ISSN: 1998-1015

CRFM Fishery Report 2006

VOLUME 1, Suppl. 2 -

First Meeting of the Ad hoc Working Group on Methods

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

CRFM Secretariat,
Belize & St. Vincent and the Grenadines
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Correct Citation:

CRFM. 2006. Report of Second Annual Scientific Meeting – Port of Spain, Trinidad and Tobago, 13-22 March 2006 – First Meeting of the *Ad hoc* Working Group on Methods. *CRFM Fishery Report – 2006*, Volume 1, Suppl. 2 93 pp.

ISSN # 1998-1015
ISBN # 978-976-8165-07-7

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

FOREWORD

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

The Report of the 2006 CRFM Annual Scientific Meeting is published in two Volumes: Volume 1 contains the proceedings of the plenary sessions and the full reports of the CRFM Resource Working Groups that met during 2006. National reports, which had been submitted for consideration by the Working Groups, are published as Supplement 1 to Volume 1, while the Report of the First Meeting of the Ad Hoc Working Group on Methods is published as Supplement 2 to Volume 1. Volume 2 contains the fishery management advisory summaries, which are the same as the first 7 sections (sections 1 to 1.7) of each of the fishery reports. Volume 1 is therefore intended to serve as the primary reference for fishery assessment scientists, while Volume 2 is intended to serve as the main reference for managers and stakeholders.

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LIST OF ACRONYMS AND ABBREVIATIONS

CARICOM	Caribbean Community
CARDI	Caribbean Agricultural Research and Development Institute
CEDA	Catch Effort Data Analysis
CERMES	Centre for Resource Management and Environmental Studies
CFF	Caribbean Fisheries Forum
CFRAMP	CARICOM Fisheries Resource Assessment and Management Programme
CITES	Convention on International Trade in Endangered Species
CPUE	Catch per Unit of Effort
CRFM	Caribbean Regional Fisheries Mechanism
DANIDA	Danish International Development Agency
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization of the United Nations
FMSP	Fisheries Management Science Programme
GEF	Global Environment Facility
GLM	Generalized Linear Models
ICCAT	International Commission for the Conservation of Atlantic Tunas
IICA	Inter-America Institute for Cooperation in Agriculture
IFREMER	Institut Français de Recherche pour l'Exploitation de la Mer (French Research Institute for Exploitation of the Sea)
JICA	Japan International Cooperation Agency
LAPE	Lesser Antilles Pelagic Ecosystem project
LFDA	Length, Frequency Data Analysis
MEY	Maximum Economic Yield
MPA	Marine Protected Area
MSY	Maximum Sustainable Yield
NOAA	National Oceanic and Atmospheric Administration
OECS	Organization of Eastern Caribbean States
TAC	Total Allowable Catch
TCI	Turks and Caicos Islands
TED	Turtle Excluder Device
TIP	Trip Interview Programme
UK-DFID	United Kingdom, Department of International Development
UN	United Nations
UNESCO	United Nations
US	United States
US-AID	US Agency for International Development
UWI	University of the West Indies
VPA	Virtual Population Analysis
WECAFC	Western Central Atlantic Fishery Commission
WG	Working Group
YPR	Yield per Recruit

1. Opening of the Meeting

On behalf of the CRFM Secretariat, Dr. S. Singh-Renton, welcomed participants to the First Meeting of the Working Group, and thanked staff of CERMES, particularly Drs. H. Oxenford and R. Mahon, for their efforts to facilitate the meeting at UWI. She also acknowledged the assistance of the Barbados Fisheries Division in providing transport for the CRFM-funded participants. Dr. S. Singh-Renton briefly reviewed the rationale for the establishment of the Working Group, and noted that the report of the Working Group would be submitted for review by the next Annual CRFM Scientific Meeting.

On behalf of UWI, the Acting Director of CERMES, Dr. R. Mahon, indicated his pleasure in being able to welcome participants to the University. Dr. Mahon emphasized the role of the University within the CARICOM region, and noted UWI's recent efforts to strengthen the working relation with the CRFM.

2. Election of Meeting Chairperson

Ms. Lara Ferreira was elected to serve as the Chairperson of the Meeting. Ms. June Masters was elected to serve as Vice-Chairperson.

3. Selection of Working Group Rapporteur(s).

The CRFM Secretariat representative volunteered to serve as rapporteur for the plenary sessions. It was agreed that smaller working groups, as and when established to carry out specific tasks, would be responsible for selecting rapporteurs to cover these working group sessions.

4. Introduction of Participants.

The Chairperson asked participants to introduce themselves. The list of participants is given in Appendix 1.

5. Review and Adoption of Meeting Agenda.

There were three modifications made to the Agenda. The revised, adopted agenda is given in Appendix 2.

6. Review and Discussion of Terms of Reference

The CRFM Secretariat representative presented the Terms of Reference of the Working Group, as adopted by the Third Meeting of the Caribbean Fisheries Forum. A query was raised regarding the countries and institutions invited to the Meeting of the Working Group. The CRFM Secretariat representative pointed out that both FAO and IFREMER were invited to the Meeting, as well as other adjacent non-CRFM States such as Venezuela.

It was pointed out that the Terms of Reference did not specifically address the issue of communications between managers and scientists. Recognizing, the importance of this issue, the meeting agreed to proceed with the current approved Terms of Reference, but recommended the insertion of another term of reference to address the issue of communications. It was also suggested and agreed that another criterion

should be included in Term of Reference no. 4, to address the ability of the method to provide advice based on the goals of management. It was understood that the amended Terms of Reference, given in Appendix 3, would have to be submitted to the Fourth Meeting of the Forum for its further review and endorsement.

In view of the fact that assessment methods are continually evolving, it was noted that the Working Group was unlikely to conclude its work in the three meetings allocated to it. It was pointed out that other organizations usually maintain a permanent working group on methods, and so consideration should be given to ensuring continuity of the work commenced by this Working Group. Having noted this, it was agreed that it was incumbent on the Working Group to ensure substantial progress during the approved three meetings. The meeting further noted that the adopted Terms of Reference facilitates review of progress and the need for continued work at the end of the three-year period.

A clarification was sought regarding the reporting process, and it was confirmed that the Working Group would report directly to the Scientific Meeting and not directly to the Forum.

Clarification was also sought on the format of the Meeting Report: whether it should be formatted according to the Terms of Reference or according to the Agenda Items. The Working Group agreed to format the report according to the Agenda Items, and to refer to the specific Terms of Reference when these were being addressed under the appropriate Agenda Item in the report.

6.1 Recommendations to the Scientific Meeting:

1) Another criterion should be included in Term of Reference no. 4, to address the ability of the method to provide advice based on the goals of management. The proposed revision to the Working Group's Terms of Reference should be re-submitted to the Forum for formal approval.

7. Review of results of manager's questionnaire study.

This item dealt specifically with the Working Group's Term of Reference no. 1.

The CRFM Secretariat compiled and circulated the completed questionnaires received from the following eight CRFM Member States: Anguilla, Belize, British Virgin Islands, Guyana, Nevis, St. Lucia, St. Vincent and the Grenadines, and Trinidad and Tobago (compilation of questionnaires given in Appendix 4). No response had been received from the following remaining States: Antigua and Barbuda, The Bahamas, Barbados, Dominica, Grenada, Haiti, Jamaica, Montserrat, St. Kitts, Suriname, Turks and Caicos. The CRFM Secretariat also presented a summary of the responses.

Some participants thought that the questionnaire was too long, and that this was probably the main reason why several Fisheries Directors and Chief Fisheries Officers tended to give it to their scientists to complete, and also possibly the reason why some countries submitted no response. A suggestion was made to divide the questionnaire into separate sections to distinguish information that could be completed by the scientists independently. It was also suggested that the questionnaire should be modified to make it shorter, and hence make it more 'manager-friendly'. However, it was pointed out that any modifications would restrict the level of comparability among questionnaire responses.

The question was raised whether there was a set of policies agreed by all CRFM Member States in respect of fisheries management. In response, it was explained that there was no regional policy on fisheries management in place at present. It was further noted that the Forum had agreed to establish a process for

handling the information generated by the annual scientific meetings, and the Forum recognized that this was particularly important for resources that were shared among States.

It was pointed out that fishery managers often do not consider trade-offs or the risks associated with trade-offs, when they develop their management objectives. The significance of communicating clearly the trade-offs and risks to managers for decision-making purposes was emphasized.

The Working Group noted that several management objectives provided in the questionnaire responses were quite broad, and so it would be important for the scientists to develop written more focused interpretations of these broad objectives, and provide feedback on this to the managers. Related to this comment, the process of 'unpacking' the management objectives provided to scientists was also briefly discussed: issues should be analysed in order to determine their consequences, to develop operational objectives, and to determine what management measures could be adopted. Institutionalizing the process was necessary.

