990-2001:

During this period of review, tuna long line technology was introduced and modified such that long line comprised mainly monofilament lines. This gear is used to target mainly the larger tuna species.

In addition, several fish aggregation devices (FADs) were introduced at various locations around the island.

5. Introduction of new fishing technologies (give description and dates) during 1999-2001: see above

6. Trends in catches or landings during 1995-2001:



Although only a short time series is available, there appears to be an overall increase in the landings of large offshore pelagics. During the period under review, slight declines in landings were observed in 1999 and 2001.

Landings in 2000 increased twofold over 1995's landings. This increase could possibly be attributed to the increase in the number of vessels entering the fisheries sector.

Dolphinfish and Tuna species make up on average more than 70 % of the landings of offshore pelagic species annually.

7. Collection of catch and effort statistics during 1999-2001 (indicate sampling coverage for each year, important landing sites, and current sampling issues):

Data collection continued as for previous years: See section 3 for description of the

National fisheries data collection system.
Landing sites with high catches of pelagic species are Vieux Fort, Dennery, and Micoud.
Recording catches from FADs proves to be challenging.

8. Research conducted during 1999-2001:
During the training of fishers in longlining technology, attempts to collect data on the various offshore pelagic species in the catch were made but due to human resource constraints collection of data was discontinued.

9. Fisheries legislation and regulations in effect during 1999-2001:
Fisheries Act No. 10 of 1984 and Fisheries Regulations No. 9 of 1994

1. Fishery Type: Reef and Slope Fisheries

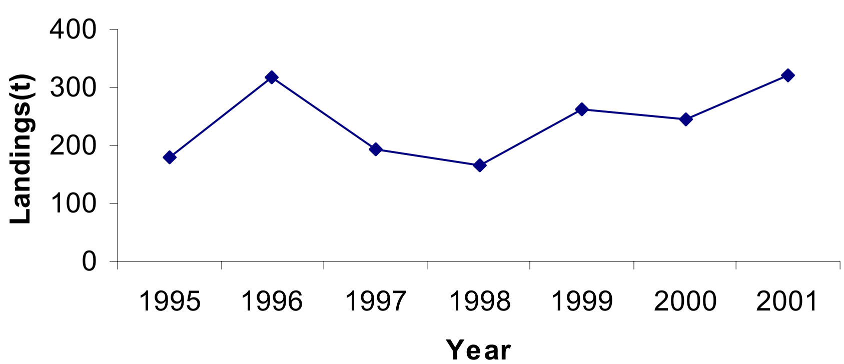
2. Management objectives: articulated in the Fisheries Resource Management Plan
- Promote stock recovery.
- Ensure sustainable resource use
- Exploit at Optimal Sustainable Yield.
- Restrict access.

3. Fishing vessel trends during 1990-2001: Registration of fishing vessels commenced in the later half of 1993. See section 4 above.

4. Gear trends during 1990-2001: Increasing use of the number of pots and gill nets however, the extent of the increase is not reliably known. Various gears are also used such as nets, palange and hand lines.

5. Introduction of new fishing technologies (give description and dates) during 1999-2001:
Information is not available

6. Trends in catches or landings during 1995-2001:



During the period under consideration, there appears to be an overall increase in the landings of large reef and bank species, however annual fluctuations in landings were noted.
Landings of reef and bank species peaked in 1996 and 2001 to almost twice 1995's landings. This increase could also possibly be attributed to the increase in the number of pots used in the fishery. Hundreds of species are landed in this category however, queen snapper contributes significantly to this category as a single species.

7. Collection of catch and effort statistics during 1999-2001 (indicate sampling coverage for each year, important landing sites, and current sampling issues):
Data collection continued as for previous years: See section 3 for description of the National fisheries data collection system.

8. Research conducted during 1999-2001: None

9. Fisheries legislation and regulations in effect during 1999-2001:
Fisheries Act No. 10 of 1984 and Fisheries Regulation No. 9 of 1994

1. Fishery Type: Small Coastal Pelagic Fisheries

2. Management objectives: as articulated in fisheries resource management plan

- Exploit at maximum sustainable yield.
- Minimize land-based sources of marine pollution
- Support appropriate TURFs

3. Fishing vessel trends during 1995-2001:
Registration of fishing vessels commenced in the later half of 1993.
See section 4 above.

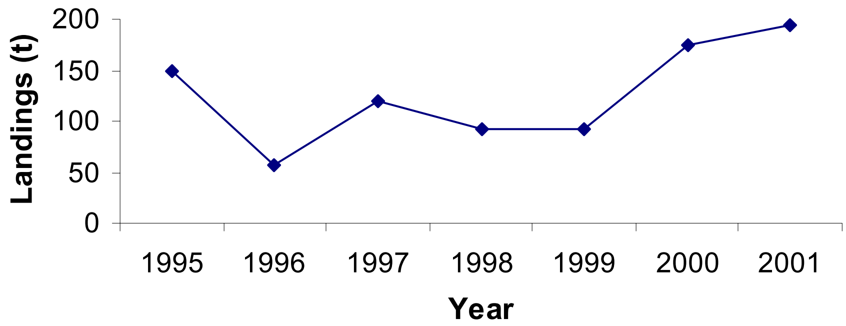
4. Gear trends during 1995-2001: 36 beach seines and 40 fillet ballyhoo in 200,2 distributed as in Table 1(Ferrari, 2002)

Community	Number of Beach Seine	Number of Fillet Ballyhoo
Gros Islet	4	2
Anse la Raye	15	8
Canaries	0	9
Soufriere	9	17
Choiseul	5	2
Vieux Fort	3	2
Micoud	0	1

Gear remains the same during the period, however due to the seasonality of resources and increase use of the near shore areas by activities other than fishing, fishers are modifying the traditional beach seines so that it is not necessary for such gears to be pulled up onto the beaches. Also, the TURFs system respected in communities is being challenged by new/young entrants into the fishery.
Further modification of gillnets to function as seines has also been observed. In 1998, nineteen (19) bottom gill nets were removed from the fishery and all were from the community of Soufriere.
The number of such gears actively involved in the fishery on an annual basis is not reliably known.

5. Introduction of new fishing technologies (give description and dates) during 1999-2001:
None

6. Trends in catches or landings during 1995-2001:



A steady decline in landings was noted for four years with a sharp increase in landings for the latter two years of the period of review. The decline in 1998 and 1999 can be attributed to the removal of several fillets from the fishery during the established of the SMMA.

The majority of the landings are made up of species from the families Carangidae and Hemiramphidae.

7. Collection of catch and effort statistics during 1999-2001 (indicate sampling coverage for each year, important landing sites, and current sampling issues):

Data collection continued as for previous years: See section 3 for description of the national fisheries data collection system.

Landing sites with high catches of coastal pelagic species are in the northern and western areas.

Due to the nature of the fishery and the market structure, it is believed that a significant portion of the landings for pelagic species is being missed.

Two significant areas for coastal pelagic landings are currently not including in the DOF sampling plan.

8. Research conducted during 1999-2001: None

9. Fisheries legislation and regulations in effect during 1999-2001:

Fisheries Act No. 10 of 1984 and Fisheries Regulation No. 9 of 1994

PART III:

INVITED TECHNICAL CONTRIBUTIONS

A Preliminary Marine Ecosystem Model for the EEZ of a Small Island State: A Case Study for Grenada and the Grenadines.

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Abstract

This paper describes the construction, parameterisation and balancing of a preliminary marine ecosystem model for the southeastern Caribbean using the Ecopath with Ecosim software. It integrates available ecological and biological information for the region, and fisheries related information specific to Grenada and the Grenadines. The main objectives are to better understand the structure and functions of components of the ecosystem, to examine the impacts of fishing on the living marine resources and to explore fisheries management policy options. Hypothetical policy exploration scenarios are investigated and data limitations and suggestions for further refinement of the model are highlighted.

Introduction

The collapse of many fisheries world-wide has prompted scientists to re-examine the methodologies used for assessing and managing fish stocks. Failure to accurately predict stock responses to increasing fishing pressure is often attributed to the single-species approach to assessment. This traditional approach examines individual species in isolation from the surrounding environment. Important inter-specific interactions (e.g. competition and predation), environmental impacts on fisheries resources and the impacts of fisheries on the ecosystem, are not considered. Traditional single-species assessments however, provide essential biological (e.g. growth, mortality, recruitment) and fishery related (fishing mortality, gear selection) inputs to models designed to incorporate the multi-species nature of the fisheries and resources. Their importance remains undisputed. However, a framework is required for integrating these estimates and examining their biological and ecological compatibility, and the overall fishing impacts on both target (well studied) and non-target species. This has contributed to the concept of ecosystem-based fisheries management. The concept is implicit in several international conventions and agreements. These include the 1982 United Nations Convention on the Law of the Sea (United Nations, 1983), the 1992 Convention on Biological Diversity (UNEP, 1992), the 1995 United Nations Fish Stock Agreement (United Nations, 1995), the FAO Code of Conduct for Responsible Fisheries (FAO, 1995) and more recently the 2001 Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem (Nuengsigkapian, 2002).

Through the CARICOM Fisheries Resource Assessment and Management Program (CFRAMP), traditional assessment of selected species is being conducted (CFRAMP, 2001). The construction of a preliminary ecosystem model for the region would incorporate existing biological and ecological information, including the outputs from CFRAMP assessments and would facilitate consideration of the ecosystem effects of fishing, consistent with the international initiatives mentioned previously.

Methodology

The marine ecosystem model is constructed using Ecopath with Ecosim (Christensen *et. al.*, 2000). The software allows for construction, parameterisation and analysis of mass-balance trophic models (Christensen *et al*., 2000). Based on an initial method by Polovina (1984) for estimating biomass of species groups, theoretical approaches in ecology which analyse the flows within the system (Ulanowicz, 1986) are also incorporated (Christensen *et al*., 2000). The software presently comprises three components: a static mass-balance snap-shot of the system (Ecopath); a time dynamic simulation module for policy exploration (Ecosim); and a spatial and temporal dynamic module for exploring optimum placement and relative size of protected areas on the resources within the ecosystem (Ecospace). These components are discussed at length in Christensen *et al*. (2000). In this paper, only the use of Ecopath and Ecosim are explored.

Ecopath operates on the basis of two master equations. The first describes the utilization of production of each group in the system and the second describes the utilization of consumption within individual groups (Appendix 1). An imbalance in the first equation is reflected in estimates of ecotrophic efficiency which exceed one. The mass and energy of functional groups within the system are balanced by varying any one of the input parameters (Appendix 1) in an iterative procedure, beginning with those of highest uncertainty. Estimates so derived are checked for biological and ecological consistency. Network statistics for the balanced model indicate the available resources, energetic flows, biomass and utilization of production within the system. With some modification (Christensen *et al*., 2000) the model can then be used to explore the ecosystem impacts of fishing and ecosystem-based fisheries management policy exploration using Ecosim and Ecospace.

Study Area and Functional Groups

The ecosystem model incorporates the EEZ (Global Maritime Boundaries Database: Veridian MRJ Technology Solution, 2000); reef (Bacon et al., 1984), and the shelf areas (Mahon, 1993) of Grenada and the Grenadines. The total study area is 25 957 km^2. Since 1999 catch data was available at the highest level of species disaggregation, this year was selected as the ‘base year’ for the model.

All marine mammals, fish and invertebrate species occurring in the area were aggregated into 51 functional groups (Table 3) based on similarities in diet, habitat and level of activity. A species listing of marine mammals was obtained from a database developed at the International Centre for Living Aquatic Resource Management (ICLARM) and improved upon at the UBC Fisheries Centre. Listings of fish species for the Caribbean Large Marine Ecosystem available in FishBase (Froese and Pauly, 2002) and invertebrate species in the reef areas of the United States Virgin Islands (Opitz, 1996) were used. Seagrasses, symbiotic algae, phytoplankton and detritus were explicitly represented. So too were exploited species (Table 3). Functional groups were assigned to the respective habitat areas based on their distributions.

Model parameterisation and data sources

The main input parameters for Ecopath with Ecosim and Ecospace are: biomass; production/biomass ratio; consumption/biomass ratio and diet composition for the respective functional groups in the system, as well as landings and discards for the designated fleet types. Parameterisation of the model is described below.

Biomass

Biomass of marine mammals was estimated using population numbers, from the database mentioned previously, for the Caribbean Province after Longhurst *et al*. (1995), assuming equitable distribution, and mean individual weight after Trites and Pauly (1998). Biomass of yellowfin tuna, albacore, bluefin tuna, bigeye tuna and skipjack tuna were calculated using estimates of maximum sustainable yield from stock assessments of the International Commission for the Conservation of Atlantic Tunas (summarized in Singh-Renton and Neilson, 1994). Equitable distribution throughout the respective species ranges was assumed and only 25% of production was estimated to go to catches (Christensen, 1996). Biomass of mackerels, dolphinfish, and flyingfish were estimated using the formula: Biomass = Catch/Fishing Mortality. Catch data were provided by the Grenada Fisheries Department and fishing mortality taken from the sources listed below. Biomass estimates for sharks, croakers and cephalopods were taken from Saetersdal et al. (1999) and the NanSis Database. This database includes abundance estimates of specific marine species from a 1988 survey off the northeastern South America. Estimates specific to the north coast of Trinidad were used because of similarities in the fisheries and ecological conditions off this coast with other islands of the southeastern Caribbean. Biomass of reef jacks, groupers, snappers, squirrelfish, triggerfish and parrotfish were estimated from data in Corless *et al*. (1997) specific to non-reserve reef areas in St Lucia. Biomass of demersal carnivores and omnivores were estimated using information in Manickchand-Heileman (1994) for north Trinidad, based on the 1988 survey mentioned previously. An equivalent biomass for queen conch in the artisanal fishing zone off the Pedro Bank, Jamaica (Appeldoorn, 1995) was assumed. Echinoderm and seagrass biomass estimated off Barbados (CARICOMP, 2001) were used. Phytoplankton biomass was estimated using primary production rate off Grenada in 1999 (methodology after Behrenfeld and Falkowski, 1997) and the associated estimate of production/biomass ratio from Opitz (1996). Detrital biomass was estimated using the equation after Pauly *et al* (1993) with input estimates of primary production mentioned previously and euphotic depth from Rajendra *et al* (1991).

Production/Biomass Ratio

The production/biomass ratio of marine mammals was taken from Trites and Heise (1996). To estimate the production/biomass ratio (P/B) of billfishes and pelagic sharks the relationship between this parameter, production/consumption (P/Q) and consumption/biomass was used (P/B = P/Q x Q/B). The same production/consumption ratio for the respective species in the central Pacific (Kitchell *et al*., 1999) was assumed and the consumption/biomass ratios estimated below. Total mortality of yellowfin tuna, skipjack tuna and blackfin tuna were estimated using an equation after Beverton and Holt (1957). This uses the growth parameters (K, L_∞), mean length in the population (assumed same as mean length in the catch) and mean length at capture (tentative estimates provided by CFRAMP). Knife-edge recruitment was assumed. Estimates of total mortality for the wahoo and dolphinfish were taken from George et al. (2001) and Parker *et al*. (2001) for the species in the southeastern Caribbean. The estimated total mortality for the four-winged flyingfish off Tobago, after Samlalsingh and Pandohee (1992), was used while the estimate for the redhind in the eastern Caribbean after Straker *et al.* (2001) was taken as representative of all groupers. The mean estimate of total mortality for the queen snapper in St Lucia (Murray and Moore, 1992), the lane snapper in Trinidad (Dass, 1983) and the southern red snapper in Tobago (Manickchand-Heileman and Philip, 1996) was taken as representative of all snappers. Total mortality of unexploited fish groups (equivalent to natural mortality) was estimated using the empirical equation after Pauly (1980). Except for exploited invertebrate groups such as the spiny lobster and queen conch, the production/biomass ratio for all other groups was taken from Opitz (1996). For the spiny lobster the mean estimate of total mortality for the species off the heavily exploited Pedro Bank, Jamaica (Haughton and King, 1992) and the reefs off the US Virgin Islands (Opitz, 1996) was used. The mean annual estimate of total mortality for the queen conch off Jamaica between 1994 and 1998 (CFMC and CFRAMP, 1999) was used. The biomass and mean turnover rate of seagrasses off Barbados and

Tobago between 1993 and 1995 (CARICOMP, 2001) was used to estimate the corresponding production/biomass ratios.

Consumption/Biomass Ratio

The consumption/biomass ratio for marine mammals was estimated using information on ration size from the database mentioned previously, population numbers and the estimated biomass above. The consumption/biomass ratios for most other groups were estimated using empirical equations after Palomares and Pauly (1989) and Pauly *et al*. (1990), and species specific data from regional studies or FishBase (Froese and Pauly, 2002). A mean annual habitat temperature of 28°C after Opitz (1996) was used. The consumption/biomass ratios of billfishes, large tunas and small tunas were taken from Kitchell *et al*. (1999). For most invertebrate groups, consumption/biomass ratios were taken from Opitz (1996), however, for the queen conch this parameter was left for estimation by Ecopath.

Diet Composition

Diet compositions of marine mammals were taken from Pauly *et al.* (1998). Information for most fish groups was taken from FishBase (Froese and Pauly, 2002). Specific estimates for billfishes, large tunas and other bathypelagics were taken from Júnior (2000) based on a study off Brazil. Diet composition of dolphinfish was taken from Oxenford and Hunte (1998) and juvenile mackerels from Finucane *et al.* (1990). Cortes (1999) was the main data source for shark diet composition and Austin and Austin (1971) the main data source for juvenile pelagic jacks. Diet compositions of most reef fishes were taken from Randall (1967) based on studies in Puerto Rico and the US Virgin Islands and Sierra *et al*. (1994) based on studies off Cuba. Opitz (1996) was the main data source for most invertebrates Exceptions include the queen conch, for which diet composition was inferred based on qualitative descriptions in Tewfik (1997) and Mahon (1987), and turtles for which diet composition was inferred based on qualitative descriptions in Rebel (1974).

Ecotrophic Efficiency

Because of a lack of biomass and mortality estimates for several groups it was necessary to make assumptions about ecotrophic efficiency to satisfy the Ecopath data input requirements. An ecotrophic efficiency of 1.0 was assumed for billfishes and pelagic sharks since these are considered highly exploited worldwide, and an ecotrophic efficiency of 0.95 assumed for other groups after Christensen et al. (2000).

Fisheries Catches and Fleet Types

Estimated species catches (1999) for Grenada and the Grenadines were provided by the Grenada Fisheries Department. Twenty-three fish groups and four invertebrate groups (turtles, cephalopods, queen conch and spiny lobster) are exploited (Table 3). Estimated catches were adjusted to account for flyingfish caught as bait, other species caught in fishing tournaments, at-sea processing of large pelagics and fish exports to Martinique (Mohammed *et al*., 2003). Catches of mackerels, reef jacks and snappers by canoes/dories and seine boats, and catches of pelagic jacks and needlefish by canoes/dories and double-enders were assumed to be juveniles of the respective groups. Five fleets were defined based on data in the Grenada Fisheries Department's Licensing and Registration System (LRS): canoes and dories; doublenders; semi-industrial boats (longliners); pirogues and beach seine boats. Fleets were represented in the model by the species composition of their catches (Table 1). This was obtained by linking recorded catch information in the Trip Interview Program (TIP) to LRS using Microsoft Access. This process resulted in 15,853 valid records from a total of 21,337 records. Invalid records include vessels recorded in TIP but not incorporated in LRS (186 vessels). These were not utilized in the analysis.

Balancing the model

The model was balanced as described in Christensen *et al.* (2000) and using an automated mass-balance routine after Kavanagh *et al.* (2002). This routine currently varies biomass, diet composition and ecotrophic efficiency in a Monte Carlo iterative procedure, with user specified confidence intervals based on the sources of input data, to derive estimates of missing parameters that satisfy both master equations. Based on the data sources previously specified and default confidence intervals after Christensen *et al.*, (2000), a confidence interval was specified for each input parameter and used in the balancing procedure after Kavanagh *et al.* (2002). These confidence intervals ranged between +/- 40% to +/- 90%. Conversion to a balanced model was achieved using a multiplier factor of 1.5 times the input confidence intervals. Input parameters were subject to the following constraints to ensure ecological validity: production/consumption ratio ranging between 0.05 and 0.3; total mortality greater than natural mortality for exploited species; cannibalism accounting for less than 20% of production; the proportion of the diet attributed to higher tropic levels should be less than 10%; ecotrophic efficiency should be less than or equal to one.

Hypothetical Policy Exploration

Hypothetical policy exploration is conducted solely to demonstrate the utility of Ecosim in exploring the impacts of fishing policy options on the biomass of selected functional groups. Readers are cautioned regarding use of the results since further checking of the output parameters of the balanced model is necessary before the reliability of results can be assessed.

Two policy scenarios and the resulting impacts on biomass of selected species groups were examined. These were limited to effort changes of the pirogue and semi-industrial fleets. Together these fleets account for 95% of the estimated annual total catch. The first scenario examined the impacts of a 100% increase in the base fishing effort over a ten-year period, and maintenance of this high level throughout the 40 year duration of the simulation. This is consistent with plans to expand the offshore fishery of several southeastern Caribbean islands, though the magnitude and associated rate of increase are purely hypothetical. The second scenario examined the resilience of the groups investigated in scenario one. Should the planned increase in effort result in unsustainably low biomass of commercially important species, would effort reversion be sufficient to promote an increase in biomass? If so, how quickly would biomass of individual groups revert to baseline levels? The initial increase in effort is the same as scenario one, but this is maintained for a 10-year period and then reduced to the baseline value within a further ten years and maintained for the remaining years of the 100-year simulation.

Using the optimum policy search routine in Ecosim, effort combinations, of the respective fleets, which satisfy specific management goals, were identified. These included (a) rent maximisation; (b) maximisation of the social value of the fishery (equivalent to the number of jobs per value of the fishery); and (c) mandated rebuilding of snapper and grouper biomass to three times the baseline value. Additional information required to execute the optimum policy search routine (Table 2) were fish prices (Grenada Fisheries Department unpublished data) from which the value of the fishery was estimated, and fixed and effort related costs (Ferreira, 2002). Effort costs were adjusted to reflect total annual costs. The number of jobs per vessel was obtained from discussions with Fisheries Department staff (C. Isaac, Fisheries Officer, personal communication, 2002).

Results and Discussion

Parameters of the balanced model are presented in Table 3. The estimated fish biomass is very low ranging, between 0.004 (pelagic sharks) and 12.14 tkm^{-2}

(triggerfish, grunts etc.) in the respective habitat areas. Compared to corresponding groups in the model for the US Virgin Islands (Opitz, 1996) these estimates are low. Opitz (1996) however, focused only on reef areas and assumed there was no fishing. The lower biomass of large carnivorous reef fishes in the southeastern Caribbean, is however consistent with reports of over-fishing (Mahon, 1990; Mahon, 1996; Mahon and Singh-Renton, 1996), and the resulting fishing 'down the food web' (Pauly *et al*., 1998). All production of billfishes, pelagic sharks, large tunas etc., mackerels and Coryphaena spp. are utilized in the system (ecotrophic efficiency of 1.00). On the other hand the small ecotrophic efficiencies of other flyingfishes (0.509), demersal and reef sharks (0.006), squirrelfish and other small reef carnivores (0.197), parrotfish, surgeonfish and triggerfish (0.122) as well as croakers, snooks etc. (0.165) are cause for suspicion. Small pelagics such as flyingfishes do not die of old age, most are subject to intense predation (Christensen *et al*., 2000).

The percentage change in initial parameter inputs was greatest for biomass of snappers (-100%) and dolphinfish (+400%); total mortality of groupers (-70%) and mullets (+161%) and consumption/biomass ratios of toothed whales (-92%) and baleen whales (+4071%). For large pelagic species, which are the present focus of fisheries development, the estimated total mortality of billfishes and pelagic sharks were increased by 26% and 59% respectively, and decreased by 38% and 65% for large tunas and dolphinfish respectively.

Generally predation mortality accounted for the greatest proportion of total mortality (Table 3). Top predators, such as large pelagic species, which have few predators, are exceptions. Predation mortality for pelagic jacks seems exceedingly high, as a result input parameters for this group should be reviewed. Juveniles of large pelagics are also subjected to high predation mortality. Apart from the large pelagic species, turtles were the only species for which fishing mortality exceeded predation mortality, though fishing mortality of groupers was also quite high.