Given that some responses appeared to confuse management objectives with policy goals, the Working Group recognised the need to provide managers with a common working definition of the term 'management objective'.

The results of the questionnaire were considered to be very useful. The Working Group therefore discussed the possibility of gathering the needed information from the outstanding Member States, and made several recommendations regarding this. The representative from FAO advised that FAO requests for information were usually channelled through several lines of communication to ensure acquisition of responses, e.g, correspondence sent to a Fisheries Director or Chief Fisheries Officer was usually copied to the Permanent Secretary in the relevant Ministry, as well as the Ministry of Foreign Affairs.

It was agreed to send out the questionnaire again to those countries, which had not yet responded, accompanied by a cover note updating these countries on the responses received so far and the usage of the data by the Working Group, as well as the Scientific Meeting. This request should be copied to the Permanent Secretaries, given that it seeks information concerning management objectives, priorities, and decision-making, which often require support at this level.

Additionally, the Working Group recommended that feedback be also provided to the next Meeting of the Forum, regarding interpretations of the questionnaire data for use by the Working Group and the Scientific Meeting and seeking verification of these interpretations.

Considering the issues raised, the Working Group recommended the establishment of two smaller working groups with the following aims: (i) to examine aspects related to improving communications between scientists and managers, including the 'unpacking' of broader objectives into more specific operational objectives; and (ii) to examine issues pertaining to data availability and practical options for improving data.

The full reports of the working groups noted in (i) and (ii) are given in Appendices 5 and 6 respectively. Plenary discussions related to findings of these smaller working groups follow:

7.1 Working Group on Communications

The Working Group on Communications presented updates during plenary sessions at periodic intervals during the meeting. It was recognized that there was incongruity between the objectives noted and the economic investment in data collection. After refining the objectives, there was concern that there would still be insufficient data for addressing the management questions identified.

In view of the time constraints, it was proposed that the Working Group focus on conducting a case study of the process of refining objectives, and use this example to provide feedback to the managers in CRFM Member States.

There was some discussion about the extent to which scientists could provide information on the social and economic considerations that arose in managing fisheries. It was clarified that while scientists could not make decisions about which social and economic options should be adopted, scientists had a responsibility for providing information on the consequences of adopting one option over another, and hence facilitate the decision-making process in this way.

The development of a procedural guide for managers to refine their objectives was considered a useful output, but it was also pointed out that there was already published literature that dealt with the issue. There was considerable discussion regarding the need to assist countries with refining their management objectives.

Several recommendations were made.

(i) A regional workshop was proposed, which would aim to provide training to managers in the use of the proposed procedural guide for refining management objectives.
(ii) National consultations, which take place when countries are ready to review their fisheries management plans, also provide an opportunity for review and refinement of objectives.
(iii) An analytical hierarchical process could be undertaken, involving interviews, weighting interpretations, and engaging in manager-stakeholder consultations to determine the priorities.
(iv) The process of refining management objectives needed to be completed at both the national and regional levels, and training workshops for the policy makers, as well as the stakeholders were recommended.

In view of time constraints, the Working Group could not discuss the above recommendations further, and so it was agreed to forward all these recommendations for consideration by the Second Annual CRFM Scientific Meeting. The detailed report of the Working Group on Communications is given in Appendix 5.

7.2 Working Group on Data

The Working Group on Data presented updates during plenary sessions at periodic intervals during the meeting.

It was noted that the Working Group had not yet examined data opportunities, i.e. what additional 'new' data could be collected by countries. Although it was clear that the investment in data collection was poor relative to the management objectives noted, the importance of making full use of the available data was emphasized. The Working Group pointed out the difficulties it faced in examining country datasets, sometimes having to make many assumptions. In view of time constraints, the Working Group on data also decided to conduct case studies for illustrative purposes, and split into even smaller groups to undertake this task.

A query was raised regarding the advantage of spending time pursuing complex models, or even a simplification of these, if the probability of the results being applied was very low. It was argued that it might be more advantageous to promote the use of simpler methods that would be more practical and which would enjoy a greater frequency of application by management within the region.

Several recommendations were made:

(i) It was proposed to develop an inventory of data availability.
(ii) It was agreed that criteria should be developed for selecting methods.
(iii) Training in use of methods was proposed: possible options such as training attachments and training sessions during the annual scientific meetings should be explored.

In respect of the proposal to develop an inventory, it was pointed out that FAO had recently formulated a questionnaire for determining data availability in a number of Eastern Caribbean territories, and that the format of this questionnaire could be utilized to gather the relevant data from remaining territories within the region. No deadline was fixed for the circulation of such a request to countries, nor for submission of country responses regarding data. However, it was understood that this task would be attempted during the inter-sessional period.

The detailed report of the Working Group on Data is given in Appendix 6.

8. Review and discussion of methods for consideration by present meeting and implications for practicality and uptake by managers

This item dealt specifically with the Working Group's Term of Reference no. 2.

The Working Group decided to develop an initial list of methods used during the last scientific meeting, as well as all other methods known to the Group, which would likely be useful for application to fisheries within CRFM Member States. In preparing the list, several general issues were raised. The incorporation of qualitative or semi-quantitative methods was noted to be critical for data limited situations. However, it was pointed out that some of these methods, particularly Bayesian techniques, required a high level of skills. Confirmation was sought regarding regional fisheries management objectives. It was clarified that the Forum had not yet dealt with this issue formally, and that management advice had only been presented and considered for the first time during the Third Meeting of the Forum in March 2005. The importance of considering the biological perspective for shared stocks and hence the establishment of regional objectives to address this, was also emphasized. It was pointed out and agreed that the establishment of a regional database and management of these centralized data were necessary for ensuring efficiency in terms of data preparation for the assessments. Several initial issues were raised for consideration in determining suitability of methods proposed. These preliminary considerations and the list of the methods developed during the present Meeting is given in Table 1 (parts A & B).

The Working Group also briefly discussed alternative types of data, which if made available, would broaden the range of assessment methods that could be applied and improve the type of management advice generated. The list of alternatives types of data considered is given in part C of Table 1.

The methods listed were then reviewed in further detail, with powerpoint presentations made whenever possible. The following subsections provide summaries of each of the methods presented, as well as the key elements of specific queries and issued discussed in each case. Additionally, it was recommended and agreed that the method review and selection process should be structured to take into account those characteristics that could strongly influence the successful application of these methods within the CRFM region. In this respect, the following characteristics were considered to be important and were proposed as criteria for determining method selection (also listed in part D of Table 1):

- Data requirements/ availability/ possibilities;

- Management advice generated (how this relates to the management objectives and questions noted in questionnaires);
- Expected management actions (practicality and social acceptability);
- Level of technical skills required;
- Types of fisheries/resources for which it is suitable;
- Costs and risks/ benefits associated with using method (trade-offs).

A summary of the method review findings and issues related to review and selection of methods is given in Table 2.

There was particular concern regarding the level of skills required to apply the various methods. Acknowledging this, the Working Group noted the importance of providing opportunities for training of and knowledge transfer to the individuals concerned. It was pointed out that CRFM's programme that supported regular technical working group meetings was already appropriate for facilitating the transfer of skills to counterparts. The Working Group recognized that data from the region were often complicated and contained gaps, and so expert assistance was almost always required for data analysis and interpretation. A few suggestions were made for enhancing expertise within the region: establishment of peer-peer collaboration support that could take place without on-site meetings; special training workshops; an additional time allocation during the scientific meeting (i.e. during the data analysis sessions) to provide more time for interaction with external experts and to allow for extensive training on specific topics, for example, extension of indices; establishment of a central source of assessment expertise for the region that could reside within the CRFM secretariat. It was agreed that the two Working Groups dealing with 'Communications' and 'Data issues' would also address the issue of training.

8.1 Low Data Management

Summary:
More often than not, our best estimates of basic fisheries parameters, such as catch levels, stock abundance, and productive capacity, are highly uncertain. A theoretical model was produced to examine the implications of these uncertainties and to explore what management steps might prove resilient even if the parameters were mis-estimated. The results showed that management systems could prove resilient if they were responsive, a property, which could be approximated by setting aside a certain fraction of the population off-limits from fishing. While a small fraction (e.g., N_{min} = 0.1, or 10%) was sufficient to insure against total collapse, a more substantial fraction (e.g., N_{min} = 0.3 or 0.4, or 30-40%) was required to maintain high production even in the face of gross mis-estimation of basic parameter values. Such a policy incurred costs. In the simplest of control rules, the cost came through catches that varied tremendously from one year to the next, including frequent closure of the entire fishery (even though on average catches were excellent). More complex control rules could reduce the fluctuations in catch levels but the cost was then borne through lower average catches. Nonetheless, there is value in having as a reference point what a management system might require to sustain productive fisheries even when information is uncertain or unknown. In practice, achieving the off-limits populations is not a simple task. For species whose movements are limited (e.g., all plants, many invertebrates, some reef-associated fish), closed areas may be appropriate and sufficient. In these cases, the off-limits population might correspond to the proportion of the management area that was closed (e.g., N_{min} = 0.1 might be approximated by a 10% closure). For more mobile species, similar results may be achieved through the use of gear limits, or size limits if individuals can be caught and released with minimal harm. In these cases, the off-limits population might correspond to the proportion of reproductive output a typical female can achieve prior to facing fishing mortality (e.g., N_{min} = 0.1 might be approximated by setting the minimum size limit at the size at which an average female has produced 10% of her lifetime egg supply). Gear limits will only be practical in single-species fisheries, though, because of the inevitability that

stocks in a multi-species fishery will mature at different sizes. The benefits of these techniques are less likely to be seen by many species, including those with high mobility in multi-species fisheries, especially if they are not likely to survive being caught and released. However, even for these fisheries any quota system can provide resilience if it ends all fishing mortality on a stock if it drops below a critical threshold (e.g., N_{min} = 0.1 might be approximated by ending all fishing on a stock if it drops to 10% of virgin biomass).

Discussion:
Clarification was sought regarding data requirements for the simulations presented. It was explained that life history parameters were needed and a basic surplus production model was applied. In terms of management controls, it was pointed out the method provided for effort controls, closed areas and gear restrictions. Regarding closed areas, this would be related to habitat distribution. Specific rules to protect the spawning stock could also be provided, such as minimum size limits, but it was also noted that upper size limits may be valuable for long-lived species. In response to queries regarding species assessment applications, it was clarified that the method was not really suitable for mobile/ migratory resources, multi-species fisheries, or for those resources that did not survive the discarding process in the case of size restrictions.

It was noted that several marine reserves have been established in a number of CRFM Member States, and that the method could be valuable in providing justification for continued and increased support of marine reserves as effective management tools. However, it was pointed out that the use of marine reserves as a management tool would have its strengths and weaknesses, and it would be important to identify and communicate the trade-offs to managers. It would also be important to monitor the continued effectiveness of such a management tool.

While the method itself required very little input data and was useful to facilitate decision-making in the short-term, the Working Group recognized that some basic fishery monitoring was necessary to ensure continued effectiveness of the strategies adopted.

8.2 Parfish

Summary:
ParFish provides a tool for the management of small scale fisheries by providing a methodology for assessment of a fishery, which can be undertaken with the involvement of fishers, and in situations where there is limited data available. It improves information on the fishery and encouraging the participation of fishers. When fishers are involved in the assessment of a fishery they are more likely to trust the results and engage in management planning. At the centre of the ParFish approach is the use of the ParFish software to undertake the analysis of the stock assessment. The software is based on Bayesian statistics and decision theory, and gives four main outputs:

- Recommended control levels for the fishery that can reduce the probability of over fishing, and be acceptable to fishers;
- The state of the stock at various levels of control;
- The probability of the stock being over fished at different levels of control; and
- the uncertainty surrounding these results.

The current version of the ParFish software is based on the logistical biomass growth model, which is described by four parameters (i.e. B_{now}, B_{inf}, r and q). The software requires 'prior' frequencies for these parameters provided through data collected in fisher interviews. These frequencies can then be 'updated' with data from other sources, such as from fitting fish stock assessment models to data. The software currently supports data obtained from long-term catch data if they are available, and fishing experiments.

Data from other sources or models can be incorporated into the software if parameter frequencies can be generated.

Discussion:
Clarification was sought regarding the minimum data requirements for application of the method, and it was noted that at the very least, fisher interview data would be needed. A query was raised regarding the possibility of whole communities having a biased outlook, but this situation had not yet been encountered. Another query was raised in respect of the estimation of the 'preference' options and also whether the communities sought justification of the preference options presented to them. It was pointed out that the estimation procedure considered trade-offs, as well as extreme situations such as stock collapse. Additionally, it was often necessary to work backwards from the preference options when explaining these to communities. It was further pointed out that fishers think not only of catch but also of profit, and that an interview can be redone until the fisher is happy that the responses reflect the 'truth'.

Two similar queries were raised regarding practical success of the method in cases of competing communities and in cases where the stakeholders did not just include fishers from the community. In the situations of competing communities, it would be possible to evaluate responses to identify and correct for possible differences/discrepancies in responses. The method could still be applied, but would need to take into account potential biases among competing groups and likely exaggerations. In the situation with different stakeholder groups, the method could consider the various 'preferences', but it would be important to try to identify any sources of conflict.

It was asked if the problem of defining a management unit could arise, and the possibility of switching species. This problem had been encountered in Zanzibar where species had been progressively fished out in a specific area, and this posed difficulties for effective management using this method. When asked whether the method could be applied to a multispecies fishery, it was explained that attempts had been made to develop a multispecies version, but that this made the method much too complicated for facilitating uptake at the local levels. The idea was therefore abandoned in view of the specific aims at that time.

8.3 FMSP Tools - Yield

Summary:
The FMSP 'Yield' software was designed to estimate standard fishery reference points under conditions of uncertainty. The age-structured population model used as the basis for Yield extends the standard Beverton and Holt / Thomson and Bell yield per recruit models by allowing for uncertainty in parameter inputs; by including a stock recruit relationship; and by allowing stochastic variation in annual recruitment rates. The probability distributions estimated for the technical reference points enables their conversion to 'precautionary' points, reflecting the uncertainties in the parameter inputs and the risk tolerances chosen by the manager.

Yield is mainly designed to estimate reference points based on the fishing mortality rate, such as F_{max}, F_{MSY}, $F_{0.1}$ and $F_{SSBx\%}$ (or $F_{\%SPR}$). Having an age-based, 'flexible selectivity', analytical model basis, Yield can also be used to investigate the impacts of size limits and closed seasons on both yield and spawning stock biomass indicators.

While yield per recruit (YPR) models will be familiar to most fisheries officers, the calculation of YPR and related reference points including stock recruitment relationships and allowing for uncertainty is technically much more difficult. The aim of the Yield software package is to allow these calculations to be made with ease and thereby promote the adoption of more precautionary management approaches.

Yield is one of four software packages produced by the UK DFID Fisheries Management Science Programme (FMSP). The different tools estimate intermediate parameters, fishery indicators and/or reference points as summarised in the table below. Yield would need to be used in combination with some other method to provide a full fishery assessment (e.g. using LFDA to estimate the indicator, F, and Yield to estimate the reference points, e.g. $F_{0.1}$ or others). CEDA and ParFish may be used on their own to estimate both indicators (e.g. stock size) and reference points (e.g. B_{MSY}) for management.

Summary of the alternative outputs provided by the four FMSP software tools

FMSP Tool	Method(s)	Outputs		
		Intermediate Parameters	Indicators	Reference Points
LFDA	Length Frequency Distribution Analysis	Von-Bertalanffy growth parameters (seasonal and non-seasonal); Total mortality, *Z*	F_{eq}	
CEDA (Catch Effort Data Analysis)	Biomass Dynamic models; Depletion models; Stock projections	*r, K, q*	B_t, N_t	MSY, B_{MSY}, F_{MSY}
Yield	Analytical models; Stochastic stock projections		B_t, N_t [1]	F_{max}, $F_{0.1}$, $F_{0.x,}$ $F_{\%SPR,}$ F_{MSY}, F_{crash} $F_{transient}$
ParFish	Biomass dynamic model with additional Bayesian priors	*r, K, q*		f_{lim}, C_{lim}, f_{opt}, C_{opt}

[1] The Yield software will project future trajectories of biomass and numbers resulting from a given catch strategy, based on current estimates of these values, but will not provide those current estimates.

The four software tools may be downloaded from the FMSP website: http://www.fmsp.org.uk. Guidance on the use of the tools is available within the help files in each programme. An FAO Fisheries Technical Paper is also in press that provides an overall framework for fishery management and the potential uses of the different software tools and other FMSP guidelines and outputs from the last ten years. A current FMSP project is also developing simple 'process' guides for managers and stock assessment scientists, guiding the use of the tools and communication aspects.

Discussion:
It was asked whether the FMSP software manual provided guidance with regard to distribution selection for model input parameters. While the manual does not provide guidance on developing the distribution pattern, it gives guidance on the distributions that may be used and the types of sampling or 'meta-analysis' data sources that may be used to estimate coefficients of variation for parameters. Another query dealt with the issue of whether the model made its various selections of each of the parameters L, K and t_0 independently of each other. It was noted that this issue was addressed in the software manual.