The fishery operates as a predator with a mean trophic level of 4.34. This reflects the high proportion of large, migratory pelagic species in the catch. The mean transfer efficiency is 10.3%. Gross efficiency of the fishery (catch/net primary production) is also very low, 0.000026, because the fishery is concentrated on apex predators. This parameter has a wide range between different systems, with high values for fisheries harvesting fish low down the food web (e.g. an upwelling fishery) and low values in systems where fish stocks are under-exploited or where the fishery is concentrated on apex predators (e.g. tunas). The weighted global average is about 0.0002. The total system throughput (the sum of all consumption, exports, respiratory flows, flows to detritus) is 14 332 t km^{-2} $year^{-1}$. Compared to the model of the USVI reef area (total system throughput of 107,473 tkm^{-2} $year^{-1}$) this is very small. However, the US Virgin Islands model covered 6.34 km^2 of high productivity reef area while this model covers 25 957 km^2, with areas of higher productivity (reef and shelf) accounting for only 7% of the total area. Approximately 21.7% of throughput goes to respiration and 35.8% to detritus. The total primary production/total respiration is one, indicating that the marine ecosystem (EEZ, reef, shelf and slope areas) off Grenada and the Grenadines is a mature one. However, other characteristics of the ecosystem indicative of maturity (Christensen, 1995) are to be investigated before such a conclusion can be made. The overall system omnivory index is 0.26. This parameter characterizes the extent of web-like features of the system, the higher the index the greater the complexity.

The confidence intervals of input parameters range between +/- 40% to +/- 90%. The model can benefit considerably from future area specific research, which will reduce the levels of uncertainty and improve its quality and

<u>Hypothetical Policy Exploration</u>

Of the ten groups examined the biomass of seven declined drastically (Figure 1) when fishing effort was increased by 100% in scenario one. Even after fishing effort stabilised at the higher level this decline in biomass continued, though at a considerably reduced rate. Conversely, the biomass of mackerels and four-winged flyingfish increased in response to decreased predation by top predators (e.g. dolphinfish, billfishes and large tunas). Biomass of small tunas decreased initially because of heavy exploitation by the pirogue and semi-industrial fleets. However, like other small pelagics biomass eventually increased in response to decreased predation. Changes in biomass result from changes in both fishing and predation pressure. Predation pressure is represented by the diet composition of the respective groups, which in effect represents the tropic linkages. Since several factors affect diet composition e.g. season and area, the model can be significantly improved if more detailed studies directed specifically at important species in the southeastern Caribbean region are conducted. The changes in biomass above are to be analysed with respect to the impacts on catch levels and the resulting social, economic and ecological consequences. Ecosim also provides output on relative yield and value of the fishery. These are not presented however, because of the preliminary state of the model at this time.

Except for small tunas, groupers and small coastal pelagics, the effort reduction after year 20 in scenario two prompted an almost immediate change in biomass towards the initial base level for most of the groups examined (Figure 2). It was only with the stabilisation of effort at the initial base value that biomass of small tunas and small coastal pelagics responded in a direction towards the initial base estimates. Small coastal pelagics are specified in the diet of all top predators in the model. The suppression of its biomass, even when biomass of most top predators was low, results from intense predation by small tunas as a result of reduced competition with other top predators. Grouper biomass showed no response until 10 years after fishing effort was reduced to the original base value. This is consistent with the life history of these species (slow growing, long-lived) and shows how susceptible the group is to over-exploitation and its low resilience. The optimal policy search routine identified relative fishing efforts of 1.6 (double-enders), 1.42 (semi-industrial vessels), 0.71 (seine boats and canoes) and 0.71 (pirogues) for maximisation of rent. Such a routine would favour the fleet with lowest operation cost and highest value of the catch. Even though semi-industrial vessels and pirogues account for the greatest catch value the higher operational costs (70-77% of total value) favours a smaller relative effort compared to double-enders which expend 42% of the value of the catch on fishery related costs. Given the greater number of persons employed in the seine fishery it was not surprising that the search routine identified a relative effort of 61.7 for this fleet compared to 7.71 for double-enders and canoes and an almost complete elimination of other fleets. To facilitate mandated rebuilding of the snapper and grouper resources to three times the initial biomass the search routine identified relative fishing efforts of 1.92, 1.54, 0.77 and 0.28 were identified for the double-enders, canoes and dories, seine boats and semi-industrial vessels respectively. The pirogue fleet was almost totally eliminated since the proportion of snappers and groupers in the catch was greatest for this fleet. The social, ecological and economic consequences and trade-offs of the policy optimisation routine are key considerations for the institution with responsibility for fisheries management.

Depending on the current management goal decisions may be made which favour a particular outcome at the expense of another. This exercise demonstrates that sustainable management of fisheries must consider the trade-offs associated with specific goals, make decisions, implement management strategies and conduct research within an adaptive management framework (Hilborn and Walters, 2001).

Data Limitations and Uncertainty

Estimates of biomass for the living marine resources in Grenada and the Grenadines were not available. Therefore, it was necessary to make assumptions about ecotrophic efficiency for several groups to satisfy the Ecopath data input requirements. In some

cases the assumptions were well justified given the observed rates of exploitation (e.g. pelagic sharks, large tunas), however, in most instances 95% of production was assumed to be utilised in the system after Christensen *et al.* (2000). In some instances estimates from other areas in the Caribbean (Jamaica, Trinidad, US Virgin Islands and St Lucia) were used though distinct differences in oceanographic conditions, species abundance, primary productivity and exploitation levels exist among these countries. This also impacts on the use of estimates of production/biomass ratio derived for similar functional groups in other islands. This model can be considerably improved if area specific information is available. Estimates of production/biomass ratio were available only for a few species of commercial importance in other islands. Since each functional group comprised several species of similar diet, habitat and activity level, equal susceptibility to fishing gear, predation and other sources of mortality were assumed and total mortality of individual species assumed representative of the group. Consumption of marine mammals within the study region is also not known. The estimate used from Trites and Heise (1996) for the British Columbian shelf is quite likely an over-estimate for the southeastern Caribbean region given the reported reduced feeding during breeding and calving in the area (Whitehead and Moore, 1982). Lack of data also resulted in the use of information for time periods that differ considerably from the model base year (1999).
There was also uncertainty regarding the accuracy of the catch statistics. Historically catches of specific species groups e.g. lobster, conch and reef species have not been adequately covered in the data collection programme (Mohammed *et al*., 2003). This situation still exists. Based on the Grenada Fisheries Department’s knowledge of local fisheries, a fixed raising factor for adjusting recorded statistics to total catches has been used since 1978. This has been adjusted to reflect recent developments in the offshore fishery but not changes in the inshore fishery. Foreign and non-commercial catches are also not included in the statistics. Because of data availability, 1999 was selected as the base year for the model. During that year however, there was a region-wide fish-kill that severely affected the fishing industry. As a result the catches are not representative of a typical year. Further refinement of existing catch and effort data is required for selection of another base year. Incomplete specification of vessel characteristics in LRS has also limited the level of detail with which fishing effort could be investigated in policy exploration scenarios. Because of incomplete coverage of the entire fleet in LRS catch and effort information for 186 vessels was disregarded in the analysis. Information in TIP accounted for only 40% of the boats listed in LRS.

Future Work

The present model is preliminary. Further checking to assess the biological and ecological validity of estimated output parameters is required. Examination of network flow indices computed by Ecopath would also facilitate this. Since there is high uncertainty associated with most of the input parameters, model sensitivity to these is to be quantified. This uncertainty will also be considered in Ecosim testing of management policy options. Validation of the model will increase confidence in outputs of Ecosim policy simulations. This process will include time series fitting of model predictions with known indicators of dolphinfish and flyingfish biomass. Time series fitting also generates vulnerability parameters, to which Ecosim simulations are known to be highly sensitive (Christensen *et al.,* 2000). To facilitate investigation of management policy issues specific to the inshore and offshore fisheries, the model structure (functional groups and tropic inter-relationships) will be adjusted accordingly. Policy options involving effort regulation and implementation of marine protected areas for reef and inshore fisheries are to be investigated. Also, with additional economic information, policy searches to identify optimal fleet combinations of effort to maximise specific management policy objectives (fisheries rent; social benefits; mandated rebuilding of species and ecosystem health) and associated trade-offs will be explored.

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References

Appeldoorn, R.S. 1995. Stock abundance and potential yield of queen conch of Pedro Bank. Ms Rept. To Jamaican Fisheries Division (cited in CFMC and CFRAMP, 1999).

Austin, H. and Austin, S. 1971. The feeding habits of some juvenile marine fishes from the mangroves in western Puerto Rico. Caribbean Journal of Science 11 (3-4): 171-178.

Bacon, P., Berry, F., Bjorndal, K., Hirth, H., Ogren, L., Weber, M. (Editors). 1984. Symposium on Sea Turtle Research of the Western Atlantic (Populations and Socio-economics). 17-22 July, 1983. San Jose, Costa Rica. Proceedings of the Western Atlantic Turtle Symposium. Volume 1. University of Miami Press. Florida, USA, 1984. 306pp.

Behrenfeld, M.J. and Falkowski, P.G. 1997. Photosynthetic rates derived from satellite based chlorophyll concentration. Limnology and Oceanography. 42:1-20.

Beverton, R.J.H. and Holt, S.J. 1957. On the dynamics of exploited fish populations. Chapman and Hall, London. 533p. Facsimile reprint 1993.

CARICOMP, 2001. Data reports from the Caribbean Coastal Marine Productivity Co-operative Research and Monitoring Network. Tables 11, 12 (seagrasses) and 13 (sea urchins) accessed electronically at http://ftp.unesco.org/csi/pub/papers.

CFMC and CFRAMP (1999). Report on the Queen Conch Stock Assessment and Management Workshop. Belize City, Belize, CARICOM Fisheries Resource Assessment and Management Programme, Lobster and Conch Resource Assessment Unit: 105pp.

CFRAMP (2001). Report of the 2000 Caribbean Pelagic and Reef Fisheries Assessment and Management Workshop. Belize City, Belize, CARICOM Fisheries Unit: CARICOM Fishery Report No. 9. 139pp.

Christensen,V. 1995. Ecosystem maturity - towards quantification." Ecological Modelling 77: 3-32

Christensen, V. 1996. Managing fisheries involving predator and prey species. Reviews in Fish Biology and Fisheries 6: 417-442.

Christensen, V., Walters, C.J. and Pauly, D. 2000. Ecopath with Ecosim: A User's Guide, Fisheries Centre, University of British Columbia, Vancouver, Canada and International Center for Living Aquatic Resource Management, Penang, Malaysia.

Corless, M., Hatcher, B.G., Hunte, W. and Scott, S. 1997. Assessing the potential for fish migration from marine reserves to adjacent fished areas in the Soufriere Marine Management Area, St Lucia. Proceedings of the Gulf and Caribbean Fisheries Institute 49: 71-98..

Cortés, E., 1999. Demographic analysis as an aid in shark stock assessment and management. Fish. Res. 39(2):199-208.

Dass, S. 1983. Some aspects of the biology of the lane snapper *Lutjanus synagris* (Linnaeus, 1758) in Trinidad. Research Report of the Institute of Marine Affairs, Hilltop Lane, Chaguaramas, Trinidad. December 1983. 27 p.

FAO, 1995. Code of Conduct for Responsible Fisheries. The Food and Agriculture Organisation of the United Nations. Rome. 41pp.

Ferreira, L. 2002. Social and Economic Assessment of the Eastern Caribbean Flyingfish Fisheries: A Regional Perspective.pp 146-156 In: FAO 2002. Report of the Second Meeting of the WECAFC Ad Hoc Flyingfish Working Group of the Eastern Caribbean. FAO Fisheries Report N0. 670.

Finucane, J. H., Grimes, C.B. and Naughton, S.P. 1990. Diets of young King mackerel and Spanish mackerel off the southeast United States. Northeast Gulf Science 11(2): 145-153.

Froese, R. and Pauly, D. Editors. 2002. FishBase and World Wide Web electronic publication. www.fishbase.org. Accessed in March 2002.

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

Haughton, M. O. and King, D.P.F. 1992. Stock assessment of the spiny lobster (*Panulirus argus*) in Jamaica. Proceedings of the Gulf and Caribbean Fisheries Institute. 42: 120-126.

Hilborn, R. and Walters, C. 2001. Quantitative Fisheries Stock Assessment: Choice, Dynamics and Uncertainty. Kluwer Academic Publishers. Massachusetts. USA. 570pp.

Júnior, T.V. 2000. Relações tróficas dos grandes peixes pelágicos da região equatorial sudoeste do oceano Atlântico. Fundação Universidade Federal Do Rio Grande Curso De Pós-Graduação Em Oceanografia Biológica. 144pp.

Kavanagh, P., Newlands, N., Christensen, V. and Pauly, D. 2002. Automated Parameter Optimization for ECOPATH Ecosystem Models. Vancouver, British Columbia, UBC Fisheries Centre: 38pp.

Kitchell, J. F., Boggs, C.H., He, Xi., Walters, C.J. 1999. Keystone predators in the central Pacific. Ecosystem Approaches for Fisheries Management. Wakefield, Alaska, Alaska Sea Grant College Program: 665-683.

Longhurst, A., Sathyendranath, S., Platt, T. and Caverhill, C. 1995. An estimate of global primary production in the ocean from satellite radiometer data. Journal of Plankton Research 17(6): 1245-1271.

Mahon, R. 1987. Report and proceedings of the expert consultation on shared fishery resources of the Lesser Antilles. FAO Fisheries Report 383: 278.

Mahon, R. (1990). "Fishery management options for Lesser Antilles countries." FAO Fisheries Technical Paper 313: 126pp.

Mahon, R. 1993. Marine Fishery Resources of the Lesser Antilles. P. 5-98 In: FAO. 1993. Marine fishery resources of the Antilles: Lesser Antilles, Puerto Rico and

Hispaniola, Jamaica, Cuba. FAO Fisheries Technical Paper. No. 326. Rome, FAO 1993. 235p.

Manickchand-Heileman, S. C. and Philip. D.A.T. 1996. Reproduction, age and growth of the Caribbean red snapper (*Lutjanus purpureus*) in waters off Trinidad and Tobago. In: Arreguín-Sánchez , F., Munro, J.L., Balgos, M.C. and Pauly, D. (Eds.). 1996. Biology, fisheries and culture of tropical groupers and snappers. International Centre for Living Aquatic Resource Management. ICLARM Conference Proceedings No 48: 137-149.

Manickchand-Heileman, S. C. 1994. Distribution and Abundance of Flatfish on the South American Continental Shelf from Suriname to Colombia. Netherlands Journal of Sea Research 32 (3/4): 441-452.

Mohammed, E. Finlay, J. and Rennie, J. 2003. Quantifying the impacts of fishing on marine resources by analysis of reconstructed fisheries time series data: A case study for Grenada and the Grenadines. Report of presentation for the Pelagic, Reef and Slope Fishes Resource Assessment Workshop of the CARICOM Fisheries Resource Assessment and Management Program. November 25-29, 2002. Kingstown, St Vincent and the Grenadines.

Murray, P. A. and Moore, E. A. 1992. Recruitment and exploitation rate of *Etelis oculatus* Val. in the St Lucian fishery. Proceedings of the Gulf and Caribbean Fisheries Institute 42: 262.

Nuengsigkapian, P. (Ed.) 2002. Summary of the Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem. Sustainable Developments:
http://www.iisd.ca/linkages/sd/sdice/sdvol61num1.html.

Opitz, S. 1996. Trophic interactions in Caribbean coral reefs. Makati City, Philippines, International Center for Living Aquatic Resources Management. ICLARM Technical Report. 43: 341p.

Oxenford, H. A., Mahon, R. and Hunte, W. 1995. Distribution and relative abundance of flyingfish (Exocoetidae) in the eastern Caribbean. I. Adults. Marine Ecology Progressive Series 117: 11-23.

Oxenford, H. A. and Hunte, W. 1998. Feeding habits of the dolphinfish (*Coryphaena hippurus*) in the eastern Caribbean. Scientia Marina 63 (3-4): 303-315.

Palomares, M. L. D. and Pauly, D. 1989. A multiple regression model for predicting the food consumption of marine fish populations. Australian Journal of Marine and Freshwater Research. 40: 259-273.

Parker, C., Singh-Renton, S., Hackett, A. and Lauckner, F.B. 2001. Assessment of the dolphinfish (*Coryphaena hippurus*) fishery using Eastern Caribbean Data. p 41-53 In: CFRAMP. 2001. Report of the 2000 Caribbean Pelagic and Reef Fisheries Assessment Workshop, Caribbee Hotel, Barbados, CARICOM Fisheries Resource Assessment and Management Program. CARICOM Fishery Report No 9:139 p.

Pauly, D. 1980. On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. J. Cons. CIEM. 39(2): 175-192.

Pauly, D., Christensen, V. and Sambilay, V. 1990. Some features of fish food consumption estimates used by ecosystem modellers. ICES Counc. Meet. 1990/G:17: 8pp.

Pauly, D., Soriano-Bartz, M.L. and Palomares, M.L.D. 1993. Improved construction, parametrization and interpretation of steady-state ecosystem models. In: Christensen, V. and Pauly, D. (Eds.) 1993. Trophic models of aquatic ecosystems. ICLARM Conference Proceedings. 26: 1-13.

Pauly, D., Trites, A.W., Capuli, E. and Christensen, V. 1998. Diet composition and trophic levels of marine mammals. ICES Journal of Marine Science. 55:467-481.

Rajendra, M. D. K., Khan, A.A., Knight, D., O'Reilly, A., Chang Yen, I., Wagh, A.B. and Desai, B.N. 1991. Some aspects of nutrient chemistry of the Caribbean Sea. Caribbean Marine Studies 2 (1&2): 81-86.

Randall, J.E. 1967. Food habits of reef fishes of the West Indies. Stud. Trop. Ocean. Miami 5:665-847.

Rebel, T. P. 1974. Sea turtles and the turtle industry of the West Indies, Florida and the Gulf of Mexico. University of Miami Press. Coral Gables, Florida, USA.

Saetersdal, G., Bianchi, G., Stromme, T. and Venema, S.C. 1999. The Dr. Fridtjof Nansen Programme 1975-1993. Investigations of the fishery resources in developing regions. History of the programme and review of results. FAO Fisheries Technical Paper 391: 434.

Samlalsingh, S. and Pandohee, E. 1992. Preliminary stock assessment for the flyingfish fishery of Tobago. Technical Report of the Project for the Establishment of Data Collection Systems and Assessment of the Fisheries Resources. FAO/UNDP:TRI/91/001/TR11. Port of Spain (Trinidad). July, 1992: 41p.

Sierra, L.M., R. Claro and O.A. Popova. 1994. Alimentacion y relaciones tróficas. p. 263-284. 1In Rodolfo Claro (ed.) Ecología de los Peces Marinos de Cuba. Instituto de Oceanología Academia de Ciencias de Cuba and Centro de Investigaciones de Quintana Roo, Mexico.

Singh-Renton, S. and Mahon, R. (1996). Catch, effort and CPUE trends for offshore pelagic fisheries in and adjacent to the Exclusive Economic Zones (EEZs) of several CARICOM States. Kingstown, St. Vincent., CARICOM Fishery Report No. 1: 94pp.

Singh-Renton, S. and Neilson, J. 1994. Potential yield of large tuna and billfish resources in CARICOM marine areas: A preliminary estimation. St Kitts and Nevis, CARCICOM Fisheries Resource Assessment and Management Program**:** 37pp.

Straker, L., Singh-Renton, S. and Lauckner, F.B. 2001. Assessment of red hind (*Epinephelus guttatus*) fishery in St Vincent and the Grenadines. Pp 54-73 In: CFRAMP. 2001. Report of the 2000 Caribbean Pelagic and Reef Fisheries Assessment Workshop, Caribee Hotel, Barbados, CARICOM Fisheries Resource Assessment and Management Program. CARICOM Fishery Report No. 9:139 p.

Tewfik, A. 1997. Life history, ecology, fisheries, stock status and management measures of the queen conch, *Strombus gigas*. Kingston, Jamaica, CARICOM Fisheries Resource Assessment and Management Programme, Lobster and Conch Resource Assessment Unit, Belize City (Belize)**:** 84-117.

Trites, A. and Heise, K. 1996. Marine Mammals: Southern BC Shelf Model. Fisheries Centre Research Reports. 4 (1): 51-55.

Trites, A.W. and Pauly, D. 1998. Estimating mean body masses of marine mammals from maximum body lengths. Canadian Journal of Zoology. 76: 886-896.

Ulanowicz, R. E. (1986). Growth and Development: Ecosystems Phenomenology. New York, Springer-Verlag.

UNEP. 1992. Convention on Biological Diversity. United Nations Environment Programme. Na 92-7807 (5 June 1992). 31 pp. Rio de Janeiro. 3-4 June 1982.
http://www.biodiv.org/doc/legal/cbd-en.pdf.

United Nations. 1983. The Law of the Sea. United Nations Convention on the Law of the Sea with index and final act of the Third United Nations Conference on the Law of the Sea. United Nations. New York.

United Nations. 1995. Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks. United Nations Report of the Sixth Session. 24 July – 4 August, 1995.

New York. A/CONF. 164/37. 40pp. Also available at: http://www.oceanlaw.net/texts/unfsa.htm.

Whitehead, H. and Moore, M.J. 1982. Distribution and movements of West Indian humpback whales in winter. Canadian Journal of Zoology. 60: 2203-2211.

Table 1. Catches (t) by fleet type in the fisheries of Grenada and the Grenadines (1999)

Functional Group	Canoe/Dory	Double Ender	Sem-industrial	Pirogue	Seine boat
Billfishes	3.15	5.64	92.49	253.34	0.76
Pelagic sharks			24.98		
Large tunas and other pelagics	0.48	9.51	180.54	288.86	0.19
Mackerels		0.26	3.43	86.73	
Juvenile mackerels	**0.48**				**2.78**
Dolphinfish	0.07	0.26	6.91	156.60	0.01
Small tunas, barracudas and other pelagics	0.97	0.48	4.74	133.47	0.14
Pelagic jacks, needlefish			10.70	26.93	
Juvenile pelagic jacks, needlefish	**0.29**	**0.03**			
Four wing Flyingfish			108.00	150.00	
Reef jacks, tilefish, barracudas, etc.		38.07			
Juvenile reef jacks, tilefish	**2.53**				**1.66**
Groupers			2.69	101.29	
Snappers			0.08	39.68	
Juvenile snappers	**1.11**				**0.08**
Squirrelfish and other small reef carnivores				2.33	
Triggerfish, grunts, porgies, angelfish				3.85	
Parrotfish, surgeonfish, triggerfish etc				62.24	
Croakers, snooks and other carn/omn demersals					1.01
Small coastal pelagics		23.98	9.05	133.47	13.81
Turtles				8.36	
Cephalopods			0.18	0.18	
Spiny lobster	1.78		0.13	80.02	
Queen conch				10.19	
% of Total Catch	0.52	3.74	21.23	73.53	0.98

n: Assumed catches of the respective fleets comprise only the juveniles of the respective species

Table 2. Economic and social information for fisheries of Grenada and the Grenadines.

Details	Canoes/ Dories	Double-Enders	Semi-industrial vessels	Pirogues	Seine boats
Number of Boats (TIP)	3	2	18	248	3
Fishery Value (EC$ Thousands) *	47	142	1496	5195	46
Fixed Costs as a % of Total Value	11	8	35	27	11
Effort Related Costs as a % of Total Value	24	34	35	50	24
Jobs/Vessel	1	2	3	3	16

Table 3. Output Parameters of Balanced Model for Grenada and the Grenadines.

Group Number	Group Name	Exploited (Y/N)	Trophic Level	Biomass in habitat area	P/B (year-1)	Q/B (year-1)	Start EE	End EE	Percentage change for Mass Balance: Biomass	P/B	Q/B	Percentage of Total Mortality Attributed to: Fishing	Predation	Other Causes
1	Baleen Whales	N	3.80	0.105	0.020	14.600		0.008	75	0	4071	0.00	0.00	100.00
2	Toothed Whales	N	5.06	0.004	0.020	9.800		0.502	-71	0	-92	0.00	65.00	35.00
3	Dolphins	N	5.07	0.001	0.030	9.800		0.784	-80	0	-90	0.00	90.00	10.00
4	Billfishes	Y	4.91	0.016	1.130	6.000	1.000	1.000		26	0	49.00	49.33	1.78
5	Pelagic sharks	Y	5.22	0.004	0.255	3.700	1.000	1.000		59	59	99.61	0.39	0.00
6	Juvenile pelagic sharks	Y	4.64	0.059	0.580	7.500	1.000	0.506		0	62	15.17	84.83	0.00
7	Large tunas and other pelagics	Y	4.71	0.027	0.765	15.330		1.000	29	-38	0	90.46	9.28	0.26
8	Mackerels	Y	4.22	0.004	1.890	15.560		1.000	100	0	0	25.87	71.59	2.59
9	Juvenile mackerels	Y	4.63	0.018	6.220	31.120	0.950	0.971		0	0	1.05	65.45	33.49
10	Small tunas, barracudas and other pelagics	Y	4.30	0.013	0.886	16.700		0.992	117	0	0	51.13	47.86	1.02
11	Dolphinfish	Y	4.94	0.005	2.120	8.470		1.000	400	-65	0	35.80	62.74	1.51
12	Pelagic jacks, needlefish	Y	4.53	0.022	0.944	9.440	0.950	0.961		0	0	2.65	70.87	26.59
13	Juvenile pelagic jacks, needlefish	Y	4.18	0.257	3.776	18.880	0.950	0.953		0	0	0.08	99.87	0.05
14	Four wing Flyingfish	Y	3.80	0.006	5.800	25.300	0.950	0.998	-99	0	0	0.28	1.55	98.17
15	Other Flyingfishes	N	3.63	0.029	3.800	12.700		0.509	-75	-5	0	0.00	9.92	90.08
16	Other bathypelagics	N	3.71	0.577	0.830	7.160	0.950	0.971		0	0	0.00	96.51	3.49
17	Demersal and reef sharks	N	4.32	0.096	0.320	4.750		0.006	-75	0	0	0.00	0.63	99.38
18	Juvenile demersal and reef sharks	N	4.47	0.013	1.188	9.500	0.950	0.928		0	0	0.00	92.09	7.91
19	Reef jacks, tilefish, barracudas, etc.	Y	4.07	3.839	1.120	5.960		0.987	-14		0	1.16	77.86	20.89
20	Juvenile reef jacks, tilefish	Y	3.85	0.756	2.390	11.980	0.950	0.975		0	0	0.29	94.69	5.02
21	Groupers	Y	4.33	0.095	0.840	5.610	0.995	0.989	-90	-70	0	46.90	50.83	2.26
22	Juvenile groupers	N	3.83	0.243	2.940	14.700	0.950	0.992		0	0	0.27	78.74	20.99
23	Snappers	Y	4.24	0.052	1.068	5.450	0.995	0.964	-100	0	0	24.34	73.50	2.06
24	Juvenile snappers	Y	3.83	0.340	2.180	10.900	0.950	0.985		0	0	0.14	78.67	21.24
25	Squirrelfish and other small reef carnivores	Y	4.07	7.785	2.013	16.100		0.197	-75		0	0.00	98.51	1.49
26	Other carnivorous reef species	N	4.08	10.661	1.080	8.660	0.950	0.955		0	0	0.00	95.46	4.54
27	Triggerfish, grunts, porgies, angelfish	Y	3.53	12.144	1.590	15.260		0.952	2	0	0	0.19	95.22	4.59
28	Other omnivorous reef species	N	3.53	6.572	2.210	23.240	0.950	0.971		0	0	0.00	83.53	16.47
29	Parrotfish, surgeonfish, triggerfish etc	Y	2.39	11.845	5.830	25.340		0.122	-75		0	1.71	70.51	27.78
30	Small herb/det reef species	N	3.05	4.646	5.000	33.390	0.950	0.995		136	-23	0.00	80.58	19.42
31	Other carnivorous demersals	N	4.04	0.131	0.610	7.560		0.975	-7	0	0	0.00	92.46	7.54
32	Croakers, snooks and other carn/omn demer:	Y	3.45	0.508	1.030	8.580		0.165	-75	0	0	0.00	88.81	11.19
33	Other omnivorous demersals	N	3.52	0.017	3.340	22.320		0.841	-88	0	0	0.00	23.23	76.77
34	Mullets and other herb/det coastal pel and de	N	2.03	7.094	3.033	20.220	0.950	0.969		161	0	0.00	92.16	7.84
35	Other carnivorous benthopelagics	N	3.80	1.068	0.620	2.960	0.950	0.974		0	0	0.00	97.90	2.10
36	Small coastal pelagics	Y	3.64	2.915	3.470	23.610	0.950	0.970		0	0	0.61	95.36	4.06
37	Sea birds	N	4.59	0.002	5.400	80.000	0.200	0.161		0	0	0.00	16.52	83.48
38	Turtles	Y	3.11	0.527	0.150	3.500	0.950	0.970		0	0	50.67	35.33	13.33
39	Cephalopods	Y	4.29	0.040	2.340	12.730		0.992	74	0	0	0.00	99.74	0.26
40	Spiny lobster	Y	3.74	7.423	1.475	7.400	0.950	0.961		0	0	0.14	97.49	2.37
41	Other crustaceans	N	2.85	108.580	1.840	25.370	0.950	0.963		0	0	0.00	99.46	0.54
42	Queen conch	Y	2.07	0.842	0.530	4.417		0.997	-69	0		0.38	60.57	39.06
43	Molluscs and worms	N	2.25	37.336	4.140	61.600	0.950	0.996		0	0	0.00	73.77	26.23
44	Echinoderms	N	2.36	0.810	0.730	6.840		0.952	-75	0	0	0.00	51.23	48.77
45	Zoobenthic sessile animals	N	2.29	344.394	1.360	12.000	0.950	0.956		0	0	0.00	96.32	3.68
46	Microfauna	N	2.00	35.386	195.000	2050.000	0.950	0.931		0	0	0.00	99.52	0.48
47	Zooplankton	N	2.80	2.472	40.000	165.000	0.950	0.681		0	0	0.00	97.76	2.24
48	Seagrasses, seaweeds and other autotrophs	N	1.00	3483.865	12.760	-		0.273	10	0		0.00	38.64	61.36
49	Symbiotic algae	N	1.00	2800.199	10.200	-	0.950	0.398		0		0.00	63.31	36.69
50	Phytoplankton	N	1.00	38.551	70.000	-		0.080	10	0		0.00	19.79	80.21
51	Detritus	N	1.00	37.892	-	-		0.999	0					

Figure 1. Relative biomass of specific groups in response to effort 'scenario 1' over a 50 year simulation in Ecosim.

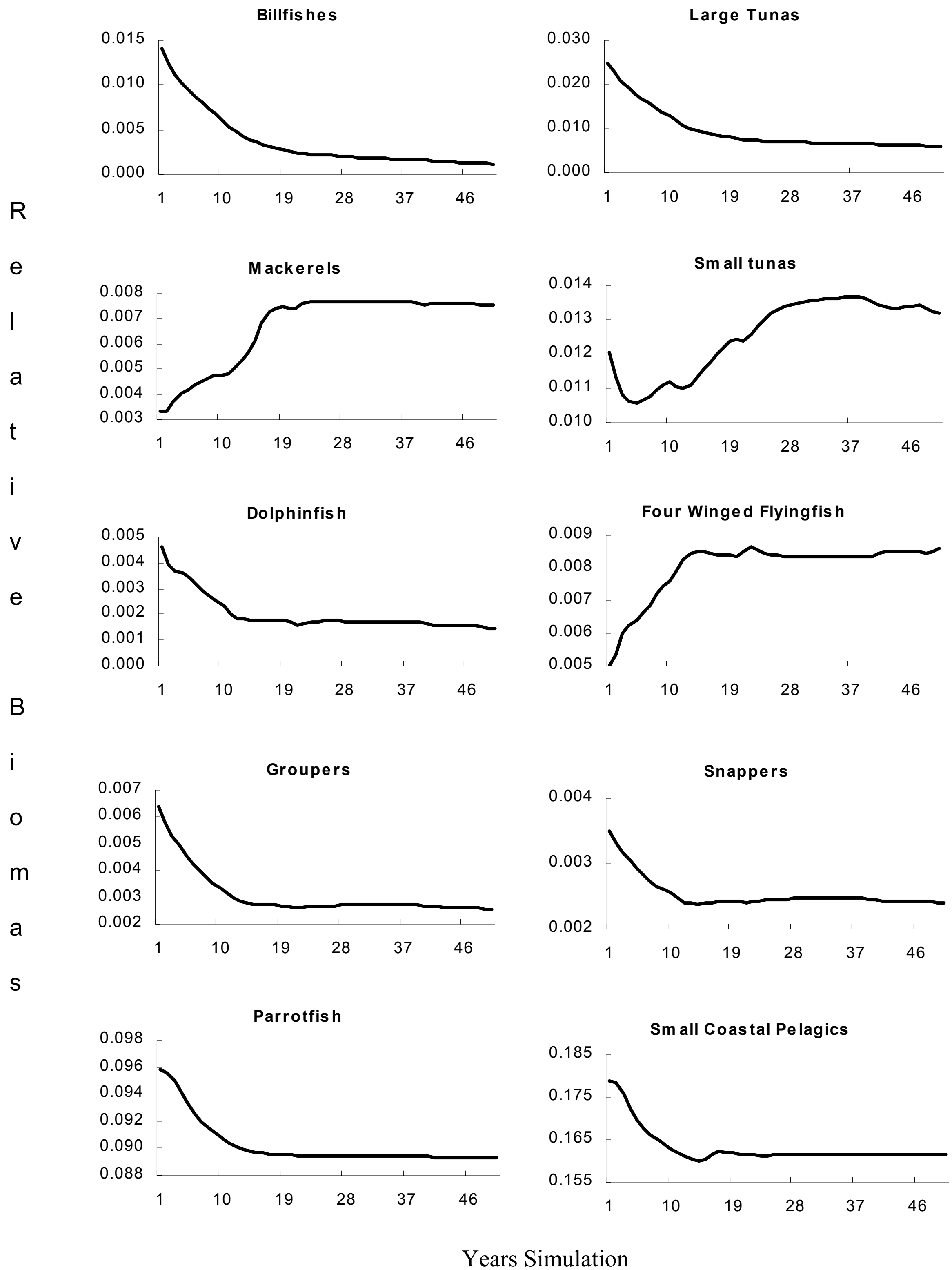
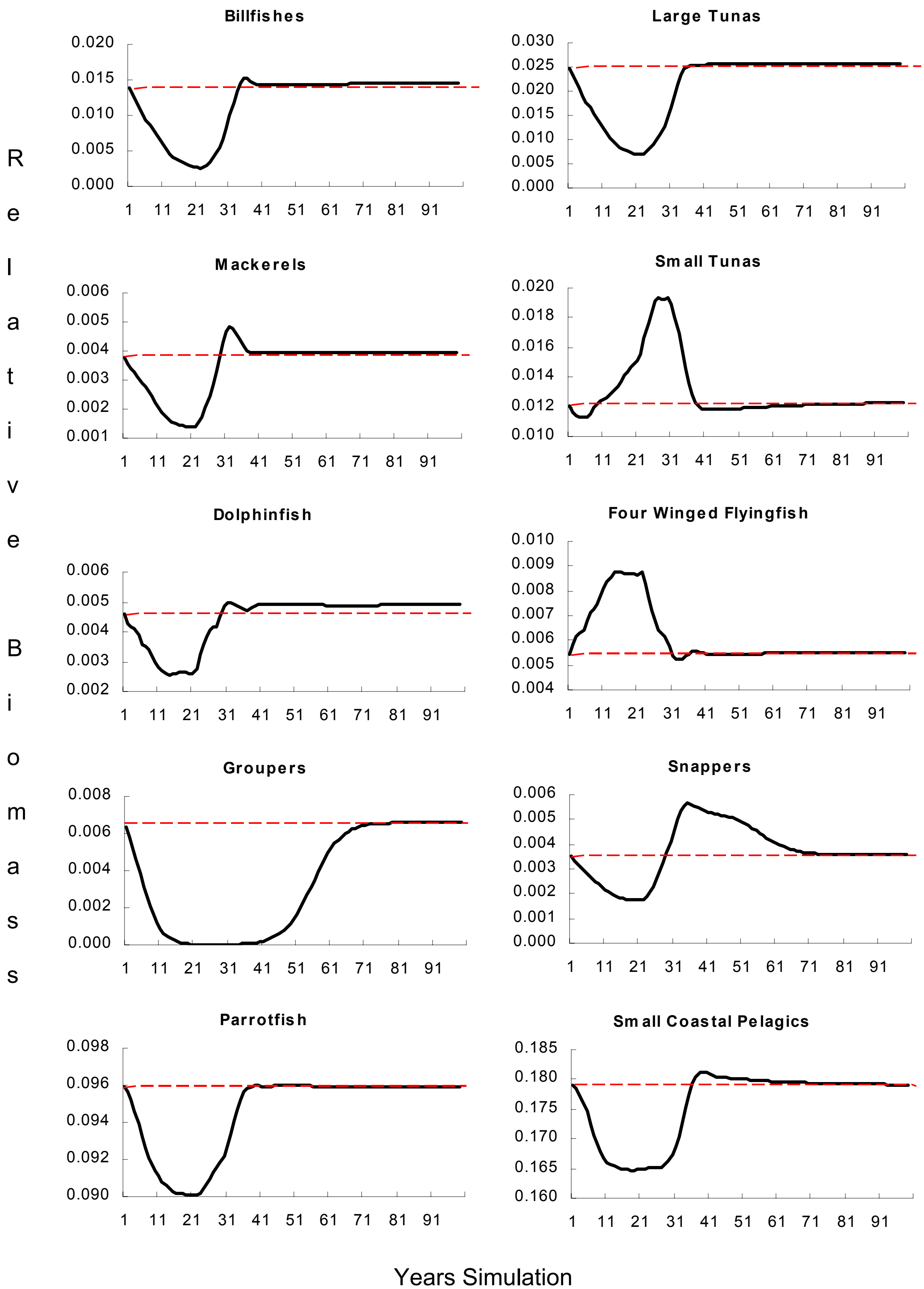


Figure 2. Relative biomass of specific groups in response to effort 'scenario 2' over a 100 year simulation in Ecosim.



APPENDIX

Ecopath Mass Balance Equations

Equation 1: (Christensen *et al.*, 2000)

Production = catches + predation mortality + biomass accumulation + net migration + other mortality

$B_i * (P/B)_i * EE_i = Y_i + \sum_{j=1}^{n} B_j * (Q/B)_j * DC_{ij} + BA_i + E_i + B_i * (P/B)_i * (1-EE_i)$

Where:

B_i Biomass of prey group i.

P/B_i Production/biomass ratio (equivalent to total mortality or natural mortality for exploited and unexploited groups respectively.

EE_i Ecotrophic Efficiency describing the proportion of total production utilized in the system.

Y_i Catch or yield of prey i.

B_j Biomass of predator j.

Q/B_j Consumption/biomass ratio of predator j.

DC_{ji} Fraction of prey i in the average diet of predator j.

BA_i Biomass accumulation of prey i

E_i Net migration of prey i.

Biomass and associated accumulation as well as net migration and yield are expressed as flows per unit area (tkm^{-2}), while production/biomass ratio and consumption/biomass ratio are expressed per year.

Equation 2: (Christensen *et al.*, 2000)

Consumption = Production + Respiration + Unassimilated Food

Quantifying the Impacts of Fishing on Marine Resources by Analysis of Reconstructed Fisheries Time Series Data: A Case Study for Grenada and the Grenadines

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Abstract
Annual time series data on fisheries catches and fishing effort are reconstructed over the period 1942 to 2001, using information from historical reports, published and unpublished papers, regional workshop and project documents, and information from the Grenada Fisheries Department's statistical databases and surveys. Through examination of fisheries characteristics (trends in annual catches, fishing effort and catch per unit effort), biological and ecological indicators (annual mean trophic level, length and fishing-in-balance index), the impacts of fishing on the marine resources between 1978 and 2001 are quantified. Results are consistent with development of the offshore fishery and a decline in the inshore fishery. Declining catch per unit effort in the offshore fishery and declining mean length and fishing-in-balance index in the inshore fishery are the major areas of ecological concern. Data limitations affecting the utility of reconstructed data for quantifying the impacts of fisheries are discussed and suggestions for improvement of fisheries statistics provided.

Introduction
Quantifying the impacts of fishing on marine ecosystems and the resulting ecological, social and economic consequences is key to identifying management policies which can reverse harmful trends, while ensuring social and economic benefits of sustainable fisheries (Pauly and Pitcher, 2000) Critical to such an analysis is time series information on fisheries catches and effort. However, with the exceptions of Barbados and Trinidad, many islands of the southeastern Caribbean lack a reliable, long enough time series of fisheries statistics.

At the 1998 Fisheries and Biodiversity Management Workshop in Trinidad, a rationale for reconstructing fisheries statistics was presented (Pauly, 1998). The 'fishing down the food web' phenomenon described in Pauly *et al.* (1998) was the impetus for such an exercise. The Food and Agriculture Organisation of the United Nations instituted a global fisheries statistical database (FISHSTAT) in 1950. Since then many countries in the southeastern Caribbean have submitted data for incorporation in this database. The sources of information are however, not documented and the existing statistics can be further refined to give more accurate estimates of catches (as compared to landings) and a more detailed breakdown of the species composition of the catch.

The objectives of this paper are to document the methodology and data sources utilized in reconstructing a time series of fisheries catches and fishing effort data for Grenada and the Grenadines and to quantify the impacts of fishing on the marine resources through examination of fishery, biological and ecological indicators. The analyses are confined to data available to the researcher at the time, however, these can be improved upon as more refined and detailed fisheries statistics become available, and improved methodology devised.

Methodology

Fisheries Catches

Catches and fishing effort were reconstructed separately for the mainland and the Grenadines. This is because of the historic differences in the major fisheries exploited and the availability of information. Traditionally the Grenadines have exploited reef and demersal resources and have traded extensively with Martinique, while the mainland has exploited the pelagic resources, with the reef and demersal resources acting as a 'buffer' during the pelagic fishery 'off-season'. Historic data are available for the mainland only. A data collection system was implemented in the Grenadines during the 1980s (exports to Martinique). and refined under the CARICOM Fisheries Program in the 1990s.

Anchor points were identified from a review of available literature. These points reflect the actual annual total or individual species catches from key information sources. When possible, anchor points were adjusted to account for the unrecorded components of the fishery using raising factors identified in the literature. In the absence of additional information data for missing years were estimated by interpolation. Data sources for the respective anchor points are: 1942 (Smyth, 1957); 1956 (Salmon, 1958); 1959 to 1968 (Vidaeus, 1969); 1974 to 1975 (Giudicelli, 1978); 1977 (Villegas, 1978); 1978 to 1999 (Grenada Fisheries Department's statistical database. Anchor points for the Grenadines were: 1942 (data in Brown, 1942 adjusted); 1984 to 1999 (Grenada Fisheries Department's statistical database) and Chakallal et al. (1997).

Total catches were disaggregated using information on species composition available in the literature and personal communication with staff of the Grenada Fisheries Department. Based on traditional common names "jacks" were identified as *Selar crumenophthalmus* and "redfish" was assumed to comprise equal quantities of snapper, coney and redhind (*Epinephelus guttatus*). Because of difficulties in species identification blackfin tuna, albacore and bonito were all classified as blackfin tuna. Individual species landings and/or associated species composition were taken from the same data sources as the anchor points. In addition information was obtained from Brown (1942), Finlay (1990) and Chakallal *et al.* (1997). Data for missing years were estimated by interpolation of annual species compositions and disaggregation of annual total catch based on the interpolated data.

The annual quantity of flyingfish and round robin caught as bait in the longline fishery was estimated for pirogues and semi-industrial vessels separately. This was estimated using information on the number of hooks utilized per trip (Samlalsingh *et al*., 1995), the mean individual flyingfish and round robin weight (from field observation), the number of vessels and number of fishing days. (Taken from the fishing effort reconstruction component of this analysis) and the duration of the fishing season. It was assumed that all were baited once per fishing day, and that one flyingfish or round robin was used per hook. Adjustments were made to account for differences in seasonal availability of each bait species.

Catches of large pelagics were adjusted for at-sea processing using conversion factors from the Food and Agriculture Organisation and information on the degree of processing in Samlalsingh *et al* (1995). Catches from billfish fishing tournaments are also included.

Catches of turtles were estimated using information in Vidaeus (1969); Rebel (1974); Meylan, 1984; Milliken and Tokunaga, 1987. Mean individual weight of the loggerhead, green turtle and hawksbill was obtained from Witzell (1984) and factors for converting hawksbill shell weight to the respective animal weight was obtained from Milliken and

Tokunaga (1987) and the website: www.tortoise.org.news/1998s28.html. Turtle catches, in most instances, were limited to export hawksbill shell to Japan.

Fishing Effort

Horsepower-days was selected as the unit of fishing effort. This allows for comparison of fishing effort among years, countries and fishery types without adjustments to account for differences in gear, vessel capacity or fishing efficiency. The unit is the sum of the product of number of boats, average horsepower and number of fishing days per year for individual vessel types exploiting a particular fishery. There was no information from which changes in overall number of fishing days by the specified vessel types and fisheries could be determined. Hence the "fishing days" component of the effort was used solely to represent the shift in effort of offshore fleets to the demersal/inshore fishery during the pelagic offseason. Fishing effort was linked to the respective fishery type based on historical information on the associated vessel design, degree of mechanisation and location of landing sites relative to fishing grounds. Temporal changes in these factors were also considered.

Data sources for the respective anchor points are as follows: 1942 (Brown, 1942); 1969 (Vidaeus, 1969); 1982 (Grenada Fisheries Department unpublished vessel census data); 1988 (Finlay *et al*., 1988); 1993 (Senga, 1995); 1997 (Grenada Fisheries Department unpublished vessel census and Straker and Jardine, 1998) and 1999 (Grenada Fisheries Department unpublished data from the Trip Interview Program).

Quantifying the impacts of fishing

Analyses were limited to catches for Grenada between 1978 and 2001. This was because of severe data limitations during the earlier period (1942 to 1977) requiring assumptions of similar species compositions over long time periods for the Grenadines. The inshore resources are believed to be over-exploited (Mahon, 1990). As a result developments since the mid-1980s have focused on the offshore pelagic fishery. To reflect these differences in resource status reconstructed catches were analysed separately for the inshore and offshore fisheries. The associated species were based on statistics provided by the Grenada Fisheries Department. The offshore fishery comprises large pelagic species caught by trolling or longlining while the inshore fishery comprises small coastal pelagic species caught with beach seines and demersal reef, shelf and slope species caught with line or fishpots. The following biological and ecological indicators were analysed:

a. Annual mean trophic level in the catch across species a to j = $\sum(C * TL)/\sum C$; where C is the reconstructed species catch and TL is the trophic level of the respective species derived from FishBase (Froese and Pauly, 2002). Estimates of trophic level for aggregate groupings (e.g. groupers) were taken as the mean of individual species estimates for all species identified for Grenada and the Grenadines in FishBase.
b. Annual fishing-in-balance (FIB) index for year i = $\log(\sum Yi * 10^{TLi} / \sum Yo * 10^{Tlo})$; where Yij is the catch of the species (group) j, TLj its trophic level in the catch, Yoj the catch at the start of the series and Tloj the mean trophic level in the catch at the start of the series. Pauly *et al* (2000) proposed the FIB index to determine whether a fishery is balanced in the ecological sense. The argument is, that given the approximate tenfold increase in biological production with a decrease by one trophic level then 'fishing down the food web' may be a deliberate choice. Hence, a decline in trophic level of the catch is insufficient to indicate a negative impact of fishing on the ecosystem. Essentially, with the FIB index, catches and associated mean trophic level are compared each consecutive year with a selected fixed base year (here: 1978). If catches increase tenfold as expected by fishing down one trophic level, then the FIB index remains constant and fishing is considered 'in-balance' (Christensen, 2000).

c. Annual mean maximum length of fish in the catch across species a to j = ∑(C * Lmax)/∑ C; where Lmax is the maximum length of the species derived from FishBase (Froese and Pauly, 2002). Mean maximum length of aggregate groups was estimated similarly to mean trophic level.

Results and Discussion

General trends in fishery catches, fishing effort, biological and ecological indicators are presented below and quantified in Table 1.

Annual Trends in Catches

The reconstructed time series data of fisheries catches for Grenada and the Grenadines (Figure 1) indicate a gradual increase in overall catches after vessel mechanisation in the mid-1950s, followed by a period of stagnation during the mid-1960s to mid-1970s resulting from government's lack of investment in the industry. A political revolution during the late 1970s to early 1980s impacted negatively on tourism. This industry accounted for a significant proportion of total fish consumption, and was an incentive to fishermen. With its decline the catch of fish followed. During the early 1980s the government launched an EC$7.1 million dollar Artisanal Fisheries Project, which provided the necessary infrastructure and financial support for development of the industry. The transfer of longlining technology by the Cubans served as a milestone in development of the industry, resulting in increased fishing effort in the offshore large, migratory pelagic fishery. The low catches observed in 1997 results from a massive fish kill in the southeastern Caribbean region and the subsequent closing of all fisheries in Grenada and the Grenadines. More recent catches show an immediate recovery of the industry.

A comparison of reconstructed catches with current information in the FAO's FISHSTAT Database shows higher catches between the late 1950s and early 1960s, from which most of the anchor points were taken from Vidaeus (1969). The data sources for the respective period in FISHSTAT are not known. Further catches in FISHSTAT were considerably higher in 1978 and 1987. A literature review revealed no supporting documentation to account for these exceptionally high catches.

Annual Trends in Fishing Effort

The reconstructed annual fishing effort for Grenada indicates an exponential increase over the time period examined. This increase has occurred in both the offshore and inshore fisheries (Figure 2a and b respectively). The higher fishing effort directed at the offshore fishery reflects the historical importance and recent development through introduction of semi-industrial longliners and expansion of the pirogue fleet. The inshore fishery has served as both a buffer (reef, shelf and slope component), a guarantee of income during the pelagic off-season, and as a source of bait (small coastal pelagic component) for the offshore fishery. Results demonstrate that monitoring solely the number of boats in the fishery is insufficient to track the changes in overall effort. While in general the number of boats exploiting the offshore fishery has increased, this has not been the case for the inshore fishery. Yet, the effective effort has increased in both fisheries predominantly as a result of increased technology through the use of engines of higher horsepower.