It was noted that within the CRFM region, the total catch was often unknown. Additionally, given the multi-species nature of the fleets and their variations, it has been difficult to link fishing effort to the fishing mortality coefficient. It was asked how management dealt with this linkage problem in other situations. In response, it was recognized that although the linkage of fishing effort and fishing mortality was sometimes difficult, there were approaches for dealing with this issue. In response to a question on

the application of the method to multi-species fisheries, it was clarified that separate assessments would be needed for each species with subsequent consideration of the management implications. The FMSP FAO paper includes a chapter on such multispecies issues.

8.4 Traffic Light Method

Summary:
A system of 'traffic light' representations of indicators was presented to the working group. It was developed as a means of capturing and presenting diverse and potentially contradictory sources of information about the various characteristics of fisheries. The individual indicators are colourized to represent ranges of good (green), bad (red) and indifferent (yellow) using fuzzy logic. Quantitative comparison and analysis of the various indicators is done using fuzzy algebra and fuzzy control theory. Integration of multiple indicators and sample decision rules to estimate quantitative responses from the traffic light information was presented although much work remains to implement these aspects.

The traffic light display was developed to ensure that the diversity of information about a fishery, conflicting signals and all, was available in the decision making process. The implementation of decision rules, assuming the managers can develop acceptable responses with the fishing communities, allows for objective evaluation of the appropriate management response to changes in fishery status.

Discussion:
A query was raised with regard to how managers related the representation of risk to their original stated objectives, and so it was clarified that the scientists often had to demonstrate the linkage of the results to the 'unpacking process'. It was pointed out that a key advantage of the method was that it considered several indicators simultaneously, and this afforded flexibility on any single indicator. This was important when trying to satisfy the concerns of various stakeholders.

An enquiry was made regarding retrospective analysis of the performance of the method. It was explained that only 1-year projections were made at a time; these analyses indicated that in most cases, the method provided for a quicker management response, e.g. opening or closing the fishery. In respect of the 'unpacking' of objectives, it was pointed out that the FMSP Tools Guide deals with this issue in some depth, and that this could serve as a useful reference for this aspect of applying the method in the region.

Persons noted that the fuzzy logic illustrations appeared confusing, and thought this would pose challenges for communicating results to managers. However, it was pointed out that the scientists began with a simple picture, but because of the close proximity of on/off positions and the dramatic switch in management strategy associated with such positions, the graded picture facilitated by fuzzy logic was more acceptable to managers.

Weighting of indicators was also briefly discussed, and it was noted that the software had a scoring mechanism to aid this process in decision-making.

The Working Group considered that this method could potentially be very useful for application within the region, and that some time should be spent in considering possible indicators that could be utilised. The Working group also noted the importance of being able to show how each indicator measures its objective, as well as the sensitivity of this. The software contains an indicator workbook that would be suitable for handling this issue. It was agreed that the working group on communications could develop a list of possible indicators for the Caribbean region, and identify the strengths and weaknesses of each of these.

8.5 $Z = \frac{K(L_\infty - \overline{L})}{\overline{L} - L_C}$

Summary:
The catch-free model is designed for situations where catch data are unavailable, unreliable, or highly uncertain. In the absence of catch information, the model is not capable of estimating absolute abundance of the population; rather it produces estimates *relative* to the virgin level of the stock. As such, the model requires an assumption about when the stock was at a virgin level. From the year in which the virgin level was assumed, the model projects the stock by following standard age-structured dynamics. Information related to effort trends, perceived depletion, or other historical aspects of the fishery can help to guide the model to an estimate of stock status at the beginning of the data time series. Current status is then estimated by fitting to the observed fishery-dependent or fishery-independent data. Required biological information, model outputs and management advice are summarized in Table 2.

Discussion:
The user-software interface was discussed, and it was pointed out that it was an interactive interface. In response to a query regarding the choice of the year of virgin biomass, it was clarified that this could be determined based on some research. The Working Group noted that the method provided a good way of modelling past conditions of the fishery.

There were obvious discontinuities in the modelled trends at the point of introducing actual data, and this was also queried. It was clarified that this was related to the treatment of effort and how it was calculated by the model. Given that adjacent years should not be expected to be too divergent from each other, the discontinuity occurring at the point at which actual data were introduced could possibly provide an indication of uncertainty in the historical trend. There was no conclusion on this point.

The Working Group noted the method had several advantages: it facilitated the generation of posterior distributions, e.g. for spawning stock biomass; it was able to include anecdotal information to provide working hypotheses; though it utilised age data, there were methods for converting size data to age data; it accounted for uncertainties in other data used; the process of re-scaling was the key concept that made the method 'catch-free'; abundance indices are required but these could be obtained from surveys and were not entirely dependent on regular monitoring of the fisheries concerned.

8.6 Generating Fs using Beverton-Holt Formula

Summary:
Mortality rates (Z) have been estimated from average length since the late 1950s. The original estimator developed by Beverton and Holt (1957),

$$Z = \frac{K(L_\infty - \overline{L})}{\overline{L} - L_C}$$

made several important assumptions: (1) the growth of all individuals follows the same Von Bertalanffy curve with parameters K and Linf, (2) the growth and mortality rates are constant through time, (3) Z is the same for all length classes after a minimum 'critical' length L_C, (4) recruitment is continuous and constant through time. Since then a number of variations of the Beverton-Holt estimator have been developed to partially relax assumptions (1) or (2), many of which are discussed in FAO Fisheries Technical Paper 323. Recently, estimators have been developed at the Virginia Institute of Marine Science and U.S. National Marine Fisheries Service that further relax assumptions (2) and (3), accounting for the transitional behavior of the average size statistic in non-equilibrium situations. Overall, estimators based on average size have the advantage of being simple and easy to apply, requiring as they do only a

random sample of the catch or population. Their greatest drawback is their sensitivity to the choice of growth curves, which in some cases may need to be 'borrowed' from similar species in other areas. They are also sensitive to large inter-annual variations in recruitment.

Discussion:
In response to a query about application to mixed gear fisheries, it was pointed out that the model could deal with different gear selectivities. However, the model was sensitive to inaccuracies in the selectivity pattern. It was added that fishing experiments could be relatively easily and cheaply conducted to estimate selectivities and so avoid the use of assumptions. The Working Group was also reminded of the availability of the FMSP Tool 'LFDA' for estimating the Z parameter using this Beverton and Holt formula and other methods (see www.fmsp.org.uk). There was also a question regarding the response of managers to the graph that clearly provided an ecosystem picture with a definite message of overfishing. It was confirmed that these results had been used to establish no-take areas and impose other restrictions.

8.7 Stock Population Simulators

Summary:
In accordance with the Terms of Reference, the Working Group has recommended using simulated data to evaluate software tools selected for assessment purposes. Two software models were presented: a) Population Simulator, a program from the NOAA Fishery Toolbox package, and b) FSIM (author: P. Goodyear), a tool for creating simulated stock populations.

Both programs simulated stock populations under different possible exploitation scenarios, assuming an age-structured population with alternative user-selected stock-recruitment. The Population simulators allow the user to create a simulated population by specifying basic population dynamics data, including growth, fecundity, natural mortality and fishery dependent information, such as selectivity, fishing mortality, and discards.

Both simulators allow the user to conduct exploratory analyses based on the implementation of various management regulations such as size limits, total catch limits, effort restrictions, selectivity modifications, etc. This enables the user to evaluate implications on stock simulated populations of alternative management regimes. The simulators provide sampling protocols, which extract catch and effort information with or without error from the fishery (ies) that it will be used as input for testing selected methods of assessment. FSIM is a more complex program in that it allows simulation of several sub-cohorts within a year and collection of size length frequency samples, or age collected samples, also with or without error.

The NOAA Fishery Toolbox package can be downloaded from the internet at http://ntf.nefsc.noaa.gov (log user 'nft', password 'nifty'), while FSIM can be requested from the author at Philgoodyear@cox.net.

Discussion:
It was asked whether this tool was used for teaching purposes, as it appeared suitable for this, as well as for the purpose of demonstrating to managers the importance of a sound data collection system. The tool appears to have been used only for demonstration purposes. A query was raised regarding omission of necessary data inputs for the simulation process. It was noted that the tool provided warnings when essential data were missing.

8.8 Ecological Risk Assessment

Summary:
This type of analysis facilitates examination of the potential impacts of fishing activities on the ecosystem as a whole. In the first instance, qualitative analyses are performed to provide an initial assessment of risk. If the risk is perceived to be higher than acceptable, then progressively more quantitative analyses are performed.