Annual trends in ecosystem resource indicators

Assumptions of constant species composition over long time periods negatively impacted on the utility of reconstructed data for quantifying the impacts of fishing on the resources, using the indicators described previously. Analyses were therefore limited to data for 1978 to 2001. A summary of the major changes in each indicator is presented in Table 1.

Increased catches, mean trophic level, mean length, FIB index (Figure 3a) and fishing effort of the offshore fishery are reflective of considerable investment and development of this fishery. This is also evident in increased catches of top predators such as yellowfin tuna and billfishes. The number of boats, associated mean engine horsepower, and geographical range of fishing have increased over this time. Management of the large pelagic fisheries is the responsibility of the International Commission for the Conservation of Atlantic Tunas. Development of the offshore fishery was promoted to offset the declines in the inshore fishery (Mahon, 1990) however, declines in annual CPUE signal possible over-investment in the fishery. Though catches continue to increase, so too has the effort, through the introduction of bigger vessels utilising more powerful engines, with a higher initial capital investment and possibly higher fuel costs. The results presented here reflect the general situation across the entire fleet. The economic implications will vary among the individual vessels, depending on the types of engines used, the associated fuel consumption and the catch per trip. This decline in CPUE could be offset financially by increasing prices for the associated species on the foreign market. Juveniles of top predators (e.g. yellowfin tuna) are also harvested. Since catches are recorded for both adults and juveniles combined it is difficult to monitor the relative contributions to overall catch. This is particularly important given the dramatic increases in catch observed in recent years. The underlying biological and ecological impacts should not be ignored if long termed sustainability is the desired management goal.

The situation in the inshore fishery is different. Despite stable catches the declining mean trophic level, mean length and FIB index (Figure 3b) all signal negative impacts of fishing on the resources. This is consistent with reports of depletion of inshore fisheries (e.g. Mahon *et al.,* 1990). Decreasing mean trophic level may reflect a shift from harvesting adults to harvesting juveniles of high trophic level species since these exhibit ontogenetic shifts in diet, or a shift from harvesting high trophic level species to low trophic level species. Since catch data were not separated by the juvenile and adult components, changes in mean trophic level represent solely changes associated with a shift in target species. Despite the decline in mean trophic level however, the fishing effort has increased considerably in this fishery. The 1999 CPUE however, reflects a decline of between 45 and 69% of the 1993 estimate.

A closer examination of trends in the inshore fishery reveals that the small coastal pelagic component (SCP) is more at risk ecologically. Inshore fisheries are also more susceptible to changes in local environmental conditions. The recent high catches in the reef, slope and shelf fishery (RSS) are possibly due to the capture of species at depths not previously exploited, as well as the increased biomass associated with fishing at lower trophic levels. The latter is supported by results of analyses on the associated mean trophic level. In the SCP fishery however, catches since 1995 have been lower than previous years. Although the decline in annual mean trophic level is smaller than in the RSS fishery, the decline in annual mean length is greater and the FIB index (Figure 3d) has been consistently decreasing. Together, the results imply that although the RSS fishery is now targeting species lower down the food web, that catches are still high and consistent with the higher production at lower trophic levels. This is not the case with the SCP fishery. Further, between 1993 and 1994 the catch per unit effort (CPUE) in Grenada has declined by 96%. Analysis of CPUE for both Grenada and the Grenadines revealed a greater decline for the SCP than the RSS fishery. Inshore fisheries fall under the management of the government of Grenada and the Grenadines. Hence it is necessary to further investigate these claims of over-exploitation and to implement adaptive management measures which can reverse the negative ecological impacts to ensure long-termed sustainability of fisheries.

<u>Data Limitations</u>

In estimating the overall annual catches of Grenada and the Grenadines several data limitations were identified. A method for estimating total catches based on recorded landings and the number of boats operating in the respective fisheries has not yet been devised. As a result reconstructed catches are confined to recorded statistics prior to 1978. Since 1978 the Fisheries Division has applied a raising factor to recorded landings in estimating total catch. Until recently however, without a basis for changing the factor to represent developments in the fishing industry, this factor has remained unchanged. A linking of information in the existing Licensing and Registration System and the Trip Interview Program can facilitate a more accurate estimation of total catches for recent years. Historically landing sites of the inshore reef fisheries, including lobster and conch have not been incorporated in the data collection programme. Amidst concern of over-exploitation of inshore resources this makes it difficult to quantify the impacts of fishing.

The recreational fishery has developed in association with the tourism industry and there are now several charterboat companies involved. However, the quantities of fish caught are presently not documented. Foreign fishing (legal and illegal) is also almost unavoidable given the close proximity of the southeastern Caribbean islands. The associated catches are either not documented or incorporated in the landing statistics of another island where the vessel lands its catch. Information concerning the latter is often not shared among the islands. The flyingfish fishery has also been relegated to a 'bait fishery" status, supporting the developing longline fishery. The quantities utilised as bait are not recorded. The associated regional implication is an underestimation of the level of exploitation of the species. All extractions from the resources of Grenada and the Grenadines, whether commercial or non-commercial, foreign or local, should be accounted for in stock assessments if the true status of fisheries is to be reliably estimated.

The species composition of recorded landings of the inshore fishery is highly aggregated. This makes it difficult to quantify the level of over-exploitation and the resulting ecological changes since the fishery catch and species composition are key indicators. This is especially so for fisheries of the Grenadines. Further, juveniles of top predators (e.g. yellowfin tuna) are also harvested. The associated catches are grouped with the adult component. Monitoring of changes in the relative proportions of adults and juveniles in the catch and quantifying the ecological consequences are therefore impossible.

Further refinement of the estimate of fishing effort would have been possible with a reliable estimate of changes in the number of fishing days over the period examined. Several factors affect the annual number of fishing days: weather and sea conditions, degree of mechanisation, availability of markets, vessel design and other environmental factors (resulting in fish kills). Changes in these factors are not well documented; hence the number of fishing days could be used only for disaggregating effort of those boats targeting both the inshore and offshore fishery.

Conclusion

Results are consistent with the observed development of the offshore fishery. However, declining catch per unit effort signals possible over-investment in the industry. High prices on the foreign market may mask negative ecological impacts, especially since the juveniles of top predators (e.g. yellowfin tuna) are also caught. They may also mask the rising cost of fishing associated with the introduction of larger (longlining) and possibly faster (trolling) vessels, with engines of higher horsepower. Catches in the reef, shelf and slope component of the inshore fishery have increased in recent years. This is possibly due to exploitation of species at depths not previously fished or to the increased biomass associated with organisms lower down the food web. The declining mean trophic level and increasing FIB index offer proof of the latter. The small coastal pelagic component of the inshore fishery seems the most negatively impacted ecologically. Declining catches, mean trophic level and FIB index present all the warning signs of a fishery in trouble.

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References

Brown, H. H. (1942). "The fisheries of the Windward and Leeward Islands." Development and Welfare Bulletin 20: 91pp.

Chakalall, Y. S., Mahon, R., Oxenford, H. and Ryan, R. (1997). "Fish exporting in the Grenadine Islands: Activities of Trading Vessels and Supplying Fishers." CARICOM Fishery Research Document No. 17: 84.

Christensen, V. (2000). "Indicators for marine ecosystems affected by fisheries." Marine and Freshwater Research. 51: 447-50.

Finlay, J. (1990). Socio-economic situation of small-scale fisheries in Grenada. The Fourth Session of the Western Central Atlantic Fishery Commission: committee for the Development and Management of Fisheries in the Lesser Antilles, Kingstown, St Vincent and the Grenadines, The Western Central Atlantic Fishery Commission.

Finlay, J., Rennie, J., Mahon, R. and Rosenberg, A.A. (1988). A fishery data collection system for Grenada. Fishery data collection systems for eastern Caribbean islands: Proceedings of an OECS/ICOD Workshop., Holetown, Barbados, The Organisation of Eastern Caribbean States, Fishery Unit, Cane Garden, St Vincent and the Grenadines.

Froese, R. and Pauly, D. Editors. 2002. FishBase and World Wide Web electronic publication. www.fishbase.org. Accessed in March 2002.

Giudicelli, M. (1978). Grenadian fisheries development mission findings and recommendations. Panama, Western Central Atlantic Fishery Commission: 1-35.

Mahon, R., Murphy, F., Murray, P., Rennie, J. and Willoughby, S. (1990). Temporal variability of catch and effort in pelagic fisheries in Barbados, Grenada, St Lucia and St Vincent: with particular reference to the problem of low catches in 1989. Italy, Rome, The Food and Agriculture Organisation of the United Nations: 74pp.

Meylan, A. B. (1984). The Ecology and Conservation of the Caribbean Hawksbill (Eretmochelys imbricata). Gainesville, Florida, Department of Zoology, the University of Florida.

Milliken, T. and Tokunaga, H. (1987). The Japanese Sea Turtle Trade: 1970-1986. Japan, Traffic (Japan) and Center for Environmental Education.

Pauly, D. (1998). "Rationale for reconstructing catch time series." ACP/EU Fisheries Bulletin 11(2): 4-7.

Pauly, D., Christensen, V. and Walters, C. (2000). "Ecopath, Ecosim and Ecospace as tools for evaluating ecosystem impact of fisheries." ICES Journal of Marine Science 57: 697-706.

Pauly, D., Christensen, V., Dalsgaard, J., Froese, R. and Torres, F. Jr. (1998). "Fishing down marine food webs." Science 279: 860-863.

Pauly, D. and Pitcher, T.J. (Eds.) (2000). Methods for Evaluating the Impacts of Fisheries on North Atlantic Ecosystems. Fisheries Centre Research Report. Vancouver, British Columbia, The Fisheries Centre, University of British Columbia. 8: 195pp.

Rebel, T. P. (1974). Sea turtles and the turtle industry of the West Indies, Florida and the Gulf of Mexico. Coral Gables, Florida, USA, University of Miami Press.

Salmon, G. C. (1958). Report on the fisheries industry in the countries served by the Caribbean Commission. Italy, Rome, Food and Agriculture Organisation: 86pp.

Samlalsingh, S., Oxenford, H. and Rennie, J. (1995). "A successful small-scale longline fishery in Grenada." 12pp.

Senga, K. (1995). Outline for requesting a grant of additional fishing vessels for Grenada. St Georges, Grenada, Japan International Cooperation agency: 22.

Smyth, J.A. 1957. The fisheries and fisheries resources of the Caribbean area. Report of the United States Department of the Interior, Bureau of Commercial Fisheries. Fishery Leaflet 259. Updated from an earlier mission by R.H. Fiedler.

Straker, L. and Jardine, C. (1998). Draft report on the analysis of Grenada fisheries survey data, July 1997. Kingstown, St Vincent; Belize City, Belize, Fisheries Division, Ministry of Agriculture and Labour,/the CARICOM Fisheries Resource Assessment and Management Program: 50pp.

Vidaeus, L. (1969). An inventory of the Grenada fishing industry.: 34.

Villegas, L. (1978). Review of the status of fishery statistics and fishery research capabilities in the WECAF Project Area. Panama, UNDP/FAO: 27.

Witzell, W.N. 1984. The origin, evolution and demise of the US sea turtle fisheries. Marine Fisheries Review, 1994. Vol. 56, Issue 4. Accessed electronically through Academic Search Elite.

Table 1. Summary of annual trends in fishery, biological and ecological indicators from analyses of reconstructed data for Grenada (1978-2001).

	Catch	**Mean TL**	**Mean L**	**FIB**
Offshore	Increased by a factor of 8.6 between 1981 and 2001	Increase by 0.09-0.28 per decade	Increase by 41% between 1979 and 2001	Increasing since 1978, reflective of development of this fishery
Inshore	Relatively stable between 1981 and 2001	Decrease by 0.018 per decade	Decline of 11% between 1979 and 2001	Declining since 1978; annual FIB below base year for the last 8 years (1994-2001)
RSS	Relatively stable; high catches in recent years (1999-2001)	Decrease by 0.046 per decade	Decline of 6% between 1979 and 2001	Generally increasing with high values in the last 3 years (1999-2001)
SCP	Lower catches from 1995 onwards	Decrease by 0.021 per decade	Decline of 12% between 1979 and 2001	Generally decreasing
	Effort	**CPUE1**	**CPUE2**	
Offshore	Sevenfold increase between 1982 and 1999	Decline of 77% between 1993 and 1999	Decline of 73% between 1993 and 1999	
Inshore	Increased by a factor of 2.5 between 1982 and 1999	Decline of 69% between 1978 and 1999	Decline of 45% between 1978 and 1999	
RSS		Relatively stable	Decline of 69% between 1993 and 1999	
SCP		Decline of 96% between 1993 and 1999	Decline of 94% between 1993 and 1999	

Mean TL: Mean Trophic Level
Mean L: Mean Length (cm)
FIB: Fishing-In-Balance Index
CPUE1: Catch per unit effort for fisheries in Grenada
CPUE2: Catch per unit effort for fisheries in Grenada and the Grenadines combined
RSS: Demersal reef, shelf and slope component of the inshore fishery
SCP: Small coastal pelagic component of the inshore fishery

Figure 1. Reconstructed annual fish catches for Grenada and the Grenadines (1942-2001)

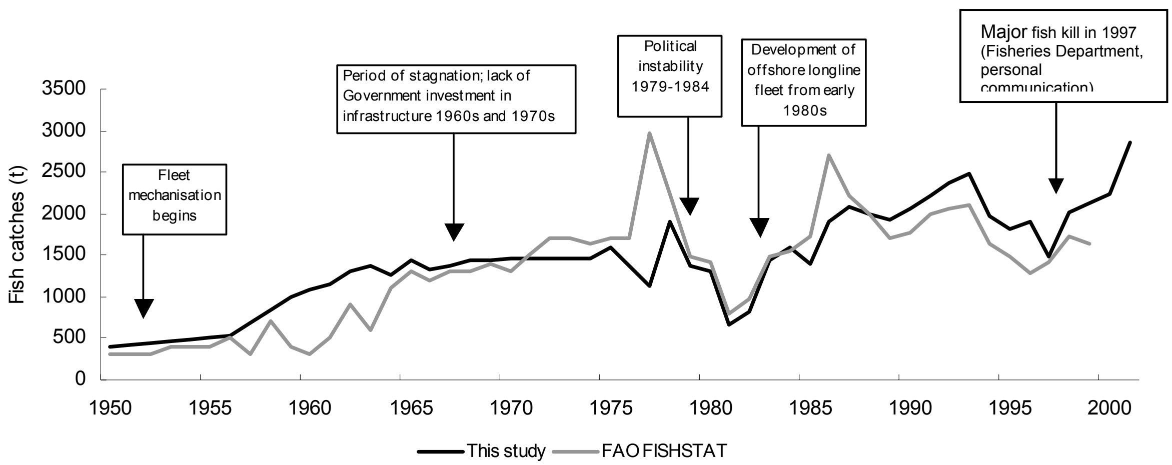


Figure 2. Reconstructed fishing effort (Hp-days) in the (a) offshore and (b) inshore fisheries of Grenada (1942-1999).

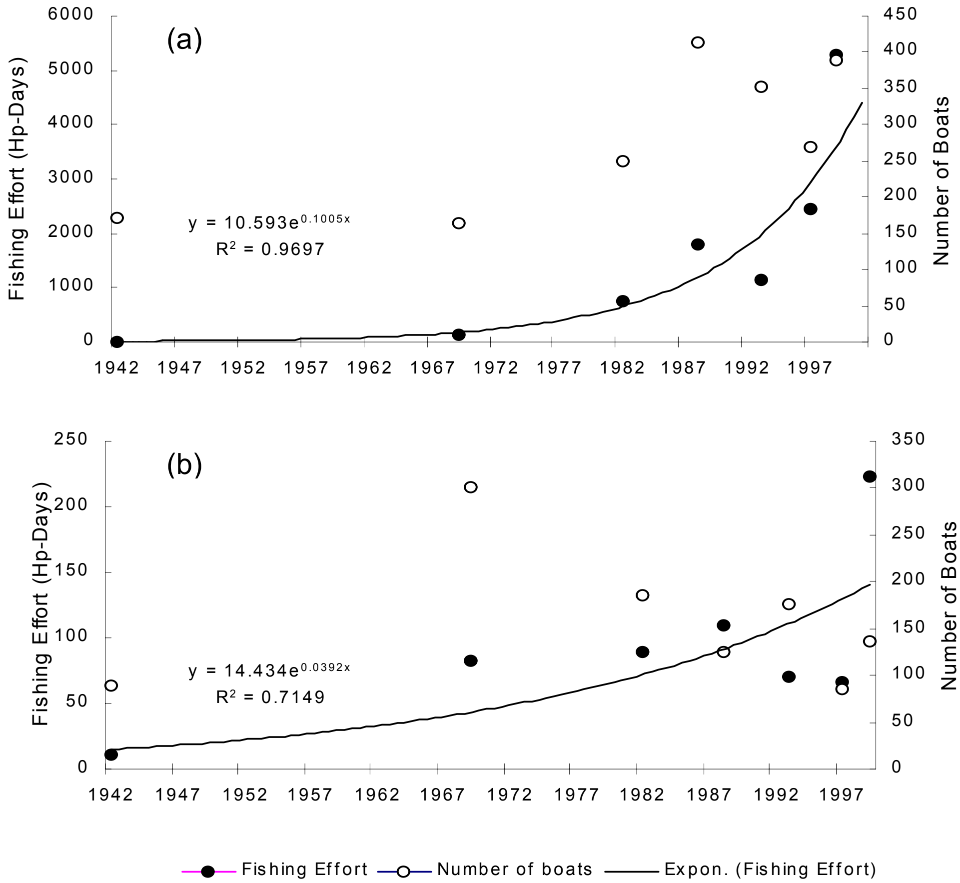
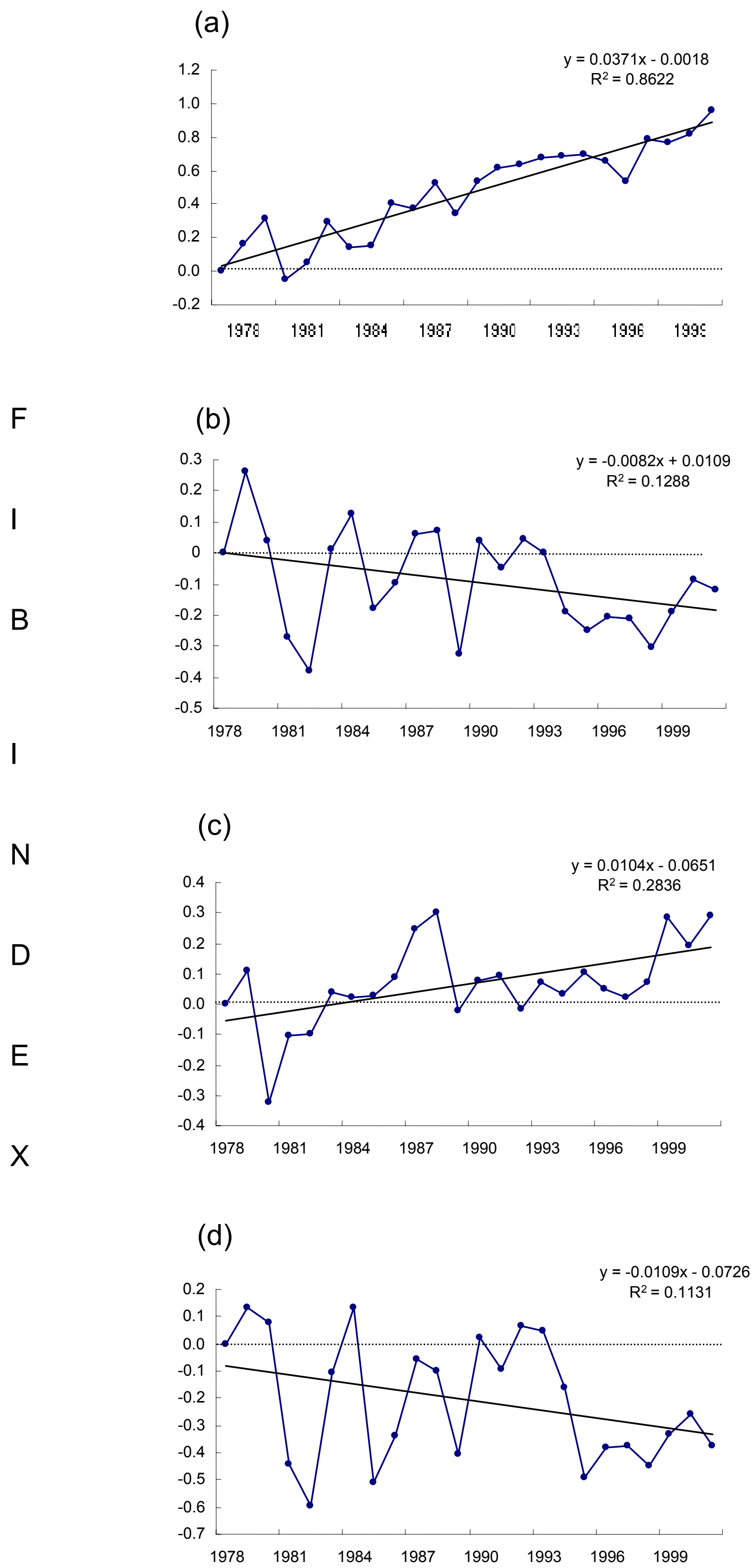


Figure 3. Trends in the annual FIB Index for (a) the offshore fishery; (b) the inshore fishery; (c) the reef, shelf and slope component of the inshore fishery and (d) the small coastal pelagic component of the inshore fishery of Grenada.



The Red Hind Fishery of St. Vincent and the Grenadines – An Interview Study

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Introduction

Red hind, (*Epinephelus guttatus*) is one of the more than 20 reef fish species landed in the demersal fishery of St. Vincent and the Grenadines. This member of the grouper family is commonly found at depths less than 30 m resting quietly above Caribbean coral reefs (Human, 1994). It commonly grows to about 40 cm but can reach a maximum length and weight of about 60 cm and 8.2 kg respectively (FAO, 1993).
It is the most important reef fish species landed in what can be described as a small-scale artisanal fishery in St. Vincent and the Grenadines, contributing approximately 5% (Table 1) of total recorded fish landings of which demersals make up a yearly total of approximately 10% (SVG Fisheries Division Data Records).

Methodology

<u>Survey Questionnaire Rationale</u>

"The St. Vincent and the Grenadines red hind survey" (See Appendix) was designed in order to gather information on the characteristics, spatial and temporal distribution of the red hind fishery and to determine the relationships between length and weights of red hind caught in St. Vincent and the Grenadines waters. The survey was intended to target all red hind fishers on mainland St. Vincent and Bequia. These two islands were chosen as the focus of the study since data collectors, who provided valuable insights into the fishery and who are an important link to the fishers, only collected data on those two islands. Also, 85.1 % of fishers that target reef/demersals come from those two islands (SVG Vessel Registry, 2002) leading to the assumption that adequate representative data for the entire state could be collected from those two islands.
Based on the list of vessels compiled from the SVG vessel registry, discussions and interviews were held with red hind fishers and data collectors to determine the proportion of boats that actually targeted red hind. One fisher from each vessel was questioned about the gear and vessel used, the fishing grounds for hind, the timing of the fishery, the sizes of fish caught and management measures for the fishery.

<u>Analyses done on weight and length data collected</u>

The lengths and weights of a representative sample of hind from different fishing grounds were measured between September and October 2002. Data were also collected for fish caught on the same day from fishing grounds around Mustique and Canouan.
Weight-length relationships

Weight-length data have generally been used either to mathematically describe the relationship between weight and length for purposes of conversion from one to the other, or measuring individual variation from an expected weight at a given length as an indicator of condition (Pope and Kruse, 2001). These types of data are more easily analyzed by linear regression after logarithmically transforming the data, which can then be useful in measuring changes in robustness/health of a fish population (Schneider *et al*., 2000).
The relationship between total length (L) and total weight (W) was calculated using the equation:

$$W = aL^b$$

The coefficients a and b were calculated from the logarithmic form of this equation:

$$\log W = \log a + b \log L$$

Log W plotted against log L gave a straight line with a slope of b and a Y-axis (log W) intercept of log a.

Fulton's condition factor

The principle underlying Coefficients of condition is that individuals that are relatively plump will characterize fish populations that have an ample supply of food resources. Fulton's K, which is the most common coefficient of condition was calculated for red hind samples using the equation:

$$K = W_g \times 10^5 / TL_{mm}^3 \qquad 2.2.3$$

Where W was the weight of the fish in grams and TL was the total length of the fish in mm^3.

Results

Distribution of the fishery

In St. Vincent and the Grenadines, red hind fishers are concentrated on the south and southwest coasts of mainland St. Vincent and on the south coast of Bequia (Figure 1).
Fishers in other areas on the mainland do not specifically target red hind but a few individuals do show up in the catch occasionally. On the west coast (Campden Park, Questelles, Clare Valley, Buccament, Layou and Barrouallie) the fishers target mainly large pelagics in preference to reef/demersals. Along the north west coast (Troumaca, Darkview, Rose Bank, Petit Bordel, Chateau Belair, Fitz Hughs and Richmond), fishers generally utilize gear not specific to hind fishing. They also use small manual boats, which prevent them from getting to the hind fishing grounds. Beach seine fishing is the main type of fishing practised on the north east coast of the mainland (Sandy Bay, Owia, Biabou and Fancy) hence fishers do not see hinds appearing in their catches.