Discussion:
It was pointed out that variants of the approach were being applied in other parts of the world. The Working Group agreed that the method deserved further attention for application within the region, and recommended that an expert in this approach be invited to the next meeting of the Working Group. The Working Group noted that further descriptive information on the approach could be obtained from visiting the website www.fisheries-esd.com/.

8.9 ECOPATH

Summary:
The Ecopath with Ecosim (EwE) modeling system is being used within the Lesser Antilles Pelagic Ecosystem project. EwE provides a highly simplified description of biomass flows between ecosystem components in a 'balanced' system and a simulation capability to explore various fisheries scenarios. The software operation is well developed with good documentation and a user-friendly interface. The conceptual construction and parameterization of valid EwE models, on the other hand, requires a great deal data, information from the literature and ecological and fisheries expertise. The process is largely 'hand-crafted' and case-specific and is the area of greatest variation from model to model. The LAPE project will use a working group of ecopath and regional experts to validate and challenge the model construction decisions as they are being made. The working group will also identify the important uncertainties to be addressed through sensitivity analyses and alternative scenarios.

Discussion:
Regarding data requirements, it was pointed out that ECOPATH exceeded any other model in terms of its data needs. The ECOPATH model being developed by FAO for the Eastern Caribbean would be able to make use of data generated by the Working Group and the scientific meeting. In response to a query about the handling of uncertainty, it was pointed out that ECOPATH was limited in this respect. ECOPATH appears most suitable for hypothesis testing and policy exploration.

Clarification was sought whether the output from the FAO cetacean project would include management advice, and this was confirmed. Given that FAO has established a Working Group on ECOPATH Modelling and in view of some overlap in the aims of this FAO Working Group and the CRFM Working Group on Methods, it was recommended that the two Working Groups maintain contact.

8.10 General comments on review and discussion of methods

It was proposed that the Working Group consider and identify those methods that produced results in the short-term, as well as those methods that could be practically applied in the long-term. Additionally, it was proposed that the Working Group take into account methods that could be applied not only at the regional level, but also at the national level.

Several other issues were also identified, pertaining to data collection, data analysis, assessment, and training. In respect of data collection, it appeared important to distinguish between data that were collected on a continuous basis and data that were collected at intervals. Data from each country should be examined to determine what is available. Regarding data analyses, it appeared important to introduce analyses that could be completed in-country, such as extension of abundance indices. For assessments, it appeared important to make available packaged models as well as custom models, and to provide training in the use of these. Training at all levels was needed, and this could be satisfied in several ways, including peer-peer collaboration.

There was also some discussion about the datasets that could be used for testing. A query was raised regarding the usefulness of testing the methods with country datasets, given that it would take much time to prepare the data and that the scientists already know the answers. After some debate on this point, the Working Group concluded that there were notable benefits to be gained in using 'real' datasets from the region for testing the methods, and that it was important for the CRFM country representatives to see the process involved.

It was also pointed out that the Working Group had not fully addressed its Term of Reference no. 1. It was clarified that in addressing Term of Reference no. 1, the manager's questionnaire survey was only the first step. The smaller working group on communications would have to determine what else was required in order to address fully Term of Reference no. 1.

9. Determine suitable implementation schedule and assign priorities to identified tasks.

This agenda item was merged with agenda item 13 for the purpose of discussion.

10. Using real and/or simulated data, explore and evaluate proposed selected methods, taking into account the capacity of sampling programmes in CRFM countries, and more generally, data-poor situations.

This item dealt specifically with the Working Group's Term of Reference no.5.

Several method tests commenced during the Meeting. Accounts of the progress made on these tests are summarized in Addendum 7. It was agreed that these tests would continue during the inter-sessional period.

Following preliminary examination of datasets, the following approach to examination and uptake of methods was put forward for consideration.

1) Establish for each stock/fishery a model that would be appropriate.
2) Data permitting, apply a detailed assessment every few years when external additional technical expertise can be made available, and establish simpler level monitoring for the years in which detailed assessments are not completed.
3) Documentation of completed assessments should be made necessary. The assessment scientists should prepare the documentation in accordance with an agreed format, e.g. similar to that used by ICCAT. Such documentation should be maintained and managed by the CRFM Secretariat.

In considering and proposing application of assessment methods, it was pointed out that the names of methods were sometimes misleading, e.g. 'catch-free model'. It was agreed that some of the method

names currently being used could give managers the wrong impression with regard to data requirements. This problem was recognized, and the 'Catch-free model was renamed ' Re-scaled age-structured production model'. Other name changes could occur as methods are further developed.

11. Review and discuss outputs of tests performed.

This item dealt specifically with the Working Group's Term of Reference no. 5.

The following method tests commenced during the Meeting. Accounts of the progress made on these tests are summarized in Addendum 7.

11.1 'Catch-free' model - case study

Discussion of preliminary results obtained during meeting: Specific queries were raised concerning the graphical outputs, shown from another study for illustrative purposes. Regarding fisheries where it was not possible to establish F for target and bycatch species, it was pointed out that this could be achieved crudely by relating the combined F to catches. A query was raised regarding the distribution used for M. In response, it was noted that a lognormal distribution was used, developed based on data available for similar species and life history information. It was also confirmed that the method could be used to establish reference points that would be linked to levels of spawning stock biomass, catch rate, and fishing mortality. It was therefore possible to use catch rate as a simple monitoring index in years when detailed assessments could not be completed.

Tests would have to be continued during the inter-sessional period, during which time also there would be an attempt to address gaps in the effort series and to obtain required estimates of selectivity.

11.2 ASPIC model - case study

Discussion of preliminary results obtained during meeting: This case study used data on the spiny lobster fishery of St. Lucia. Comments and discussions focused mostly on observed temporal and spatial trends in catch and effort, as well as sex and size composition of the catches. The importance of conducting basic exploratory analyses of the data was emphasized.

11.3 Estimating Zs, using Beverton and Holt estimator – case study

Discussion of preliminary results obtained during meeting: Preliminary tests used data on the spiny lobster fisheries of The Bahamas and St. Lucia. It was confirmed that knife-edged selectivity was assumed for both fisheries, but it was agreed that selectivity might be expected to be lower for older lobsters. A query was raised regarding the use of length frequency data rather than age data for obtaining length values, and it was noted that this could be considered. In addition, there was also a query concerning the use of Yield Per Recruit analysis to obtain a reference point on mean size. It was agreed that this issue would be addressed during the inter-sessional period. Regarding the application of the method to CRFM multi-fleet fisheries situations, it was clarified that estimates of selectivity would be required for the different fleets concerned. If the data on fleets were combined, and the relative pattern of fleet operations remained consistent, the method could also still be applied.

In concluding, the Working Group made a general note about the sensitivity of datasets that was well illustrated during the demonstrations conducted. It was pointed out that data collection programmes should always strive to ensure that data could be stratified and hence linked by time, gear, and area, as this provides greater flexibility for data usage and analysis.

12. Develop recommendations for application of approved methods to CRFM fisheries situations.

This item dealt specifically with the Working Group's Term of Reference no.6.

The Working Group considered it premature to try to address the specific Term of Reference associated with this Agenda item during the present meeting. This was due to the fact that testing of methods was not yet completed. It was therefore agreed that only preliminary recommendations could be made at this time. Preliminary method-specific recommendations, where relevant, are presented in the reports of the tests performed (see Appendix 7), and would be updated when tests are completed.

13. Finalize inter-sessional work plan and assignments.

It was agreed to continue testing at least the three methods reported under agenda item 11 during the inter-sessional period.

Regarding the implementation plan for addressing the Working Group's Terms of Reference, the status of work was assessed in this respect. Additionally, the Meeting identified several tasks that were considered important in advancing the process over the next year. Table 3 provides a summary of the conclusions on this issue.

13.1 Recommendations to the Scientific Meeting

1) Considering the importance of establishing methodology for refinement of management objectives and prioritising assessments from year to year through development of an ecosystem risk assessment approach, it was recommended that a suitable expert be invited to make a presentation on this subject to the Working Group, and to provide technical guidance for establishing a process of refining management objectives suited to regional needs.

14. Proposed date of second meeting.

It was agreed to hold the second meeting of the Working Group in May 2006.

15. Review and adoption of meeting report.

In view of time constraints, and incomplete sections of the report, it was agreed to adopt the report using e-mail.

16. Adjournment.

Participants acknowledged the efforts of the Chairperson. In closing, the Chairperson thanked the participants for their contributions to the deliberations, and thanked the UWI and the CRFM for their role in organizing and facilitating the meeting.

The meeting was adjourned on 27 May 2005 at 16.30 p.m.