Fishing gear and methods

The fishery can be divided into two discrete groups based on the types of gear used. The mainland fishers tend to prefer the vertical bottom line and the bottom long line, both referred to, as "palangue", but they also use hand lines.

Palangue

The bottom long line, which is a modified version to the surface long line is set on the bottom and targets bottom dwelling fish such as groupers, snappers, sharks and amberfish. The gear is kept in place on the bottom using anchors and sinkers and consists of a main line, which holds between 7 and 12 smaller lines between each sinker. Baited or un-baited hooks are attached to these lines. Buoys and sinkers along with the baited branch lines are attached to the mainline at selected intervals to minimize snarling on the bottom and to maximize the area covered, while maintaining symmetry. This gear carries between 200 and 400 crampy hooks of size No. 5, 6, 10, 11, 12 and 13 and is set on the bottom in depths of about 30 to 45 m of water. It is deployed about 5 times during a normal fishing trip, which lasts from 4 a.m. to 4 p.m. The gear is retrieved soon after the entire line has been deployed, usually 20 minutes.

The vertical bottom line, which is also called palangue, contains baited branch lines that are attached to a main line. It is kept in place by a sinker that is placed at the bottom end and buoys attached to the surface end of the mainline. The gear normally consists of no more than about 20 hooks of size similar to that of the bottom long line, targets the same species and is left to soak only for about 15 to 20 minutes.

Fish Pots, spear guns and hand lines

In Bequia, the other major landing site for red hind, 10% of fishers use fish pots, 30% use spear guns and the remaining 60% use hand lines to target red hind.

The use of fish pots, which is called "trapping", is a passive form of fishing. The frame of the trap is constructed with chicken wire, wood or steel and is formed into different shapes depending on the type of trap desired. The three main types of traps used are the arrowhead trap, the box trap and the Z-trap. These traps are baited and placed around coral reefs to catch lobsters and reef fish.

Spear guns are used along with scuba gear or when free diving. Free divers use only snorkel masks and fins.

Hand lining which is locally called "banking" or "keeping up", uses a gear made up of a single line, which is usually deployed to a depth of between 10 to 45 m for about 10-15 minutes. Each line carries 5 to 6 baited crampy hooks of size No 5, 6, 7 or 8. Live or dead bait is placed on each hook attached to the line. Usually three fishers go out hand lining; one "keeps the boat up" while the other two persons fish.

<u>Seasonality of the fishery</u>

90% of the fishers on mainland St. Vincent and Bequia who indicated that they target red hind, fish for this species all year round. The 10% that indicated they only target hind for 4 or 5 months out of the year came from Bequia. These Bequia fishers spend the other months catching lobsters, primarily because they fetch a better price; EC$10-$12 (retail price) per pound depending on the time in the season as compared to EC$6 per pound for red hind.

<u>Vessels</u>

Pirogues

The vessels utilized by 90% of the red hind fishermen interviewed on mainland St. Vincent are pirogues manned by a crew of two or three persons. These are made from fiberglass or wood and range in sizes from 3 to 12 m in length. These boats are imported from Trinidad. Some may have a semi-deck deck, which is an additional covering over the bow of the boat and carry outboard engines with horsepowers ranging from 8 to 75.

Double Enders

Fishers on both mainland St. Vincent and Bequia use double enders occasionally. 10% of fishers interviewed on the mainland said they used double enders but nobody interviewed from Bequia said they used that type of vessel. These boats are made from wood, contain two bows and are constructed in Bequia, Questelles, Clare Valley and Barrouallie. These hand-made vessels, range in length form 10 to 18 feet and are usually manually powered however, some are powered by outboard engines of about 6 to 45 horsepower.

Speedboats

In Bequia, fishers are moving slowly away from double enders and are preferring the use of speedboats locally called "cigarettes". These are constructed in Bequia from mahogany marine plywood and are covered with one coat of fiberglass or epoxy. They range in sizes from 14 to 20 feet and are powered with outboard engines between 15 to 60 horsepower. 100% of fishers interviewed from that island used cigarettes.

<u>Fishing grounds</u>

The Grenadine Bank, which is the archipelagic system of Grenada and St. Vincent and the Grenadines, provides a fairly extensive and continuous shelf from Grenada through the Grenada Grenadines and the St. Vincent Grenadines up to Bequia. This is separated from the narrow St. Vincent island shelf of mainland St. Vincent by a deep-water passage (Oxenford, 1996). The fishing grounds for red hind are located all along this Grenadine bank and parts of the island shelf of St. Vincent (Figure 1).

Fishers indicated that their catches from these areas are made up of coney (*E. fulva*), great barracuda (*S. barracuda*), various snapper species (*Lutjanidae*), parrotfish (*Scaridae*), doctor fish (*Acanthuridae)*, other groupers (*Serranidae*), triggerfish (*Balistedae*), grunts (*Haemulida*e), sharks amberfish *(Carangidae)* and other reef species in addition to red hind.

Fishers from Bequia tend to prefer the banks just south of the island and those surrounding Balliceaux, Battowia and Mustique. Fishers on the mainland also use these grounds but most prefer the areas around Canouan and Petit Canouan because the catches from these areas are reported to be larger. About 14 miles separate the grounds around Mustique from the grounds around Canouan but fishers on the mainland indicated that the amount of fish caught in the Canouan area more than compensates for the extra money spent on fuel.

Some mainland fishers also fish on the eastern side of St. Vincent in the areas around Argyle and Mount Pleasant. These areas are not favored though, due to the strong tides and currents resulting in the loss of a lot of their gear.

Catches of Red Hind

Fishers from Bequia on average recorded maximum catches of up to 20 kg per trip while those from St. Vincent recorded maximum catches of up to 80 kg per trip. Fishers on the mainland indicated that when they go to the fishing grounds around Mustique, they catch on average, a minimum of 20 kg of fish per trip. Conversely, when they go to the grounds around Canouan and Petit Canouan, their catches reach as much as 80 kg per trip and even exceed that figure on occasion.

Mainland fishers generally catch red hinds weighing between 0.67 kg to 1.81 kg while Bequia fishers usually catch hinds between 1.3 kg to 1.81 kg. This difference in catch weight may be attributed to the catchability of the gear types used. A collective review of the results from both islands highlighted that 43% of fishers indicated that the maximum size of hind caught for the year was 11.8 kg, another 43% said 2.2 kg while 5 % said 2.7 kg.

Bait

Small coastal pelagics, predominantly robins (*Decapterus macarellus*), jacks (*Selar crumenophthalmus*), dodgers (*Decapterus punctatus*), ballyhoo (*Hemiramphidae*), and sprats (*Harengula pensacolae*) are used as bait for both palangues and hand lines. Dodger is the preferred bait of the majority of red hind fishers because it does not spoil as easily as the other species, is cheaper and usually is caught at an appropriate size that a whole one can be used to bait hooks. However, robins are used more often because dodgers are seasonal. Robins are also used in preference to other species because of their texture and their characteristic smell, which is very attractive to fish. Fishers indicated that their largest landings were recorded when dodgers and robins were the bait species used.

The availability of bait greatly affects not only the number of times per month the fishers target red hind but also the grounds visited and the time they leave shore. When bait is available and plentiful, fishers fish for hind six days per week. However, when not available or plentiful (at that time bait becomes expensive) the fishers on the mainland target various other species using hand lines. When bait is acquired late on a particular fishing day, fishers tend not to venture far out preferring to stay on the island shelf of mainland St. Vincent.

Fishing Aids and Fish Storage

Red hind fishers generally do not use fishing aids to assist them with their fishing activities. A few have compasses, cell phones and VHF radios. Most fishers store their catch in a shaded area of the boat covered with a piece of rug or similar material. Others carry coolers containing ice, which is purchased from the Fisheries Complexes located at some of the landing sites.

<u>Management Measures</u>

The hook sizes employed by red hind fishermen allows for a larger range of sizes of fish within the catch. This is a potential problem because immature and/or undersized fish that have not had the opportunity to reproduce are caught. Fishers indicated that if they get small, immature red hind in their catches they would not release them. Their rationale was that once under sized fish were caught, it made no sense to release them because they would either die anyway due to the depth from which they were brought up or larger fish like sharks would eventually eat them.

Red hind fishers realize the destructive tendencies of the palangue and as a result do not go to the same area everyday of a month. They indicated that the palangue sinks to the bottom onto the reef and pulls up everything that it attaches to including bottom substrate Therefore, they alternate their fishing locations allowing an area to rest for a few days before it is fished again.

80% of fishers interviewed indicated that there were no management measures in place for the protection of red hind, 10% indicated that they did not know the answer to the question and 10% indicated that there were certain areas where it was illegal to fish (marine conservation areas designated as no fishing zones by the St. Vincent Fisheries Division). Measures such as size restrictions and seasonal closures were the two most common management measures fishers felt should be put in place to protect the species but most felt that nothing should be done.

While 76% of hind fishermen indicated that limiting new people from coming into the fishery would not help to protect the interests of those fishing now, another 24% thought it would. Those not in favor of the limit indicated that everyone has to earn a living so it would be unfair to stop anyone from joining the fishery. Generally fishers could not suggest ways that they, as red hind fishers, could help to protect and manage this resource.

<u>Analyses done on length and weight data</u>

Length-weight relationships

The length-weight relationship for the 80 red hind sampled in September to October 2002 was

$$\text{Weight} = 2.00 \times 10^{-5} * (\text{Length})^{2.919}.$$

The relationship estimated in 2000 (Straker *et al*, 2001) from sampling over 80 fish was:

$$\text{Weight} = 0.005*(\text{Length})^{2.276}.$$

The length-weight relationship was also calculated individually for Mustique and Canouan from fish weight and length data collected on the same fishing day.

For Mustique, the length-weight equation based on 24 samples was:

$$\text{Weight} = 1.12 \times 10^{-5} (\text{Length})^{3.052}$$

For Canouan, the length-weight equation based on 18 samples was:

$$\text{Weight} = 2.55 \times 10^{-5} (\text{Length})^{2.784}$$

Fulton condition factors (K)

To best compare the coefficient of condition of fish from different locations, data should be from fish of the same species, length, age and sex and should have been collected on the same date (Williams, 2000). Comparison of Fulton's condition factor was made between red hind collected on the same day from Mustique and Canouan. The individual K values were calculated and are listed in Tables 2.0 and 3.0. The average K value for Mustique was found to be 1.344 and for Canouan 1.186. These K values were plotted against length of fish (Figure 2).

Discussion

The study revealed that there are various factors when considered together, determine the characteristics of the red hind fishery in St. Vincent and the Grenadines and make it difficult to carry out the quantitative assessments necessary for the development of a proper management plan for the fishery. Some of these are:

1) The lack of data collectors in all the Grenadine islands other than Bequia, which leads to loss of a lot of valuable landings information.
2) Bait availability, which determines not only when red hind fishers go out to target this species but also the fishing grounds visited and the gears used when fishing.
3) The non-exclusive nature of the fishery results in the utilization of gears and fishing practices that are not designed solely with the purpose of catching red hind.
4) The lack of boats containing engines in the certain parts of mainland St. Vincent that prevents fishers from accessing red hind stocks.
5) The gears used for hind are not specific to this species. Also, the lack of clear distinction of the bottom long line and vertical bottom line means that one cannot totally separate the data obtained to carry out individual analyses on the respective catches.
6) The lack of will by fishers to assist with the management of the resource, which they depend on for their livelihoods.

Length-weight relationships

A Comparison of the length-weight relationship obtained in 2000 (Straker *et al.*, 2001) and those in 2002 shows that these populations were significantly different from each other ($\alpha = 0.05$). This means that there have been major changes in the population of red hind from 2000 to 2002. These changes are so significant that it appears that two entirely different populations were sampled. For Mustique and Canouan it was also found that the length-weight relationships were significantly different from each other ($\alpha = 0.05$). Given that this comparison is based on data collected on one day only, the assumption that these could be treated as separate would need to be verified by additional sampling. In addition, in both instances, the results need to be looked at with a bit of caution because the sample sizes were very small. To obtain more accurate weight length equations, larger sample sizes need to be looked at.

The ordinary least squares regression coefficients estimated from the log-transformed data can be used to compare relative condition differences among populations or to assess temporal changes in condition within a population (Cone, 1989). If regression slopes of two populations are similar, a larger intercept could indicate a population in better condition, or at least heavier at a given length. Likewise, a greater slope would indicate better condition if population intercepts were similar. Intersecting regression lines (one population having a higher slope but lower intercept than another) could indicate general differences in condition among broad sized categories of individuals (Pope and Kruse, 2001).

Comparisons of the 2000 data to the 2002 data indicated that the 2002 samples produced a higher slope but a lower intercept than the 2000 samples. Additionally, comparison of the Mustique and Canouan data indicated that the Mustique samples produced a higher slope but a lower intercept than the Canouan samples. At a glance, these results may indicate that certain size categories of individuals are in better condition in 2002 than they were in 2000 or and vice versa. The same can be said for the Mustique and Canouan populations. However, as with the length-weight relationships one needs to look at larger sample sizes to make a more conclusive statement about the condition of red hind in the two areas.

Condition indices

Condition indices can be used to assess various aspects of fish populations, including the general health of fish stocks, the effects of management actions, community structure and environmental influences (Pope and Kruse, 2001). In order to compare fish condition of individuals taken from two different populations, data should be from fish of the same species and should have been collected on the same date (Williams, 2000). The Mustique and Canouan populations were therefore, chosen to investigate the coefficient of condition because samples were collected from these two locations on the same day. In addition, it was felt that these two areas could be separated into individual populations because of the distance separating them and because of the preferential selection of these areas by fishers, thus isolating them into different fishing zones.

The higher average Fulton's coefficient (K) value for the Mustique population indicates that this population is in a better condition than the Canouan population. This result is also demonstrated from the graph showing the relationship between red hind length and Fulton's index for the two populations (Figure 2). The difference in the condition of the populations could be due to the different types of gear employed by fishers exploiting these areas. Fishers from the mainland, who use mainly palangue, prefer the fishing grounds around Canouan while those in Bequia frequent the grounds around Mustique. There is less destruction of the habitat (from the gears used) around Mustique as compared to that of Canouan, which may result in the habitats and therefore the actual fish around Mustique being in better condition.

In addition, fishers from the mainland along with others from around the southern Grenadines congregate on the fishing grounds around Canouan resulting in more fishing pressure being applied to the stocks there. Therefore, it is expected that the population around Mustique, which possibly faces less fishing pressure, is healthier.

Conclusion

The information gathered from this study offers fishery managers in St. Vincent and the Grenadines information needed to begin the development of management plans for the red hind fishery. In addition, it highlights areas that fishers need to be educated about to not only protect the resource but also the environment that the resource depends on.

Recommendations

1) Condition indices should be used along with ecological, biological and environmental information to properly determine the condition of the fish being caught. It is therefore suggested that these indices be used along with other parameters and stock characteristics of the species to enable a more comprehensive understanding of the status of the resource.
2) It is important that other conventional methods such as spatial distribution and abundance techniques and eco-modelling be used in completing our understanding of the status of the resource.
3) The idea was to compare the condition indices for different years and seasons but no data was available to do this for red hind. It is recommended that data collection continues during different seasons and years and these be compared to ascertain the true seasonal and yearly condition of red hind in the waters of St. Vincent and the Grenadines.
4) Gear selectivity may be a confounding factor and so must be taken into consideration when comparing condition indices. However, because of the many gear types used for capturing red hind and other reef species and the non-target nature of the fishery, this may only become possible after many years of data collection. It is important that selectivity be looked at nonetheless.
5) An independent study needs to be carried out to determine the movement of red hind along the Grenadines Bank and between this bank and the mainland to determine if this is really a separation of red hind into separate populations.
6) In order to fill the gaps in the present data collection programme it may be necessary to employ surveys of this nature annually or as often as possible. Also, research by other institutions should be incorporated in the formulation of a comprehensive understanding of the status of the red hind resource of St. Vincent and the Grenadines.

7) Fishers need to be educated about the characteristics of habitats (e.g. coral reefs cannot regenerate within days) so as to improve their appreciation and understanding of habitat protection and destructive fishing practices.

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References

Can, Faith M, Nuri Bafiusta and Mustafa CEK. (2002). Weight-Length relationships for selected fish species of the small-scale fisheries off the south coast of Skenderun Bay. Turk J. Vet. Anim. Sci. 26: 1181-1183.

CFRAMP. (2001). Report of The 2000 Caribbean Pelagic And Reef Fisheries Assessment And Management Workshop. CARICOM Fishery Report No. 9 139 p.

Cervigón, F., Cipriani, R., Fischer, W., Garibaldi, L., Hendrickx, M., Lemus, A.J., Márquez, R., Poutiers, J.M., Robaina, G. and Rodríguez, B. (1993). FAO species identification sheets for fishery purposes. Field guide to the commercial marine and brackish-water resources of the northern coast of South America. FAO, Rome. 531p.

Human, Paul (1994). Reef fish identification: Florida, Caribbean, Bahamas. Paramount Miller Graphics, Inc. 396 p.

Hill, Loren G., William J. Matthews, Tony Schene and Kenneth Asbury. (1981). Notes on fishes of Grand River, Chouteau Creek, A Pryor Creek, Mayes Country, Oklahoma. *Proc. Okla. Acad. Sci.* 61: 77-77.

Oxenford, Hazel (1996). Project proposal for: Investigation of stock movements, distribution and migration of the primary seine fishery species, jacks (*Selar Crumenophthalmus*) and robins (*Decapterus spp*.) on the Grenada and St. Vincent shelves, and field-based validation of growth rates. MAREMP, University of the West Indies, Barbados. 20 p.

Panayotova, Marina. (2001). Growth parameters of the Black Sea sprat (*Sprattus sprattus* L.) during the period 1988-2000 along the Bulgarian Black Sea coast. Institute of Oceanology, Bulgarian Academy of Sciences, Varna.

Pope, Kevin L. and Carter G. Kruse (2001). Assessment of fish condition data. Chapter 10. Texas Tech. University.

Schneider, James C., P. W. Laarman, and H. Gowing. 2000. Length-weight relationships. Chapter 17 *in* Schneider, James C. (ed.) 2000. Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 25, Ann Arbor.

Sparre, P. and S. C. Venema (1992). Introduction to tropical fish stock assessment. Part 1. Manual. *FAO Fisheries Technical Paper* No 306.1 Rev. 1. FAO, Rome. 376 p.

Straker, Leslie E. (2001). The assessment of the reef fishery of St. Vincent and the Grenadines, using red hind (*Epinephelus guttatus* L.) and coney (*Cephalopholis fulva* L.) as indicator species. Msc. Thesis, University of Hull, England. 102 p.

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

Williams, J.E. (2000). The coefficient of condition of fish. Chapter 13 *in* Schneider, James C. (ed.) 2000. Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 25, Ann Arbor.

Table 1.0 Percent Landings of Red Hind from 1979 to 2001

Year	Red Hind Landings (lbs)	Total Landings (lbs)	Red Hind Landings as a Percent of Total Landings
1995	82, 771	1, 693, 747	4.9
1996	73, 979	1, 637, 487	4.5
1997	88, 252	1, 831, 432	4.8
1998	49, 620	2, 038, 670	2.4
1999	81, 602	1, 649, 809	4.9
2000	105, 624	1, 809, 355	5.8

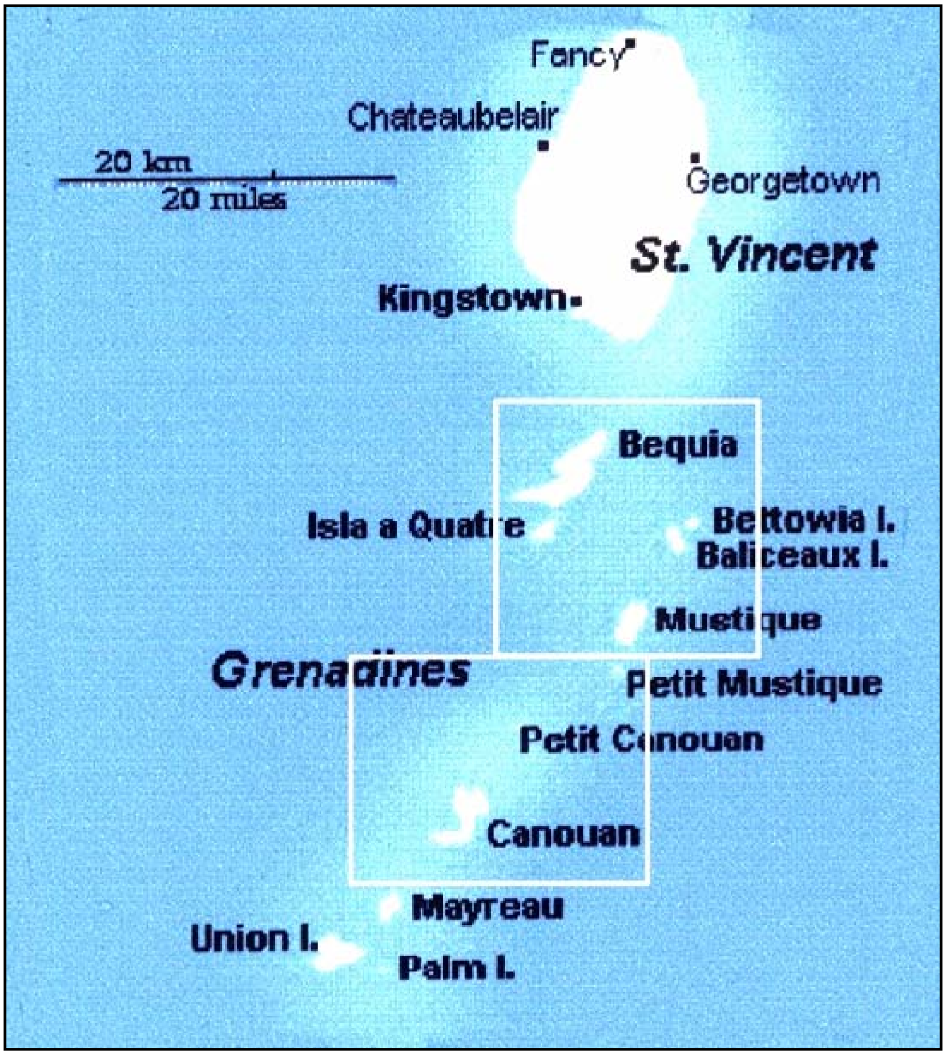

Figure 1. Map of St. Vincent and the Grenadines showing fishing grounds around Mustique and Canouan for red hind.

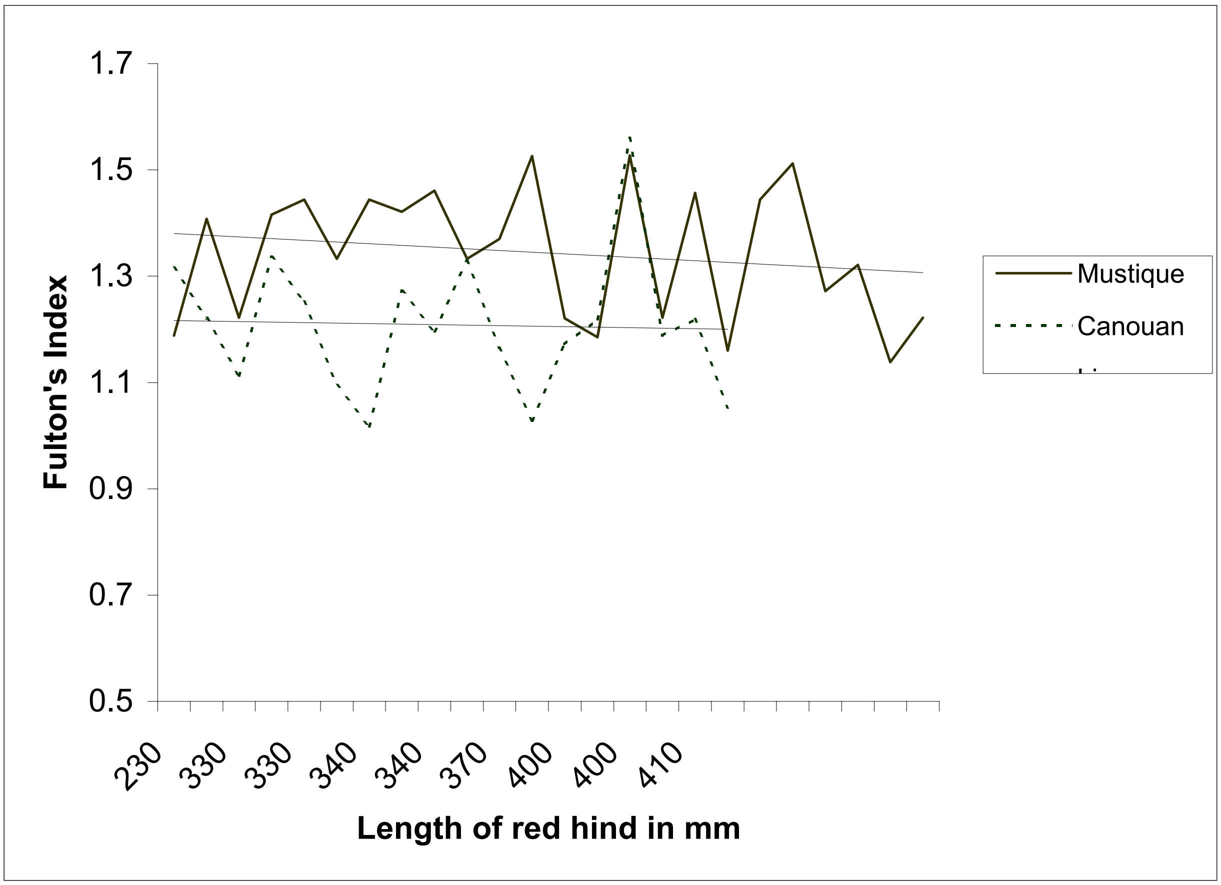

Figure 2. Comparison of the relationship between Fulton's Index and red hind length for Mustique and Canouan, with linear trend lines added.