TABLES

Table 1 List of Methods considered by the Working Group and related issues

A. Preliminary points raised during the meeting for consideration in exploring suitability of proposed methods

Management objectives need to be defined and then addressed by assessments
Available Controls
- Effort (limited entry, closures)
- Closed areas / marine reserves
- Closed seasons
- Minimum size (Maximum size)
- Catch TAC and catch quotas (conch; catch documentation schemes)
- Gear controls
- Moratorium (high risk species; e.g. turtles)

Reference points and decision rules
- Traffic lights and simple output procedures

Standardisation of CPUE
- Data validation
- CPUE trends

Bayesian priors and "subjective" information
Multi-species multigear fisheries
Shared stocks, shared data and regional objectives

B. Fishery Assessment Methods Proposed During the First Meeting

Low-data management:
- One-off closures and gear controls to allow automatic response system.
- Life history: upper size limits, specific rules to protect spawning stock

Traffic light approach and variants; fuzzy logic; multiple indicators; decision rules
Catch-effort data analysis, abundance indices / total catch
Catch-free model: reconstruct fishery history, absolute catch is not required.
Length frequency data analysis (LFDA) – life history parameters
Catch-at-length, catch-at-age statistical models
Yield (per recruit model) – life history parameters required
Spatially explicit models
- GIS and spatial presentation of data
- Need to be developed
- Management unit

Simple length indicators – life history parameters required
Mean, median, upper percentile
- Reference points based on M or YPR
- Maturity based
- Example: Sea urchins St. Lucia

Multiple indicators / reference points: how to combine them
ParFish: Stock assessment for co-management
Simulations

C. Preliminary List of alternative types of data that would be useful if made available

1. Spatially explicit fisheries data

2. Habitat data: survey frame and ecological reference points
3. Socioeconomic data:
4. Age data: catch-at-age, life history parameters

NB: The Working Group highlighted the importance of ensuring good data management (i.e. database management), particularly regarding accessibility and quality of data.

D. Proposed criteria for aiding selection of methods

1. Data requirements/ availability/ possibilities
2. Type of management advice (ability to provide information based on stated objectives)
3. Expected management actions (practicalities)
4. Level of skills required
5. Attributes of the fishery (multispecies, multigear)
6. Cost, risks/ benefits of applying a particular method (the issue of trade-offs)

Table 2 Summarized review of methods presented and discussed the Meeting, in accordance with proposed selection criteria noted in Part D of Table 1.

Method	**Data requirements**	**Mgmt advice produced**	**Mgmt measures**	**Level of skills required**	**Costs and risks/ benefits / Dependence on prior beliefs**	**Type of stock / fishery**	**Working group**
'Low data'	Knowledge of distribution and movements of stock, or of species composition/ selectivity of gear (depending on control intended)	Simple advice produced, hopefully safe and precautionary, but highly conservative (more severe than feedback based mgmt)	Closed areas, size limits, catch quotas (but these require more data)	Relatively minimal quantitative skills, but good qualitative understanding of fish stock and fishery	Sensitive to poor understanding of basic data / distribution and movement, selectivity of gear, poaching	Any	St Lucia lobster TCI lobster
Parfish	Special Interview, Catch-effort time series, fishing experiment (flexible)	Target and limit controls	Effort control, catch TAC, marine reserve	Medium	Uses priors, rapid, inexpensive, not fully tested	Small scale co-managed	
Yield	Growth, maturity, L/W relationship, M, SRR (not for YPR version); uncertainties in inputs	F-based reference points: Per-recruit: F_{max}, $F_{SSBx\%}$, $F_{0.1}$, With SRR: F_{MSY}, $F_{transient}$	Effort / catch controls (also guidance on closed seasons and size limits	Medium (have user interface but need to understand alternative RPs etc)	Note need for other method to estimate indicator, F, to make mgmt advice	Single species	
Traffic Light Method	utilizes any/all data, indicators, analytical results available	attempts to synthesize many attributes of fisheries, can implement objective assessment of	non-specific, means of monitoring progress toward (or away) operational	software is hand crafted, not user friendly, construction of objectives/indicator/reference point sets	utility depends on clarification of objectives and establishing decision rules for management implementation	Generally single-species, multi-gear but can incorporate species	

		decision rules, relates indicators to management objectives	objectives	requires detailed knowledge fisheries (policy, biology, economics,…)		interactions (ecological or technical)	
Catch-free ASPM	Bio: Growth, maturity, L/W relationship, M; Other: Indices, effort trends, assumption of year at virgin level	Population trajectory from virgin to current level (on relative scale); estimate of F trajectory; estimates of benchmarks	Effort control scenarios; Probability distribution of future B levels relative to benchmark	High level; no GUI and no manual at present	(+) can incorporate priors for parameters and perceptions re: status; flexible; (-)	Single species	Conch? (Jamaica) (TCI)
Z estimator from mean length	Random sample of lengths from catch or from survey of population	total mortality rate (fishing mortality rate if natural mortality rate is known)	Effort control	Low	Easy, cheap, perhaps less precise than more data intensive methods (sensitive to large variations in recruitment)	Any	TCI lobster
LFDA	LF data (preferably time series)	VBGF + Z estimators	Effort / quota control	Low-medium	Assumes constant M, recruitment, etc		TCI lobster
Ecopath with Ecosim (EwE)	massive, generally must be compiled from a wide range of sources, different (related) ecosystems, related species, rules of thumb,…	operational management should not be based on EwE, policy exploration and 'what if…?' scenarios can be treated, can effectively identify issues/questions	supports simulation of F, effort and catch control scenarios, can include economic factors, also has an extension, Ecospace, to consider	complex computer program with adequate documentation, running models and simulations is easy for a computer literate user, model construction	expensive to produce, little likelihood of predictive outputs for operational use, does provide coherent (or at least consistent) means of examining 'entire' ecosystem	Multispecies/ multigear ecologically embedded	

		for further study	spatially explicit management (MPA, area quotas)	(data compilation, parameter selection,…) requires considerable knowledge and expertise regarding the system in question, adequate treatment of uncertainty requires particular innovation			
Population simulator NOAA NFT							
FSIM v3.0					More for length-based simulations, e.g. with different gears, selective		

Table 3 Summary of the status of work, identified tasks and recommendations in respect of fulfillment of Terms of Reference

Term of reference	Status of work	Tasks
1	In progress. Eight countries responded to fishery manager's questionnaire. Working group on Communications was established to examine further refinement of management objectives.	(i) Questionnaire to be circulated again to remaining countries during the inter-sessional period. (ii) CRFM Secretariat to provide accompanying note to questionnaire, that would also provide feedback on the usage of the information so far, and ask countries to review literature on refinement of management objectives. (iii) During the inter-sessional period, Trinidad and Tobago Fisheries Division to undertake in-country exercise of 'unpacking' objectives, and to provide a progress report to the Working Group
2	In progress.	(i) Work to be continued at next meeting
3	In progress. There was some discussion on the need to develop both short-term and long-term plans in respect of selection of methods for application	(i) Work to be continued at next meeting
4	In progress. An additional criterion was added to the Term of reference	(i) Work to be continued at next meeting. Proposed revision to Term of Reference is to be submitted for review and endorsement by the Scientific Meeting and the Forum
5	In progress. The testing of three methods commenced using real data from countries	(i) Work to be continued inter-sessionally and at next meeting
6	In progress.	(i) Work to be continued at next meeting
7	In progress. Identified need for refinement of management objectives and establishment of process	(i) Review of literature during inter-sessional period, and identify expert for guiding process at next meeting
8	In progress. Working Group on Data was established to address issues.	(i) Compilation of data inventory to be undertaken during the inter-sessional period. For this purpose, the Working Group recommended use of a similar format to that of the questionnaire used by FAO for its cetacean project.
9	In progress	Report of first meeting will be forwarded to the Scientific Meeting

APPENDICES

Appendix 1

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Appendix 2

FIRST MEETING of the CRFM Ad Hoc Working Group on Methods
(UWI, Cavehill Campus, Barbados, 23-27 May 2005)

MEETING AGENDA (as adopted by working group)

23 May 2005

(i) Registration (0830-0900h)

1. Opening of Meeting
2. Election of Meeting Chairwoman
3. Selection of Working Group Rapporteur(s).
4. Introduction of Participants.
5. Review and Adoption of Meeting Agenda.
6. Review and Discussion of Terms of Reference.
7. Review of Results of Manager's Questionnaire Study.
8. Review and discussion of methods for consideration by present meeting, and implications for practicality and uptake by managers.
9. Determine suitable implementation schedule and assign priorities to identified tasks.
10. Using real and/or simulated data, explore and evaluate proposed selected methods, taking into account the capacity of sampling programmes in CRFM countries, and more generally, data-poor situations.
11. Review and discuss outputs of tests performed.
12. Develop recommendations for application of approved methods to CRFM fisheries situations.
13. Finalize inter-sessional work plan and assignments.
14. Proposed date of second meeting.
15. Review and adoption of meeting report.
16. Adjournment.

Appendix 3

Terms of Reference of the CRFM Ad Hoc Working Group on Methods

(Revised Version proposed by Working Group)

Background and Rationale

CRFM objectives include, *inter alia*: the efficient management and sustainable development of marine and other living aquatic resources within the jurisdictions of Member States; and the provision of technical advisory and consultative services to fisheries divisions of Member States in the development, management, wise use, and conservation of their marine and other living aquatic resources. Pursuant to these objectives, the Caribbean Fisheries Forum (CFF), during its first annual session in 2003, endorsed the establishment of five fish resource working groups, for the purpose of coordinating fisheries assessment activities at the regional level and the provision of advice to inform planning and decision-making in respect of fisheries development, management and conservation issues.

In view of the present limited financial resources and assessment skills within CRFM States, and having recognized the need to regularize and broaden regional evaluation of the work completed by each of the groups concerned, the CRFM held its first annual scientific meeting in 2004. This forum was essentially a joint meeting of all CRFM fish resource working groups, and also facilitated useful discussion on issues of common concern to all the working groups, such as data quality and the appropriate application of various assessment tools to the management situation within CRFM States.

During the 2004 scientific meeting, participants acknowledged the importance of optimizing the usage of the various types, amounts and quality of data usually gathered and made available within CRFM States. Noting that it was often not possible for fisheries staff within CRFM States to apply the more conventional assessment methods requiring high quality, reliable, and detailed data, meeting participants recommended the establishment of an Ad Hoc Working Group on Methods, to devote specific attention to developing and testing assessment methods, which could be more widely applied to data-poor situations and also which make better use of the types and quality of data collected by CRFM countries.

Terms of Reference

Consistent with the recommendations of the First Annual CRFM Scientific Meeting, an Ad Hoc Working Group on Methods is established with agreed terms of reference as follows:

1) Review current management advice needs and constraints within CRFM countries.
2) Develop recommendations to improve communications between scientists and managers
3) Conduct a comprehensive review of resource and fisheries assessment methodology, with emphasis on those methods suitable for application to Caribbean fisheries. This will involve presentation of software tools, with examples of applications.
4) Based on review noted in (2), select those tools considered most useful for providing immediate contributions to the fisheries management process within the CRFM region.
5) Develop and apply criteria for evaluating the performance and suitability of the tools examined. Possible evaluation criteria include:
    a) Scientific accuracy and validity of the method;
    b) Ability of tools to incorporate uncertainty and provide advice on risks;
    c) Data requirements and the ease of collecting such data;
    d) Skills required by users;

e) The accessibility and availability of these skills within the region;
f) Level of usage of tools by fisheries officers and scientists within CRFM countries (or ease of presentation and understanding of the concepts/ reference points/ outputs);
g) Advancement of the management process, i.e. level of understanding and usage by management groups.
h) Ability of the method to provide advice based on the goals of management.

6) Test selected software tools using simulated and real data from CRFM countries.
7) Develop recommendations for applying assessment tools to specific fisheries management situations within CRFM countries.
8) Consider and pursue additional tasks pertaining to development and application of appropriate assessment methods, as appropriate.
9) Develop practical recommendations to improve data collection for successful implementation of approved assessment methods.
10) Document findings in meeting reports, and present findings to the Annual CRFM Scientific Meetings.

Mode of Operation

The CRFM Secretariat will be responsible for coordinating the activities of the Working Group.

The Working Group, through the CRFM should work closely with staff of national and regional institutions, and of regional organizations such as FAO (WECAFC) and OECS, in order to make full use of available technical expertise. The CRFM will ensure collaboration with non-CRFM countries to secure the inclusion of their inputs.

Membership of the Working Group & Participation

CRFM Member countries are members of the Ad Hoc Working Group on Methods and will be responsible for ensuring implementation of agreed Working Group recommendations at the national levels. It is essential that rapporteurs of CRFM Resource Working Groups participate in the activities of the Working Group.

Other scientific representatives from CRFM countries will also be invited to participate at their own expense. Fisheries staff in territories adjacent to CRFM Member countries, fisheries staff of regional organizations such as FAO, and OECS, fisheries staff of research institutions such as UWI, will be invited, at their own expense, to participate in meetings of the Working Group. Working Group meetings can take place given the presence of at least six different country representatives. A Chairperson, Vice-Chairperson, and Rapporteur should be elected, as required.

Working Group Meetings

An on-site meeting of the Working Group should be convened once every year during the period 2005-2007. Following this period, the progress and continued need for the Working Group will be reviewed and its terms of reference updated and renewed, if necessary.

Appendix 4

COMPILATION OF FISHERY MANAGERS' QUESTIONNAIRES COMPLETED BY CRFM MEMBER COUNTRIES

The primary purpose of the Ad Hoc Working Group on Methods is to investigate and develop methods of fishery data analysis and assessment that are suited to the types of data information systems that are practical for CRFM Member Countries, and also which are able to address the particular management needs identified by fishery managers in the region. The Working Group is also expected to develop recommendations for application of analysis methods during CRFM scientific meetings. In working towards this goal, some specific information and advice were sought from fishery managers within CRFM countries, in order to guide the efforts of the Working Group.

To facilitate acquisition of the relevant data, the CRFM Secretariat drafted and circulated a questionnaire for completion by Chief Fisheries Officers, Directors of Fisheries, or persons holding a related position and responsibility at the national level.

Completed questionnaires have been received from 8 countries. A compilation of the completed questionnaires was prepared for review by the First Meeting of the Ad Hoc Working Group on Methods, and is included in this Addendum.

FISHERY MANAGER'S QUESTIONNAIRE

Note to Fishery Managers: This questionnaire has been designed to gather information useful for re-evaluating current management advice needs and existing constraints to the provision of this within CRFM countries. The information provided will be used to optimize, as well as customize, the development and application of assessment tools in respect of the management process.

Instructions for completion: *Please tick or encircle your answer choices. In the case of multiple choice questions, you may tick or encircle all the choices that apply. Please print all responses.*

ANGUILLA

1. Fishery Manager's Name (Director or CFO) **Mr. Othlyn Vanterpool**

2. What sources of information are currently used for establishing management objectives for your fisheries?

(a) National consultations
(b) Social and economic data available from national statistics authority
(c) Stakeholder interview survey data
(d) **Local/Traditional ecological knowledge (ethno-scientific information)**
(e) Adopt objectives used by other countries with similar fisheries situations.
(d) International fisheries instruments
(e) Other (specify) ……..

3. Do you actively measure/monitor the achievement of management objectives?
(a) **No (*please go to question 4*)** (b) Yes (*please go to question 5*).

4. If you answered negatively in (3), please indicate the constraints to monitoring management objectives.

(a) Insufficient data collected to allow evaluation.
(b) Officers do not have sufficient time to analyse available data and hence prepare management advice
(c) Officers do not have sufficient skills and experience to analyse available data and hence prepare management advice
(d) Assessment tools being used by officers are not appropriate, as these tools do not provide answers to the management questions of direct concern.
(e) Defined objectives are too broad, and so officers do not provide specific management guidance on specific issues of concern, e.g. providing advice on suitable gear restrictions and acceptance of this as an effective management tool.
(f) Other, specify ……

*** Technical capabilities are limited due to the lack of necessary equipment and tools for assisting with the trend in harvesting; thus monitoring maximum sustainable yields.**

5. In table I that follows, list the management objectives for each fishery/ stock, allocate a priority rank to each of the objectives by fishery (using a scale of 1 to 5, with 1 used to indicate highest priority), then list the data collected to facilitate monitoring/measuring of the achievement of the listed objectives, and finally indicate the software tools currently used to analyse the available data (the first data input row shows an example).