APPENDIX

Questionnaire administered to fishers on mainland St. Vincent and in the Grenadine island of Bequia.

		Interview No………	Interview No………
Landing site name:			
Interview date *(dd/mm/yy):*			
Name of fisher:			
Vessel name/registration number:			
Vessel type *(pirogue; dinghy; speedboat; long liner; double ender; other, specify)*:			
Vessel length (*ft/m*):			
Vessel horsepower:			
Which fishing aids do you use? (*VHF; SSB radio; depth sounder; GPS; compass; other, specify*)			
Do you want to catch red hind when you go out fishing? (*Y/N*)			
What are the most common species you catch along with red hind?			
How often do you fish for red hind?	No. of days per week?		
	Which months in the year?		
Which areas are fished in which months?	Months		
	Areas		
Generally which area do you visit most to catch red hind?			
Why did you choose this area? (*easy to get to; larger red hinds; more red hinds; fewer fishers; good weather conditions; other, specify*)			
How often do you go to this area?	No. of times per week?		
	No. of times per month?		
	No of months per year?		
What is the usual amount of red hind most commonly caught in this area in a single fishing trip? (*note units*)			
What is the usual size of red hind most commonly caught in this area in a single			

fishing trip? (*note units*)				
What is largest size of red hind caught so far this year?		Total length		
		Weight		
Is there an area(s) you used to fish for red hind but now do not?		Area(s)		
		Year fishing stopped		
What are the reasons why you have changed your fishing location? (*less fish; smaller fish; more fishermen; better equipment; change of residence; other, specify*)				
What is the main gear(s) you use to catch red hind? (*bottom line; traps; spears; palangue; hand line; other, specify*)		Gear(s)		
		Since which year used?		
Is there any other gear you have used in the past apart from that one?		Gear		
		Reasons why not in use now		
Do you think that the amount of red hind in the sea around SVG is decreasing?		Yes / No		
		Since which year?		
Are there any management measures in place for red hind that you know of? (*size restrictions; gear restrictions; closed areas; closed seasons; other, specify*)				
What other measures do you think can be put in place that will help protect the red hind population and still be acceptable to local fishermen?				
Do you agree that limiting new people from coming into the fishery will help to protect the interests of those fishing now? (*Yes/No*)				
How can fishermen help to protect and manage the red hind fishery?				
Please describe the gear you use most	Palangue	No. of lines dropped from main line?		
		Total no. of hooks on palangue?		
		Hook size? *(inches)*		

often		Depth of hook/line/fishing? *(ft)*		
		Soak time? *(hours)*		
		No. of sets per trip		
	Handline	No. of hooks per line?		
		Hook size? *(inches)*		
		No. of lines per trip?		
		Soak time? *(hours)*		
		Depth of line? *(ft)*		
	Trap	Mesh size? *(L x W)*		
		No. of traps set?		
		Soak time? *(hours)*		
	Spear gun	Spear (hook) size? *(inches)*		
		No. of spears used per trip?		
What type of bait do you use to fish for red hind?				
Canouan Area	Cost of fuel needed to get to Canouan?			
	Distance form St. Vincent? (*miles)*			
	Usual weight of red hind caught there? *(lbs)*			
Mustique Area	Cost of fuel needed to get to Mustique?			
	Distance from St. Vincent? *(miles)*			
	Usual weight of red hind caught there? *(lbs)*			

The Use Of Statistical Techniques To Examine Analyse And Interpret Commercial Fisheries Data

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Introduction

This report is based on the presentation that was given at the 2002 Joint Meeting of the CRFM LPWG, RSWG & SCPWG Fisheries Working Groups. It is assumed that the data collection procedure is completed and also that the data have been entered into a spreadsheet ready for statistical analysis using SPSS. The report emphasises that notwithstanding the completion of the data entry procedures some time should be spent cleaning and examining the data before statistical analyses are attempted. It is recommended that the statistical analyses are as simple as possible; in many instances more complex statistical analyses do not reveal any major additional information. However, care should be taken to ensure that the analyses are valid and meaningful; in particular concomitant variables (covariates) have to be considered.

Initial manipulation of spreadsheet ready for analysis

Figure 1 is part of an SPSS spreadsheet of dolphin catch and effort, which was prepared, cleaned and analysed for the 2000 Caribbean Pelagic and Reef Fisheries workshop (CFRAMP 2001). It required approximately 1.5 working days to clean and examine this data from the SPSS data which was originally received. At the time the strong commitment of the various fisheries officers responsible for this data was noted. As a result this fairly lengthy cleaning process was neither tedious nor unrewarding. As a further emphasis to this, data received for the 2002 joint meeting was much cleaner and took much less time to examine.

An example of the data received in 2002 is shown in Figure 2. This is 1994-2001 catch and effort data from St Vincent and the Grenadines. The data contained a total of 5,008 records. There were 19 variables, of which only about half are visible in Figure 2. The variables were labeled as follows:

sequence; vesselid; fishery; intdate; day; month; year; repstate; sitelocn; crewsize; daysout; daysfish; gearcode; soaktime; areafish; species; weight; meastype; price

It is assumed that the meanings of these labels are well known to the reader.

Some of these variables are what SPSS terms “string variables”. These are variables which are non-numeric and probably contain characters other than the digits 0 to 9. Unfortunately SPSS can do very little with these string variables, so if they are to form any part of the analysis (even if only as classification variables) they must be recoded. A string variable such as *sequence* does not need to be recoded, as it will not be used in any analysis. Also *vesselid* may not need recoding unless it is desired to look for any effects of individual vessels. This is unlikely, especially as variables such as *crewsize* and *gearcode* can be used to differentiate between different vessel types. However of the variables visible (wholly or partially) in Figure 1, *fishery, repstate* and *sitelocn* will probably need recoding. Note that the string variable *intdate* will not be required for the analysis as the numeric variables *day, month* and *year* contain the same information.

The *intdate* variable was entered by the original data entry persons from the recording forms and these were then used to create *day, month* and *year*

The information in the string variables such as the fishery codes RF and MX does not have to be lost to less clear numbering as SPSS allows string variables to have labels for each of the numeric codes and these labels can be displayed in the spreadsheet in preference to the numeric values.

There are five fisheries codes as follows:

CP - coastal pelagic species
MX - mixed species
OP - oceanic pelagic species
RF - reef species
SL - slope fish species

These were recoded (using the SPSS recode facility) as CP-1; MX-2; OP-3; RF-4; SL-5. The labels used were the full description (e.g. 'reef species' rather than 'RF') to ensure that the SPSS statistical analyses output were as clear as possible. Figure 3 shows part of the SPSS spreadsheet after recoding of *fishery, restate, sitelocn* and some other variables which are not visible. The value labels are switched on so we see entries such as 'reef species', 'Greathead', but in reality SPSS is storing these values as numbers. The variable names were changed slightly, for example *fishery* became *fishcode.* This is because it is not easy to recode a variable into itself; it is better to create a new variable and delete the old one. However, the old spreadsheet should always be preserved, possibly on the diskette which was received or maybe in another folder. Then all is not lost if there are any errors made in recoding (such as recoding two previous categories into a single category).

As well as recoding the field widths were narrowed and reducing all the field widths to the maximum necessary reduced the size of the file from 636KB to 403KB. For example the numeric variable *month* will take numbers in the range 1 to 12, so the field width should be declared as '2'. Any field width wider than '2' will increase the size of the file.

Examination and cleaning of the data

Having got the spreadsheet in a form that all the data can be examined it is now possible to run some SPSS routines. Note, however, that we are not yet ready to run any analyses, as we do not know how clean our data are. It is possible that there are many errors and these may affect the outcome and interpretation of any statistical analysis.

A good way to start is to run frequencies on all categorical variables and descriptives on all quantitative variables. As previously noted the first two variables on the spreadsheet, *sequence* and *vesselid* are not going to be used in the analyses, so it probably is not worth the trouble to examine these. But *fishcode* is important and so the SPSS frequencies routine was run with the result displayed in Figure 4.

Here we see proof of the improvement of data collection and entry procedures since the 2000 meeting. All 5,008 records have valid fishery codes (something that did not happen with the 2000 data!), so we do not have to go back and examine the data for unknown codes. Note here that if there were any strange codes, these would have been converted to missing at the recoding, so we would need to go back to the original data received to find what the rogue codes were. So if the original dataset (as received) was not saved, we would have lost any chance of trying to decide what the unknown codes should have been. This would be particularly serious if in fact the unknown code was really a valid code which was carelessly omitted from the codes list.

Some of the SPSS frequencies output is often redundant or even misleading. The Frequency and Percent columns are clear enough. The valid percent eliminates any missing values, so if there are no missing values, as here, it does not add any information. The cumulative percent is only useful if the categories are continuous, so here again it does not give any useful information. Unfortunately it is not possible to suppress or delete the Valid Percent and Cumulative Percent columns.

The SPSS frequencies directive has the option of a bar chart output. The output of this option for *fishcode* is shown in Figure 5. Many people find graphics easier to understand than numerical tables. In this case the graphics illustrates very clearly what should have been evident from the frequency table in Figure 4. Only three of the five fishery types appear with any frequency in this data set with reef species predominating at over 60% of the total. Do not forget that although Figure 5 brings home the message more forcibly, Figure 4 contains the hard scientific data.

Another categorical variable which needs to be examined for possible strange codes is *sitelocn* which has been recoded into *stelocat* – 'Site Location'. Here 34 site location codes were supplied:

ADBA - Admiralty Bay
ASHT - Ashton Bay
BARR - Barrouallie
BIAB - Biabou
TRVS - Trading vessels (Grenadines)
BRIT - Britannia Bay
BUBA - Buccament Bay
CALL - Calliaqua
CAPA - Camden Park
CHAT - Chateau Belair
CLIF - Clifton Bay
CLVA - Claire valley
DARK - Dark View
FANC - Fancy
FITZ - Fitz Hughes
FRBA - Friendship Bay
GRBA - Greathead Bay
INBA - Indian Bay
LAYO - Layou
NKFM - New Kingstown Fish Market
LOBA - Lower Bay
LOWM - Lowman's Bay
LPBA - La Pomme
MUST - Mustique
OWIA - Owia
PAFA - Paget Farm
PALM - Palm Island
PENE - Petit Nevis
PEBO - Petit Bordel
QUES - Questelles
PFFC - Paget Farm Fishing Centre
ROBA - Rose Bank
SABA - Sandy Bay
TROU – Troumaca

Frequencies were again run; these are not presented here. However there were seven missing values noted in the 5001 observations. As explained above these missing values could be due to a code which is not listed above, or perhaps a code above wrongly entered. For example ABDA instead of ADBA. In this case the missing values turned out to be seven records where no site location code was entered; the field was left blank.

Gear code is obviously a very important categorical variable. Twelve possible gear codes were supplied:

BLIN - bottom long line
BSNE - beach seine
DIVE - free dive
FPOT - fish pot
GNET - gill net
HLIN - handline
PALN - palangue or longline
POTS - fish pot
SCUB - dive operation with scuba gear
SGUN – spear gun
SLIN - surface longline
TROL - trolling gear

When the frequencies procedure was first run, there were 205 missing values. The data were examined closely and it was discovered that the spear gun code (SGUN) had been omitted from the list of possible codes. This indicated that errors can arise after data entry and be caused by those who are trying to check for errors. Vigilance is required at all stages. When the missing code was inserted and frequencies rerun, SPSS output shown at Figure 6 was obtained.

All is now OK; the 205 values for 'spear gun' are in the table where they should be and not as missing values. The corresponding bar chart is shown as Figure 7. In this bar chart the rather long value labels have caused some formatting problems. The frequency table and bar chart both indicate that over 80% of the records were either 'handline' or 'palangue or longline'

Measure type (*meastype)* is an important variable. It indicates the units of the weight of fish recorded (*weight).* In this case all 5008 entries turned out to be 'RP' or 'rounded pounds'. In much of the 2000 data measure type was mixed. In that case *weight* had to be recoded using a logical equation. If *meastype* was rounded pounds weight was not changed, but if it was kilograms or some other unit weight had to be multiplied by an appropriate conversion factor.

It should be mentioned here that it is strongly recommended that data are recorded in units most familiar to the respondent. So if fish are being weighed in one unit at one site and another unit at another, then the data should be recorded as weighed with the measure type field appropriately coded. The data are also entered as recorded. The software will then be used to adjust to standard units. Attempts to standardise at data collection and data entry stages are likely to lead to errors which may be hard to detect.

When frequency checks are completed on all the categorical type data then the quantitative type data can be examined using the SPSS descriptives command. We can start with *weight* as this is obviously a very important variable. As already mentioned measure type was always rounded pounds, so there is no need to do any recoding of that variable. Figure 8 shows the descriptives for *weight.*

In common with all weight data noted from these studies, this data set seems to have a skewed distribution. The 5% trimmed mean (calculated by finding the 5% of observations which comprise the largest values and the 5% which comprise the smallest values and eliminating these before computing the mean of the remaining 90%) is somewhat below the raw mean, but more significantly the median is well below the mean. The standard deviation is almost equal to the mean. This suggests a Poisson or Negative Binomial rather than a Normal distribution. The maximum value is well above the mean and the skewness statistic is large compared to its standard error. There is no evidence of any kurtosis (the value of this statistic is 3 if there is no kurtosis). It should be noted here that the standard error of the mean (s.e.m.) is small only because this is a large data set. Remember that s.e.m. is obtained by dividing the standard deviation by the square root of the number of observations. In turn the confidence intervals for the mean are calculated from the s.e.m. so their relative closeness is again a reflection of the large data set and is certainly not necessarily an indication that many or most of the values are close to the mean. It should also be remembered that the standard errors of skewness and kurtosis are a direct calculation from the number of observations. Thus all data sets with the same number of observations will always have the same standard errors for skewness and kurtosis. Therefore these standard errors (for skewness and kurtosis) don't give much information; they just help to remind of the size of the data set.

A very useful way of examining quantitative data is to draw a stem-and-leaf plot as shown in Figure 9. In this example the stem width is given as 10.00. This means that for the weight data the stem represents the 'tens' digit and the leaf the 'units' digit.

Each leaf (i.e. digit on the right) represents 25 cases.

Thus there are 506 weights between 0 and 4.9 of which about 75 are between 1 and 1.9 (represented by the three '1' leaves) and about 100 between 2 and 2.9 (represented by the four '2' leaves). The' &' indicates that there are other leaf values (in this case 0 to 0.9 which could include some zero weights) with less than 25 cases when rounded (actually less than 13 cases)

Lower in the plot we see 103 weights between 50 and 54.9; about 50 of these are between 50 and 50.9; 25 between 53 and 53.9; 25 between 54 and 54.9. There are a small number of cases (less than 13) with some or all of the leaf values which are not listed (51 and 52)

There are 205 extreme values (larger than 67).

The stem-and-leaf plot resembles a detailed histogram rotated through 90°. In fact SPSS will allow the user to rotate as can be seen from the invitation at the bottom left of Figure 9 to "Double click to edit pivot table". Although we cannot do this pivoting now, we can swivel our heads and see the skewed nature of the histogram represented by the stem-and-leaf plot.

No proper examination of a quantitative variable is complete without a box plot and this is shown for *weight* in Figure 10.

This box plot brings out clearly the skewed nature of the variable *weight*. The box indicates the quartile range with the median identified. The antennae indicate the range of the other values excluding the extreme values, which are labeled with case numbers outside the antennae. Labeling with case numbers enables us to find and check these extremes. Most of these extreme values are probably valid.

We must beware any assumptions of normality; as indicated previously the data are most likely Poisson or Negative Binomial. Unfortunately the SPSS GLM (General Linear Models) directive does not allow us to specify non-normal distributions – so it is not really very "general". In 2000 we overcame this by transforming the weight data by the loglog transformation (y = log(log(x))). Examination of the box plots after a log transformation still suggested a skew distribution, but after taking logs of the log transformed data the box plot looked quite normal.

If data are normally distributed, then the median should be in the middle of the box and the antennae on either side of the box should be of the same length. There should not be too many outliers.

Another variable recorded is *price.* Figures 11, 12 and 13 show, respectively, the descriptives, stem-and-leaf plot and box plot for *price.* The descriptives suggest that price is even more skewed than weight. Here the standard deviation is three times the mean, a very unusual situation when there are no negative values.

The complete stem-and-leaf plot is not visible in Figure 12 but it can be seen that most of the prices are values such as $4.00, $4.50, $5.00 and $6.00. However there are 444 extremes of less than or equal to $2.00.

The entire box plot is visible in Figure 13, although the print is too small to try to pinpoint the many outliers. This box plot reveals that there are many prices over $100.00 (the descriptives gave a maximum price of $348.00). Compared to the overall range the box of the quartile range has squashed almost to a single line. Clearly the data needs a lot of cleaning before any analysis of price can be attempted. There are many zero price values and how can price which is usually around $4.00 to $6.00 (price per pound?) sometimes rise to over $100.00? Enquiries revealed that price is not properly sampled for each fishing trip, and an average value may be used and changed arbitrarily. Also the units of price do not seem to have been understood and agreed before the data were collected; perhaps data entry errors also contributed something to these problems.

Analysis of the data

This section will assume that the main interest in these data is the effect on *weight* of the other variables observed. The oldest, and perhaps still the best known, statistical technique for examining this interest is multiple regression. It should be mentioned that before the development of electronic computers even this technique was impractical for the type of multivariate situation we have here. Without computer software to aid us multiple regression with more than about four independent variables is a very challenging computational situation.

If a multiple regression is to be attempted here it will be necessary to create dummy variables to represent independent variables such as *grcode (gearcode)* which represent qualitative rather than quantitative effects. There are seven gear codes so it is necessary to create seven dummy variables, one representing each gear code.

Figures 14 and 15 show part of the SPSS spreadsheets before and after creating the dummy variables for the gear codes. Each of the dummy variables created, namely *freedive, fishpot, handline, palangue, scuba, speargun* and *trollgea* takes the value of unity (1) when the record represents the corresponding gear code and the value zero (0) otherwise. All the records visible in Figure 15 are 'palangue or longline' so all the dummy gear code variables except *palangue* are set to zero. Notice that the value labeling is still switched on so instead of seeing the stored values of unity for *palangue* we can see the value labels.

When running a multiple regression some type of backward or forward selection procedure should be adopted with the best advice usually being to select a stepwise forward procedure starting with the null model. This means that the routine will initially fit a model with just a constant term. It will then look among the declared independent variables (including dummy variables if these exist) for the variable that best fits the dependent variable of interest, *weight* in this case. It will then fit a model with a constant and this independent variable. Then it will search for the variable which, together with the variable already selected, best fits the dependent variable. Note that this may not be a variable which fitted well before the selection of the first variable. On the other hand there may be variables which were close to selection at the previous stage which are now far from selection. This is because several of the independent variables may be correlated with each other and fitting one of these effectively eliminates the need to fit another.

The above process is repeated adding a variable at a time until none of the variables not included would add significance to the fit according to some defined stopping rule, usually based on some significance level such as 5% or 10%.

A multiple regression fits a model to the independent variable but is not the easiest way to compare the effect on the dependent variable of different levels of an independent variable, for example the effect of crew size on weight of fish caught. For this a General Linear Model (GLM) can be employed. Here the model fitted becomes less important than the effects of the variables. The well known Analysis of Variance (ANOVA) procedure is now recognised as a special case of a GLM. Another advantage of GLMs is that dummy variables are automatically taken care of without having to recode. Indeed the user of a GLM routine has to make the distinction between continuous and categorised (or what we have been calling quantitative and qualitative) variables.

GLMs do not only include normal distributions but other ‘link’ distributions can be specified, e.g. Poisson. However as already mentioned the SPSS GLM routine does not have the facility of specifying non normal distributions, so it may be necessary to transform variables before doing a GLM with SPSS.

Another refinement of GLM not available with SPSS (and this one is not available with most software) is the General Additive Model (GAM). Here the relationship with the independents does not have to be linear but can be quadratic, cubic etc. The only way to fit GAMs with most software is to create new variables which are squares, cubes etc. of the original continuous (quantitative) variables. Clearly there is no need to consider the squares, cubes etc. of dummy variables.

Although we have not yet decided how to transform the skewed weight variable (possible options are square root, log and loglog) a GLM analysis with weight untransformed was run and part of the output shown in Figure 16. Here there was an error as the dummy variables were used for the gear codes instead of the variable *grcode* appropriately specified as categorised (qualitative). However this ‘incorrect’ analysis is presented as it reveals that all the gear codes are confounded with other variables.

The order of fit of a GLM is very important and it will be noticed in Figure 16 that *year* was the last variable fitted. This is because it was thought that the main interest in the fitting of *weight* was to see if there were any year to year variations. For this reason *year* was fitted as a categorised (qualitative) variable. If this was not done then the routine would only use 1 degree of freedom for *year* and this would only be significant if there were a linear trend over the period. We are interested in any variation from year to year even if that variation does not have a pattern. In other words even if we were fitting a GAM *year* would still have been a categorised variable. In fact in this exploratory analysis other variables such as *soaktime* and *daysfish* are also categorised; it would not make much sense doing this in the final analysis.

Fitting *year* last ensures that any effects observed for year are not really due to something else (e.g. crew size varying from year to year; more fishing in some months in some years; etc.).

The first striking thing about this analysis has already been mentioned. There are no degrees of freedom (and zero sum of squares) for all the gear code dummy variables. This means that all of the gear codes have unique values of the (categorised) variables previously fitted (e.g. *soaktime, daysfish*).

As often happens with large data sets most effects are significant with the exception that *daysout* does not seem to affect weight after the effects of *month* and *crewsize* have been fitted. This is probably because *daysout* and *crewsize* may be correlated.

Even after fitting all the other variables (or perhaps 'over fitting' would be the best description as there are many unnecessary categorised variables) *year* is still very significant and a post hoc analysis for this variable would be very interesting. Part of this post hoc analysis is shown in Figure 17.

The part of the analysis visible shows the quite dramatic result that weights in 2001 were much higher than in the other years under study. In fact the other seven years, 1994 to 2000, fall into two groups with catches for 1996, 1999 and 2000 being higher than for 1994, 1995, 1997 and 1998. Thus there is a fairly clear trend of generally increasing weights of catch.

This explanatory analysis has given such a clear result, for the effect of *year* on *weight,* that it is not really necessary to do much more to investigate this. If only SPSS is available *weight* should be transformed and variables such as *crewsize, daysfish* and *soaktime* should be declared as continuous (quantitative) whereas *grcode* needs to be categorised (qualitative). If some other software is in use then a Poisson or negative binomial GLM should be fitted. However, as mentioned above, the main finding has already been revealed.

It is worth mentioning here that it may be tempting to start the exploratory analysis with mean catches (*weight)* by a factor of interest (e.g. *year* or *month)*. However this may not be useful and could be misleading as there are many covariates which may not be constant over time. A GLM with the variables of most interest fitted last will safeguard against such misleading conclusions.

Another model fitting type of approach to this type of fisheries data is the use of regression trees. Figure 18 is taken from ICCAT (1998) and shows a pruned regression tree.

In Figure 18 the terminal node is YFT size and if this is 0-10 kg, then the yellowfin catch per hour fishing (YFC) is 0.0420 kg. The right side of the tree indicates the nodes for YFT size other than 0-10kg. If SETTYPE is free and LONG5 less than 5˚ then YFC is 0.4109. The reader is supposed to notice the YFC of 22.1200 at the node representing YFT size not 0-10kg; SETTYPE free; LONG5 not less than 5˚; FISHYR not 1991,1992,1994,1995; MONTH not 5,7,8,9,10; FISHYR not 1996; LONG5 less than 10˚ and VESSELCAT not 5 or 6. One is forced to wonder whether this is a genuine result or whether the apparent catch of about 20 times the normal for certain conditions is based on a very small number of rather unusual observations represented at the node. There is no evidence of widespread use of regression trees. The only conclusion must be that the jury is still out.

Bayesian methods have been suggested for fisheries data of this type (Walters and Ludwig, 1994). This suggestion does not yet seem to have found any widespread adoption, but it would be advisable to remain abreast of the current literature to see if there is any evidence of adoption and whether such methods might be applicable to Caribbean data.

Some conclusions

Large data sets will contain some errors. Besides errors made in data collection, data entry personnel are also making errors. In today's busy world it is not always possible to employ the old techniques of entering data twice and checking for consistency.

Data with coded values e.g. *fishery, gearcode, sitelocation* and *areafish* need to be checked to see whether there are any missing or unusual codes.

Numeric data (e.g. *soaktime, price, crewsize, weight* etc) need to be examined to see if these are unexpectedly large or small values. There may of course be values within expected ranges which are still wrong. These will not necessarily be picked up by data checks, but if they are not too numerous and if the data set is large they will not have a big influence on the analyses and conclusions. Unexpectedly large or small values can, however, impact considerably on the analysis even if the data set is large.
Data should be examined for distribution pattern if the method of analysis has assumptions which may be violated.
If there are extreme values which are valid consideration should be given as to whether any data rescaling is necessary.
Much more time will usually be spent examining and cleaning data than doing the formal analyses. Some analyses which may be considered are:

- Stepwise multiple regression (some variables may need transforming)
- General Linear Models (GLM) (Poisson or negative binomial link)
- General Additive Models (GAM) (Poisson or negative binomial link)
- Regression trees
- Bayesian methods

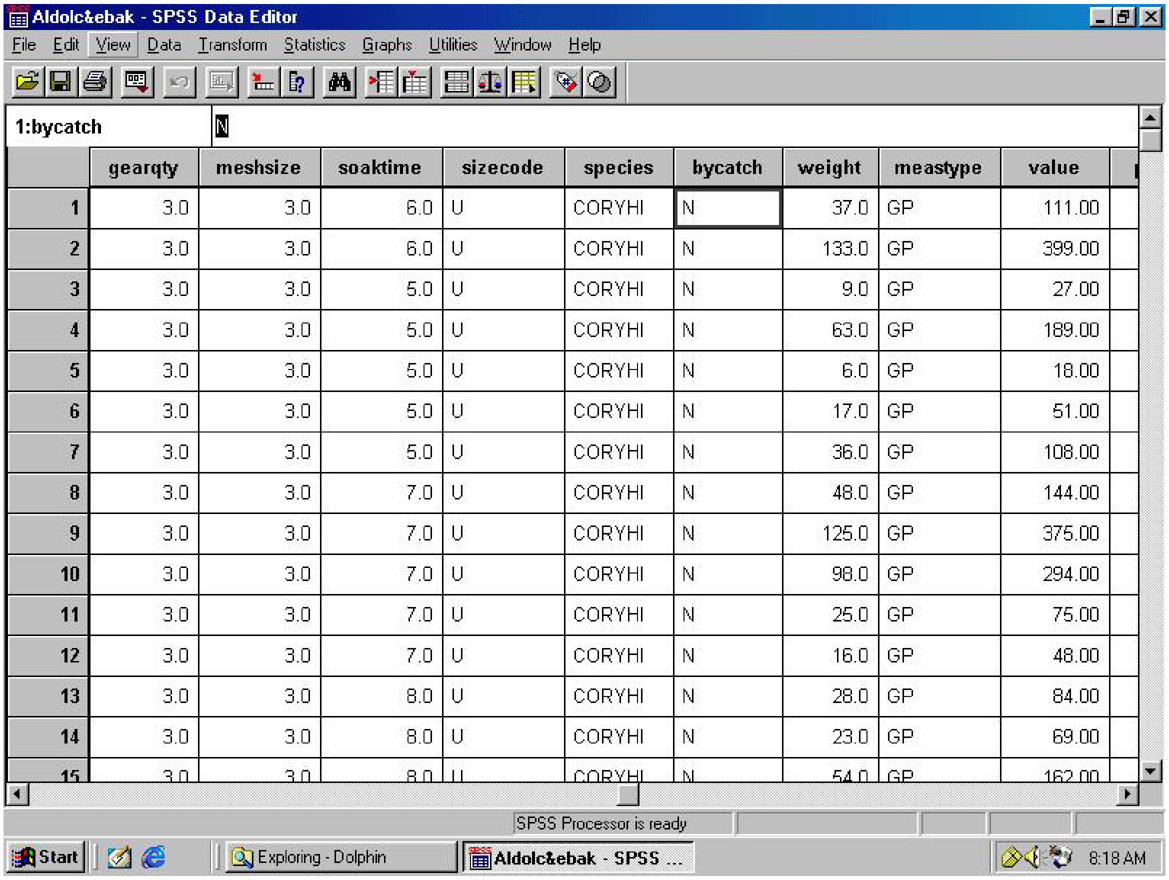
Work elsewhere has usually focused on the first three methods bulleted above; but as noted elsewhere literature should be continually monitored for new and innovative ways of examining and analyzing data.

References

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

ICCAT. 1998. Report of the ICCAT workshop on abundance indices from tropical tuna surface fisheries. Miami, Florida, USA – May 11 to 15 1998. International Commission for the Conservation of Atlantic Tunas. 35p.

Walters C J and Ludwig D. 1994. Calculation of Bayes posterior probability distributions for key population parameters. Can J Fish Aquat Sci. 51. 713-722.



	gearqty	meshsize	soaktime	sizecode	species	bycatch	weight	meastype	value
1	3.0	3.0	6.0	U	CORYHI	N	37.0	GP	111.00
2	3.0	3.0	6.0	U	CORYHI	N	133.0	GP	399.00
3	3.0	3.0	5.0	U	CORYHI	N	9.0	GP	27.00
4	3.0	3.0	5.0	U	CORYHI	N	63.0	GP	189.00
5	3.0	3.0	5.0	U	CORYHI	N	6.0	GP	18.00
6	3.0	3.0	5.0	U	CORYHI	N	17.0	GP	51.00
7	3.0	3.0	5.0	U	CORYHI	N	36.0	GP	108.00
8	3.0	3.0	7.0	U	CORYHI	N	48.0	GP	144.00
9	3.0	3.0	7.0	U	CORYHI	N	125.0	GP	375.00
10	3.0	3.0	7.0	U	CORYHI	N	98.0	GP	294.00
11	3.0	3.0	7.0	U	CORYHI	N	25.0	GP	75.00
12	3.0	3.0	7.0	U	CORYHI	N	16.0	GP	48.00
13	3.0	3.0	8.0	U	CORYHI	N	28.0	GP	84.00
14	3.0	3.0	8.0	U	CORYHI	N	23.0	GP	69.00
15	3.0	3.0	8.0	U	CORYHI	N	54.0	GP	162.00

Figure 1. Dolphin catch and effort data analysed for 2000 Caribbean Pelagic and Reef Fisheries workshop.

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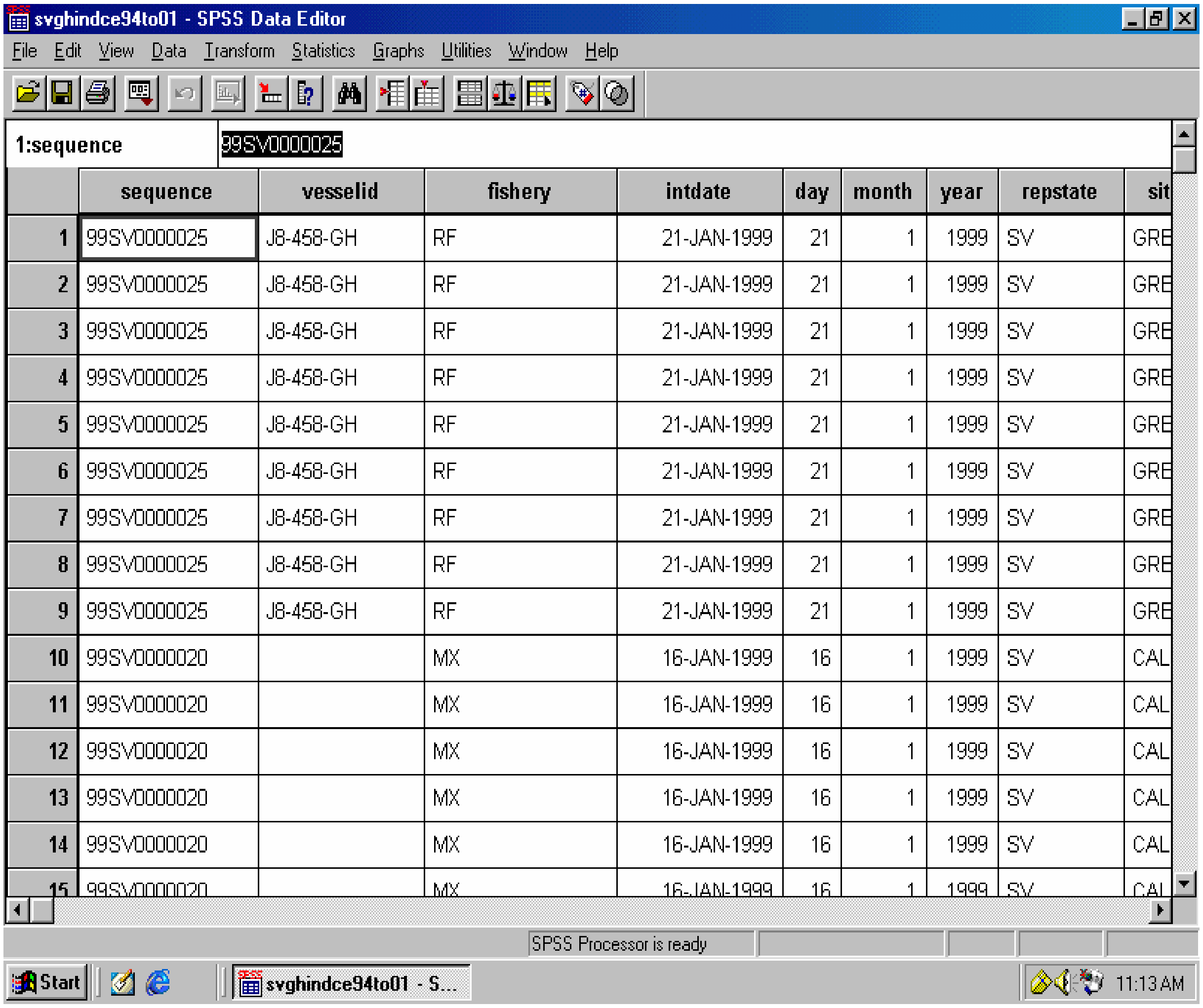
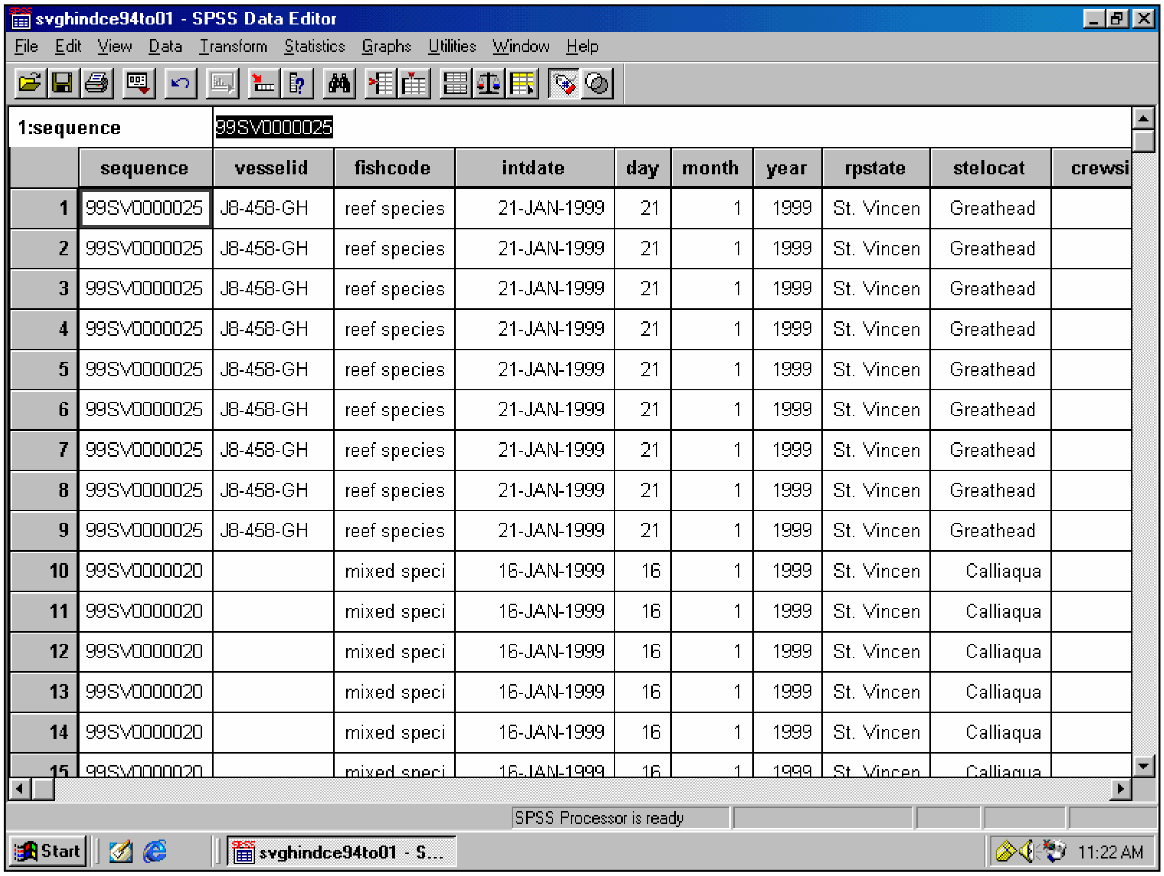


	sequence	vesselid	fishery	intdate	day	month	year	repstate	sit
1	99SV0000025	J8-458-GH	RF	21-JAN-1999	21	1	1999	SV	GRE
2	99SV0000025	J8-458-GH	RF	21-JAN-1999	21	1	1999	SV	GRE
3	99SV0000025	J8-458-GH	RF	21-JAN-1999	21	1	1999	SV	GRE
4	99SV0000025	J8-458-GH	RF	21-JAN-1999	21	1	1999	SV	GRE
5	99SV0000025	J8-458-GH	RF	21-JAN-1999	21	1	1999	SV	GRE
6	99SV0000025	J8-458-GH	RF	21-JAN-1999	21	1	1999	SV	GRE
7	99SV0000025	J8-458-GH	RF	21-JAN-1999	21	1	1999	SV	GRE
8	99SV0000025	J8-458-GH	RF	21-JAN-1999	21	1	1999	SV	GRE
9	99SV0000025	J8-458-GH	RF	21-JAN-1999	21	1	1999	SV	GRE
10	99SV0000020		MX	16-JAN-1999	16	1	1999	SV	CAL
11	99SV0000020		MX	16-JAN-1999	16	1	1999	SV	CAL
12	99SV0000020		MX	16-JAN-1999	16	1	1999	SV	CAL
13	99SV0000020		MX	16-JAN-1999	16	1	1999	SV	CAL
14	99SV0000020		MX	16-JAN-1999	16	1	1999	SV	CAL
15	99SV0000020		MX	16-JAN-1999	16	1	1999	SV	CAL

Figure 2. St. Vincent and the Grenadines 1994-2001 catch and effort data on red hind as received before the 2002 Joint Meeting of the Fisheries Working Groups.



	sequence	vesselid	fishcode	intdate	day	month	year	rpstate	stelocat	crewsi
1	99SV0000025	J8-458-GH	reef species	21-JAN-1999	21	1	1999	St. Vincen	Greathead	
2	99SV0000025	J8-458-GH	reef species	21-JAN-1999	21	1	1999	St. Vincen	Greathead	
3	99SV0000025	J8-458-GH	reef species	21-JAN-1999	21	1	1999	St. Vincen	Greathead	
4	99SV0000025	J8-458-GH	reef species	21-JAN-1999	21	1	1999	St. Vincen	Greathead	
5	99SV0000025	J8-458-GH	reef species	21-JAN-1999	21	1	1999	St. Vincen	Greathead	
6	99SV0000025	J8-458-GH	reef species	21-JAN-1999	21	1	1999	St. Vincen	Greathead	
7	99SV0000025	J8-458-GH	reef species	21-JAN-1999	21	1	1999	St. Vincen	Greathead	
8	99SV0000025	J8-458-GH	reef species	21-JAN-1999	21	1	1999	St. Vincen	Greathead	
9	99SV0000025	J8-458-GH	reef species	21-JAN-1999	21	1	1999	St. Vincen	Greathead	
10	99SV0000020		mixed speci	16-JAN-1999	16	1	1999	St. Vincen	Calliaqua	
11	99SV0000020		mixed speci	16-JAN-1999	16	1	1999	St. Vincen	Calliaqua	
12	99SV0000020		mixed speci	16-JAN-1999	16	1	1999	St. Vincen	Calliaqua	
13	99SV0000020		mixed speci	16-JAN-1999	16	1	1999	St. Vincen	Calliaqua	
14	99SV0000020		mixed speci	16-JAN-1999	16	1	1999	St. Vincen	Calliaqua	
15	99SV0000020		mixed speci	16-JAN-1999	16	1	1999	St. Vincen	Calliaqua	

Figure 3. St. Vincent and the Grenadines 1994-2001 catch and effort data on red hind after recoding and reducing field widths.

Fish code

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	coastal pelagic species	944	18.8	18.8	18.8
	mixed species	880	17.6	17.6	36.4
	oceanic pelagic species	44	.9	.9	37.3
	reef species	3091	61.7	61.7	99.0
	slope fish species	49	1.0	1.0	100.0
	Total	5008	100.0	100.0	
Total		5008	100.0		

Figure 4. St. Vincent and the Grenadines 1994-2001 catch and effort data on red hind. SPSS output from frequency of *fishcode.*

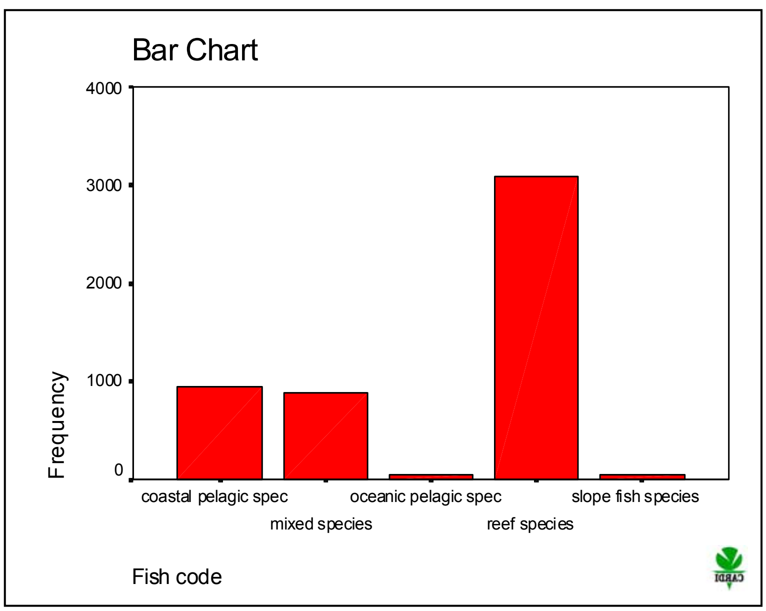


Figure 5. St. Vincent and the Grenadines 1994-2001 catch and effort data on red hind. Bar chart output from SPSS frequency of *fishcode*

Gear code

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	free dive	35	.7	.7	.7
	fish pot	235	4.7	4.7	5.4
	handline	2141	42.8	42.8	48.1
	palangre or longline	2104	42.0	42.0	90.2
	dive operation with scu gear	208	4.2	4.2	94.3
	spear gun	205	4.1	4.1	98.4
	trolling gear	80	1.6	1.6	100.0
	Total	5008	100.0	100.0	
Total		5008	100.0		

Figure 6. St. Vincent and the Grenadines 1994-2001 catch and effort data on red hind. SPSS output from frequency of *gearcode.*

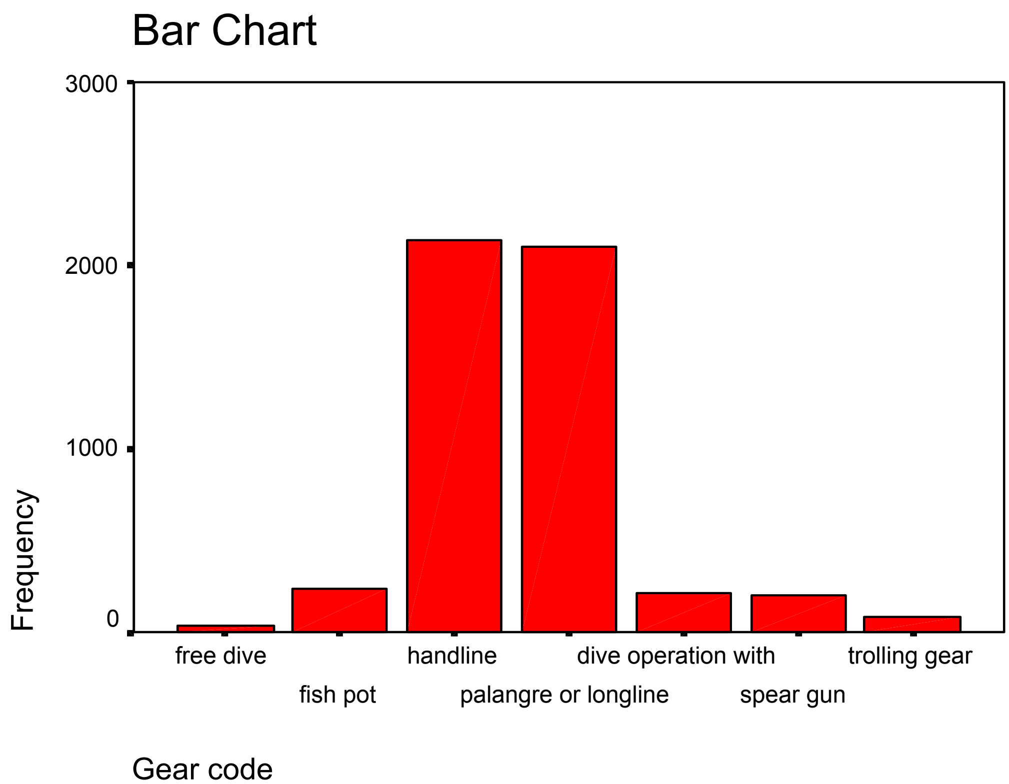


Figure 7. St. Vincent and the Grenadines 1994-2001 catch and effort data on red hind.
Bar chart output from SPSS frequency of *gearcode.*

Descriptives

			Statistic	Std. Error
WEIGHT	Mean		22.1622	.2734
	95% Confidence Interval for Mean	Lower Bound	21.6263	
		Upper Bound	22.6982	
	5% Trimmed Mean		20.2348	
	Median		15.4000	
	Variance		374.256	
	Std. Deviation		19.3457	
	Minimum		.50	
	Maximum		150.00	
	Range		149.50	
	Interquartile Range		23.0000	
	Skewness		1.624	.035
	Kurtosis		3.231	.069

Figure 8. St. Vincent and the Grenadines 1994-2001 catch and effort data on red hind. SPSS output from descriptives of *weight.*

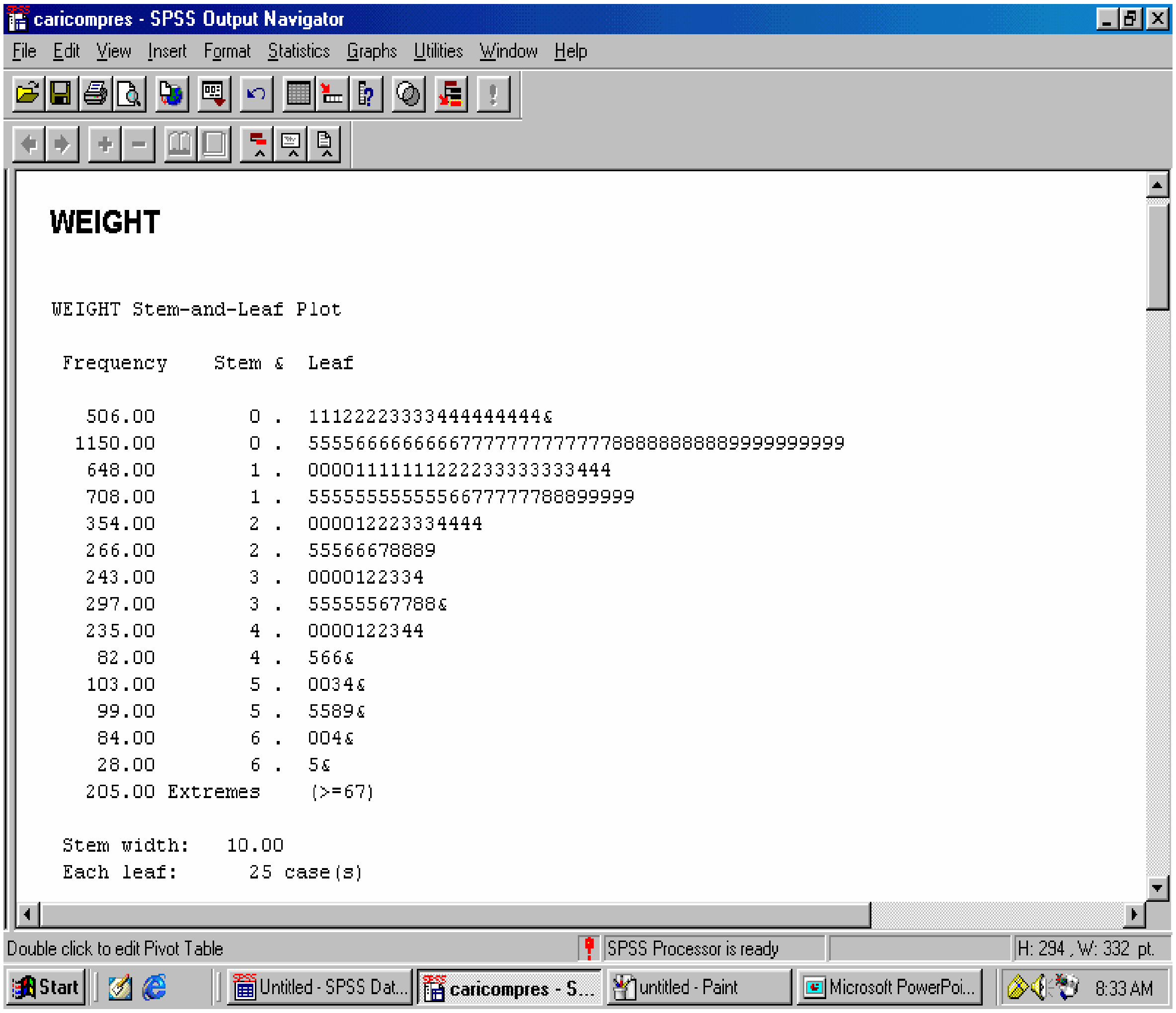


Figure 9. St. Vincent and the Grenadines 1994-2001 catch and effort data on red hind. Stem-and-leaf plot of *weight* as output by SPSS.

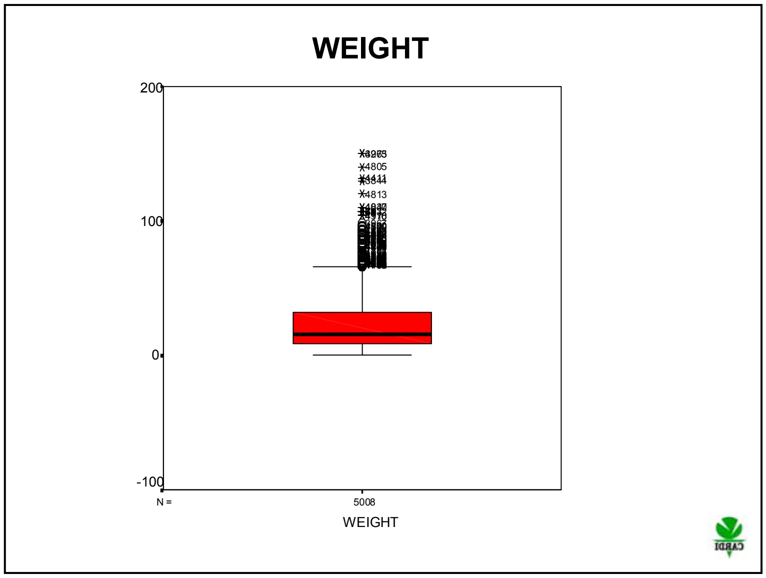


Figure 10. St. Vincent and the Grenadines 1994-2001 catch and effort data on red hind. Box plot of *weight* as output by SPSS.

			Statistic	Std. Error
PRICE	Mean		8.4275	.3749
	95% Confidence Interval for Mean	Lower Bound	7.6925	
		Upper Bound	9.1625	
	5% Trimmed Mean		4.8747	
	Median		4.5000	
	Variance		703.891	
	Std. Deviation		26.5309	
	Minimum		.00	
	Maximum		348.00	
	Range		348.00	
	Interquartile Range		1.5000	
	Skewness		9.895	.035
	Kurtosis		108.345	.069

Figure 11. St. Vincent and the Grenadines 1994-2001 catch and effort data on red hind. SPSS output from descriptives of *price.*

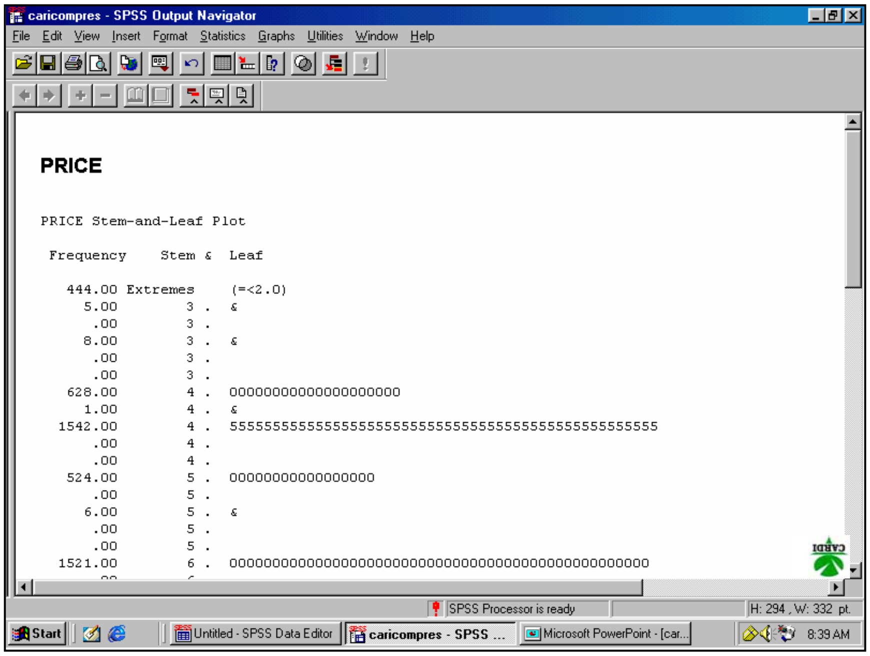


Figure 12. St. Vincent and the Grenadines 1994-2001 catch and effort data on red hind. Stem-and-leaf plot of *price* as output by SPSS.

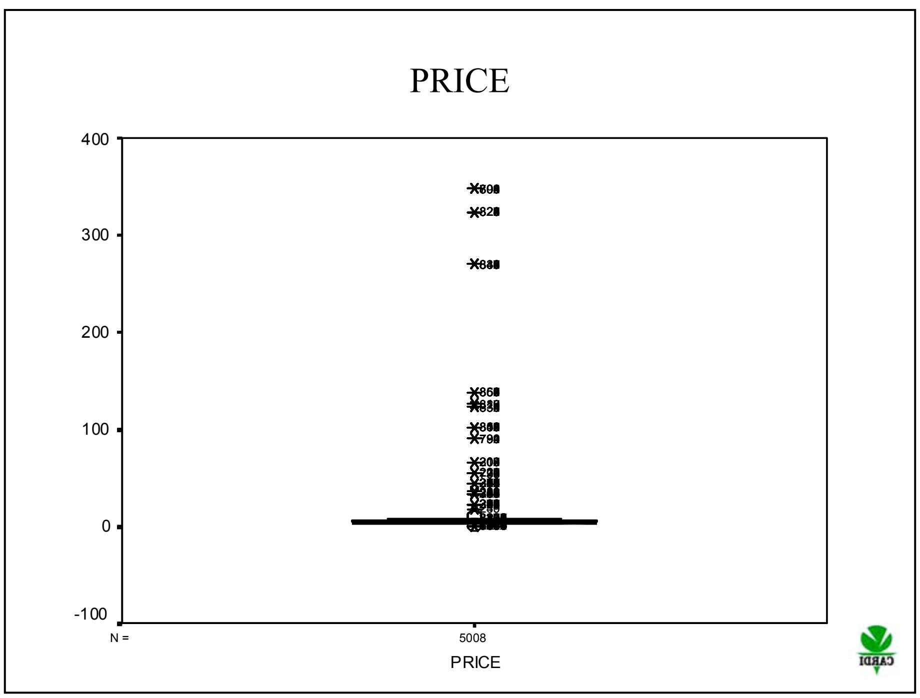
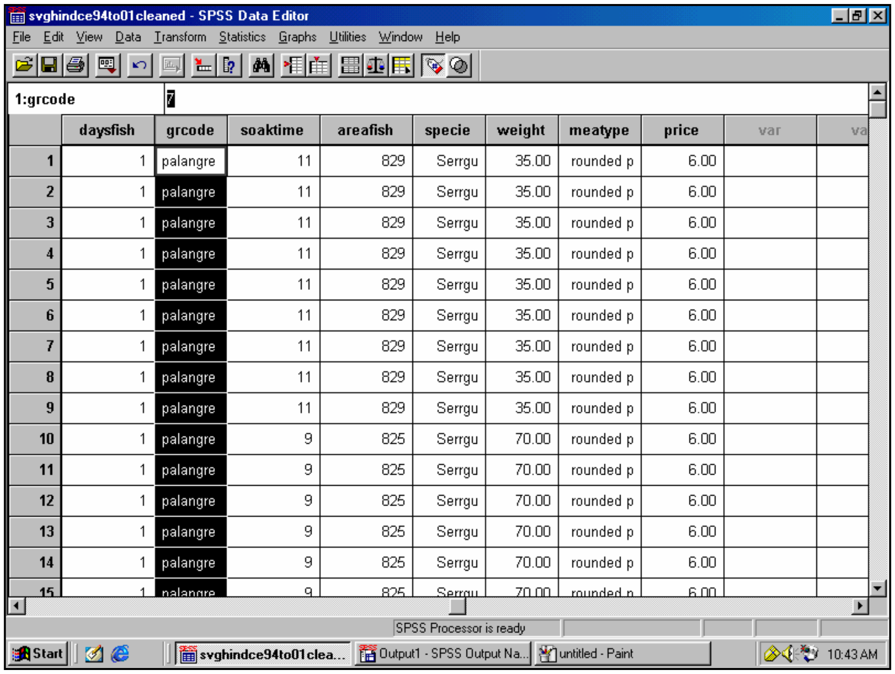
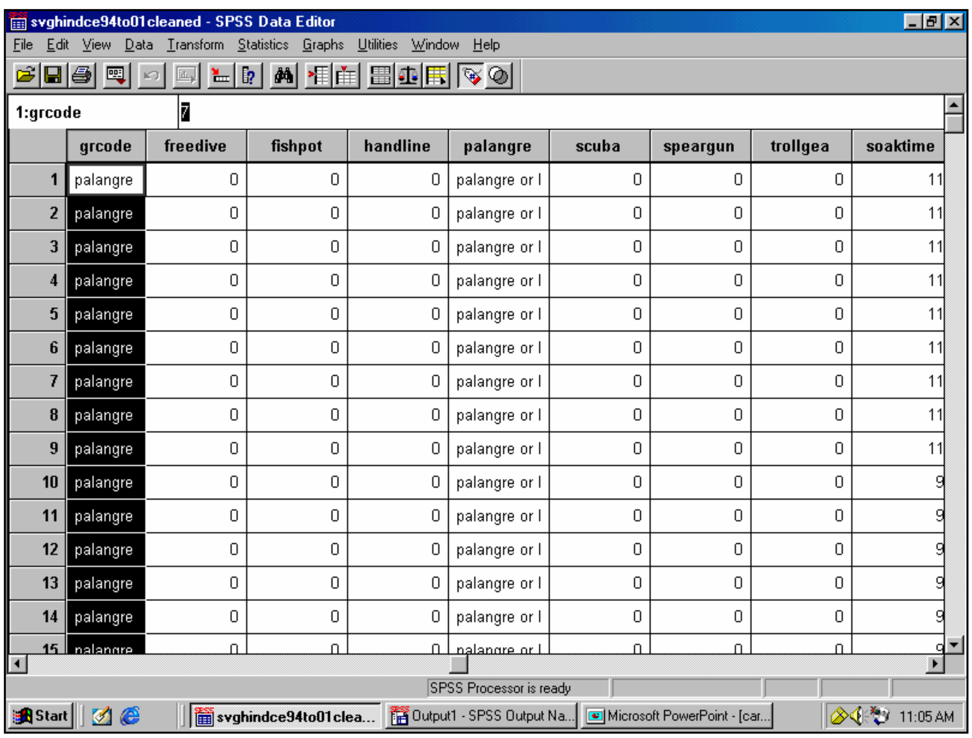


Figure 13. St. Vincent and the Grenadines 1994-2001 catch and effort data on red hind. Box plot of *price* as output by SPSS.



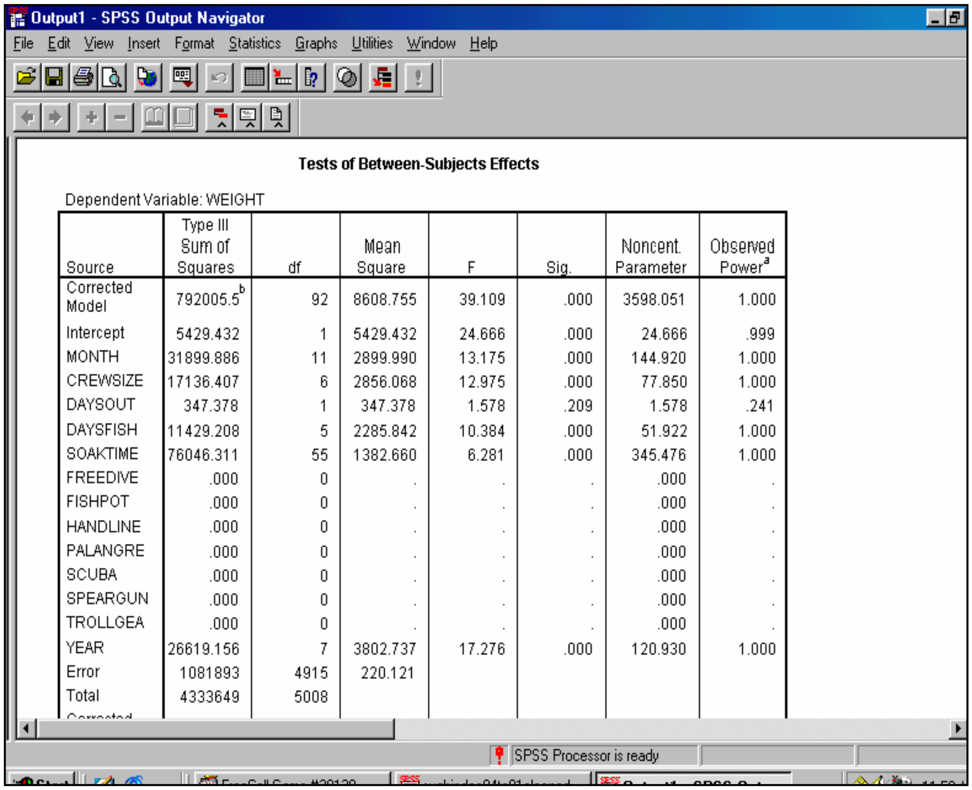
	daysfish	grcode	soaktime	areafish	specie	weight	meatype	price	var	va
1	1	palangre	11	829	Serrgu	35.00	rounded p	6.00		
2	1	palangre	11	829	Serrgu	35.00	rounded p	6.00		
3	1	palangre	11	829	Serrgu	35.00	rounded p	6.00		
4	1	palangre	11	829	Serrgu	35.00	rounded p	6.00		
5	1	palangre	11	829	Serrgu	35.00	rounded p	6.00		
6	1	palangre	11	829	Serrgu	35.00	rounded p	6.00		
7	1	palangre	11	829	Serrgu	35.00	rounded p	6.00		
8	1	palangre	11	829	Serrgu	35.00	rounded p	6.00		
9	1	palangre	11	829	Serrgu	35.00	rounded p	6.00		
10	1	palangre	9	825	Serrgu	70.00	rounded p	6.00		
11	1	palangre	9	825	Serrgu	70.00	rounded p	6.00		
12	1	palangre	9	825	Serrgu	70.00	rounded p	6.00		
13	1	palangre	9	825	Serrgu	70.00	rounded p	6.00		
14	1	palangre	9	825	Serrgu	70.00	rounded p	6.00		
15	1	palangre	9	825	Serrgu	70.00	rounded p	6.00		

Figure 14. St. Vincent and the Grenadines 1994-2001 catch and effort data on red hind before adding dummy variables for *grcode*



	grcode	freedive	fishpot	handline	palangre	scuba	speargun	trollgea	soaktime
1	palangre	0	0	0	palangre or l	0	0	0	11
2	palangre	0	0	0	palangre or l	0	0	0	11
3	palangre	0	0	0	palangre or l	0	0	0	11
4	palangre	0	0	0	palangre or l	0	0	0	11
5	palangre	0	0	0	palangre or l	0	0	0	11
6	palangre	0	0	0	palangre or l	0	0	0	11
7	palangre	0	0	0	palangre or l	0	0	0	11
8	palangre	0	0	0	palangre or l	0	0	0	11
9	palangre	0	0	0	palangre or l	0	0	0	11
10	palangre	0	0	0	palangre or l	0	0	0	9
11	palangre	0	0	0	palangre or l	0	0	0	9
12	palangre	0	0	0	palangre or l	0	0	0	9
13	palangre	0	0	0	palangre or l	0	0	0	9
14	palangre	0	0	0	palangre or l	0	0	0	9
15	palangre	0	0	0	palangre or l	0	0	0	9

Figure 15. St. Vincent and the Grenadines 1994-2001 catch and effort data on red hind after adding dummy variables for *grcode*

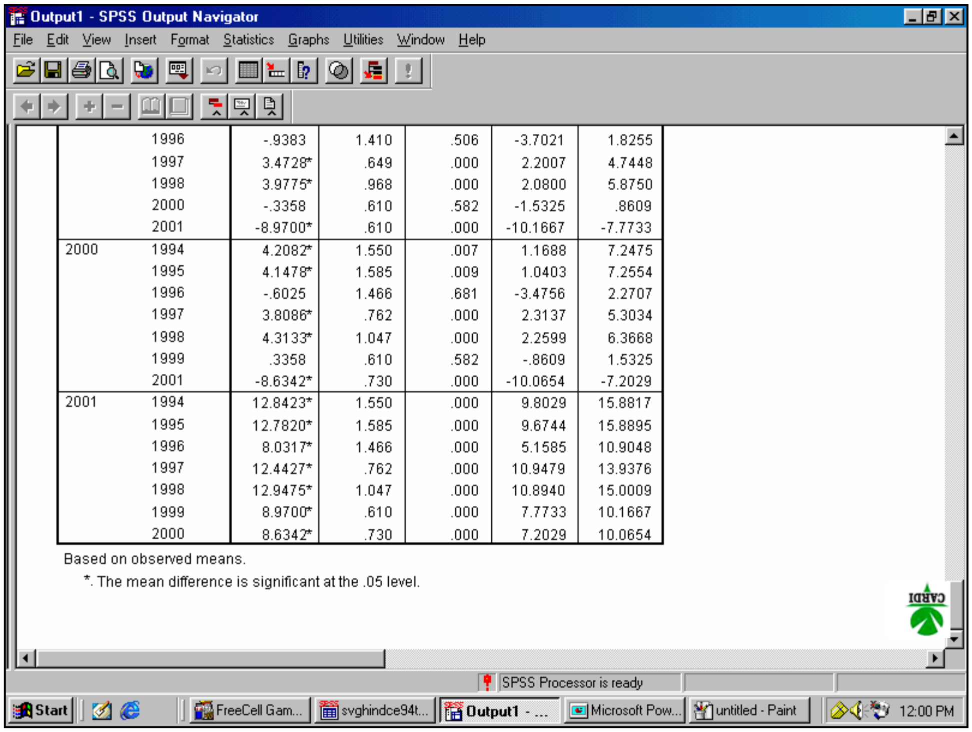


Tests of Between-Subjects Effects

Dependent Variable: WEIGHT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Corrected Model	792005.5[b]	92	8608.755	39.109	.000	3598.051	1.000
Intercept	5429.432	1	5429.432	24.666	.000	24.666	.999
MONTH	31899.886	11	2899.990	13.175	.000	144.920	1.000
CREWSIZE	17136.407	6	2856.068	12.975	.000	77.850	1.000
DAYSOUT	347.378	1	347.378	1.578	.209	1.578	.241
DAYSFISH	11429.208	5	2285.842	10.384	.000	51.922	1.000
SOAKTIME	76046.311	55	1382.660	6.281	.000	345.476	1.000
FREEDIVE	.000	0	.	.	.	.000	.
FISHPOT	.000	0	.	.	.	.000	.
HANDLINE	.000	0	.	.	.	.000	.
PALANGRE	.000	0	.	.	.	.000	.
SCUBA	.000	0	.	.	.	.000	.
SPEARGUN	.000	0	.	.	.	.000	.
TROLLGEA	.000	0	.	.	.	.000	.
YEAR	26619.156	7	3802.737	17.276	.000	120.930	1.000
Error	1081893	4915	220.121				
Total	4333649	5008					

Figure 16. St. Vincent and the Grenadines 1994-2001 catch and effort data. SPSS output of GLM fit of *weight* as the dependent variable.



	1996	-.9383	1.410	.506	-3.7021	1.8255
	1997	3.4728*	.649	.000	2.2007	4.7448
	1998	3.9775*	.968	.000	2.0800	5.8750
	2000	-.3358	.610	.582	-1.5325	.8609
	2001	-8.9700*	.610	.000	-10.1667	-7.7733
2000	1994	4.2082*	1.550	.007	1.1688	7.2475
	1995	4.1478*	1.585	.009	1.0403	7.2554
	1996	-.6025	1.466	.681	-3.4756	2.2707
	1997	3.8086*	.762	.000	2.3137	5.3034
	1998	4.3133*	1.047	.000	2.2599	6.3668
	1999	.3358	.610	.582	-.8609	1.5325
	2001	-8.6342*	.730	.000	-10.0654	-7.2029
2001	1994	12.8423*	1.550	.000	9.8029	15.8817
	1995	12.7820*	1.585	.000	9.6744	15.8895
	1996	8.0317*	1.466	.000	5.1585	10.9048
	1997	12.4427*	.762	.000	10.9479	13.9376
	1998	12.9475*	1.047	.000	10.8940	15.0009
	1999	8.9700*	.610	.000	7.7733	10.1667
	2000	8.6342*	.730	.000	7.2029	10.0654

Based on observed means.

*. The mean difference is significant at the .05 level.

Figure 17. St. Vincent and the Grenadines 1994-2001 catch and effort data. SPSS output of post hoc examination of *year after* GLM fit of *weight* as the dependent variable.

(Notice that among the many windows open is a game of FreeCell. It is possible to have a bit of fun while doing a statistical analysis!)

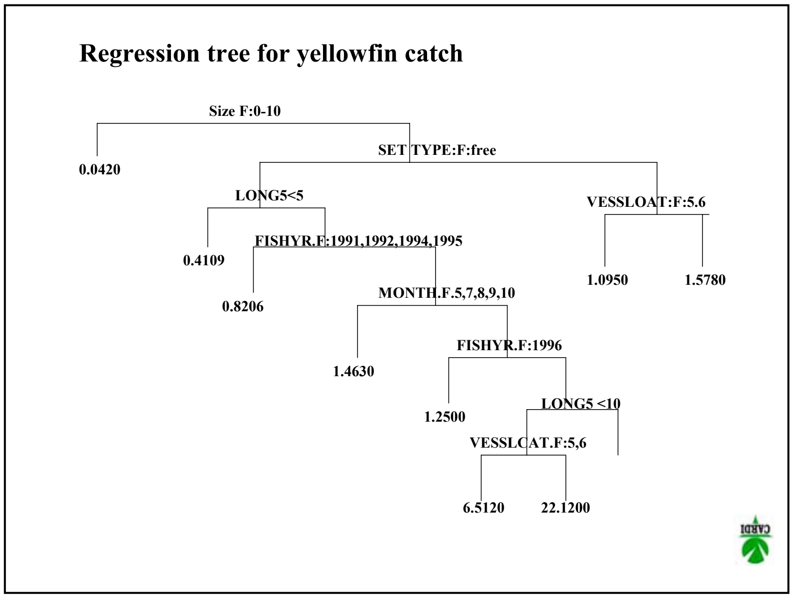


Figure 18. Regression tree for yellowfin tuna catch per hour of fishing.