Table I. Management objectives by fishery / stock

Fishery (identify specific species or stock)	Management objectives	Priority of objective	Data collected to measure achievement of objective	Sampling coverage (% total)	Analysis tools used [FISAT, prepared FAO Excel spreadsheets, SPSS, Other, specify]	Decision-making rules / reference points used, if any	Current management measures in place for each fishery / stock. Indicate if decision rule was used to establish measure
EXAMPLE. Large pelagic fishery – Spanish mackerel	1) Maximize employment opportunities 2) Maximize biological yield 3) Protect juvenile stock	1) 1 2) 2 3) 3	1) Social and economic data, catch and effort data 2) Catch & effort data 3) Catch, effort, age/size and maturity data	1) 20% 2) 30% 3) 30%, 15%	1) Excel 2) Surplus Production (ASPIC) 3) Excel spreadsheet for yield per recruit, VPA	1) Minimum net profit = 5% of costs 2) Lower limit of estimated MSY range 3) $F_{0.1}$	Mesh size limit for gill nets ($F_{0.1}$ value used).
Reef fishery -	**1) Maximize employment opportunities**	**1) 1**	***Catch & effort data***	**20%**			**- Wire mesh size limit - Ban on gillnets**
Conch fishery -	**1) Maximize employment opportunities**	**1) 1**	**Catch & effort**	**20%**			**- size limit**
Lobster fishery -	**1) Maximize employment opportunities 2) Protect juvenile stock**	**1) 1 2) 2**	**Catch & effort**	**20%**			**- size limit - mesh wire size limit - No taking of egg bearing lobsters**
Large pelagic fish -	**1) Maximize employment opportunities 2) Protect juvenile stock**	***1) 1***	**Catch & effort**	***20%***			
Mammals	**1) Maximize employment opportunities**	***1) 1***	**Catch & effort**	***20%***			

6. How much work time is currently allocated for data review and analysis tasks and hence also development of assessment skills by the fisheries officers so involved? (Answer is assumed to represent time for a single individual)

(a) < 5% of work time
(b) 10-15% of work time
(c) 15-20% of work time
(d) 20-30% of work time
(e) > 30% of work time

7. In table II that follows, please provide information the qualifications of your officers involved in stock assessment work, and list the data analysis and assessment tools with which they are familiar (the first data input row shows an example.

Table II. Qualifications and experience of staff conducting assessments

Officer (names can be omitted)	Qualifications (include training courses)	Experience with analysis and assessment tools
Example: officer 1	**B.Sc., M. Phil, 1995 FAO-Danida training course in assessment**	**Excel, S-Plus, FISAT, ECOPATH**
Officer 1:	***MSc in Tropical Coastal Management***	**Excel & FISAT**
Officer 2:		
Officer 3:		
Officer 4:		

8. In table III that follows, note the top specific management questions, by fishery or stock, which currently concern management groups in your country (the first data input row shows an example).

Table III. Current management questions of highest priority.

Fishery	Question
Example: queen conch fishery	1) How effective are marine reserves in enhancing the spawning stock biomass?
1) Lobster Fishery	**At what rate is the Stock replenishing itself?**
2) Reef Fishery	**Is the stock over fished?**

BELIZE

1. Fishery Manager's Name (Director or CFO) …**Beverly Wade……..**

2. What sources of information are currently used for establishing management objectives for your fisheries?

(a) National consultations✓
(b) Social and economic data available from national statistics authority✓
(c) Stakeholder interview survey data✓
(d) Local/Traditional ecological knowledge (ethno-scientific information)✓
(e) Adopt objectives used by other countries with similar fisheries situations. ✓
(f) International fisheries instruments✓
(g) Other (specify) ……..

3. Do you actively measure/monitor the achievement of management objectives?

(a) No (*please go to question 4*)✓ (b) Yes (*please go to question 5*).

4. If you answered negatively in (3), please indicate the constraints to monitoring management objectives.

(a) Insufficient data collected to allow evaluation.✓
(b) Officers do not have sufficient time to analyze available data and hence prepare management advice
(c) Officers do not have sufficient skills and experience to analyze available data and hence prepare management advice✓
(d) Assessment tools being used by officers are not appropriate, as these tools do not provide answers to the management questions of direct concern.
(e) Defined objectives are too broad, and so officers do not provide specific management guidance on specific issues of concern, e.g. providing advice on suitable gear restrictions and acceptance of this as an effective management tool.
(f) Other, specify ……

5. In table I that follows, list the management objectives for each fishery/ stock, allocate a priority rank to each of the objectives by fishery (using a scale of 1 to 5, with 1 used to indicate highest priority), then list the data collected to facilitate monitoring/measuring of the achievement of the listed objectives, and finally indicate the software tools currently used to analyze the available data (the first data input row shows an example).

Table I. Management objectives by fishery / stock

Fishery (identify specific species or stock)	Management objectives	Priority of objective	Data collected to measure achievement of objective	Sampling coverage (% total)	Analysis tools used [FISAT, prepared FAO Excel spreadsheets, SPSS, Other, specify]	Decision-making rules / reference points used, if any	Current management measures in place for each fishery / stock. Indicate if decision rule was used to establish measure
EXAMPLE. Large pelagic fishery – Spanish mackerel	1) Maximize employment opportunities 2) Maximize biological yield 3) Protect juvenile stock	1) 1 2) 2 3) 3	1) Social and economic data, catch and effort data 2) Catch & effort data 3) Catch, effort, age/size and maturity data	1) 20% 2) 30% 2) 30%, 15%	1) Excel 2) Surplus Production (ASPIC) 3) Excel spreadsheet for yield per recruit, VPA	1) Minimum net profit = 5% of costs 2) Lower limit of estimated MSY range 3) $F_{0.1}$	Mesh size limit for gill nets ($F_{0.1}$ value used).
Reef fishery -	1,2,3	1	2	-	1	Currently – open for fishing without restriction	No gill nets or traps should be placed within a distance of 100m from the coral reef. No management measures except for 11 spawning aggregation Marine Reserves for snappers, groupers, jacks and other species
Conch fishery -	1,2,3	1	2	1	1	2	Minimum shell length – 7 inches, minimum weight of 3 ounces (market clean) closed season = 1 July – 30 Sept. it is illegal to buy, sell or have fillet or diced lobster meat.

Lobster fishery -	1,2,3	1	2	1	1	2	Minimum carapace length of 3 inches, minimum tail weight of 4 ounces. The closed season is 15th Feb – 14th June. It is illegal to buy, sell or have fillet or diced lobster meat.
Shrimp fishery -	2,3	2	3	1	1	Depending on abundance (max – 69 %) of juvenile shrimp in catches.	
Ground fish -	2,3	2	-	-	-	Currently – open for fishing without restriction.	
Small coastal pelagic fish -	1,2,3	2	-	-	-	Currently – open for fishing without restriction.	
Large pelagic fish -	-	3	-	-	-	Currently – open for fishing without restriction.	

6. How much work time is currently allocated for data review and analysis tasks and hence also development of assessment skills by the fisheries officers so involved? (Answer is assumed to represent time for a single individual)

(a) < 5% of work time
(b) 10-15% of work time
(c) 15-20% of work time✓
(d) 20-30% of work time
(e) > 30% of work time

7. In table II that follows, please provide information the qualifications of your officers involved in stock assessment work, and list the data analysis and assessment tools with which they are familiar (the first data input row shows an example.

Table II. Qualifications and experience of staff conducting assessments

Officer (names can be omitted)	**Qualifications (include training courses)**	**Experience with analysis and assessment tools**
Example: officer 1	B.Sc., M. Phil, 1995 FAO-Danida training course in assessment	Excel, S-Plus, FISAT, ECOPATH
Officer 1 M. Gongora	B.Sc., M.Sc. General Fishery Biology	Excel, SPSS
Officer 2 R. Carcamo	B.Sc. General Fishery Biology	Excel, SPSS
Officer 3 J. Villanueva	B.Sc. General Fishery Biology	Excel, SPSS

8. In table III that follows, note the top specific management questions, by fishery or stock, which currently concern management groups in your country (the first data input row shows an example).

Table III. Current management questions of highest priority.

Fishery	**Question**
Example: queen conch fishery	1) How effective are marine reserves in enhancing the spawning stock biomass?
1) Lobster Fishery	1. How effective are the current minimum size and minimum weight limits? 2. Is the current closed season effective? 3. What is the main source of larval recruitment for Belize?
2) Conch Fishery	1. How effective are the current minimum size (shell length) and minimum weight limits? 2. Is the current closed season effective? 3. What is the main source of larval recruitment for Belize?
3) Shrimp Fishery	1. What is the size of the stock? 2. How many shrimp trawlers can fish the stock? 3. For how long can the stock be fished on any given year?

BRITISH VIRGIN ISLANDS

1. Fishery Manager's Name: Bertrand Lettsome, *Chief Conservation and Fisheries Officer*

2. What sources of information are currently used for establishing management objectives for your fisheries?

(a) National consultations ✔
(b) Social and economic data available from national statistics authority ✔
(c) Stakeholder interview survey data
(d) Local/Traditional ecological knowledge (ethno-scientific information) ✔
(e) Adopt objectives used by other countries with similar fisheries situations. ✔
(f) International fisheries instruments ✔
(g) Other (specify) Social and economic data from *ad hoc* surveys.
Economic data from relevant establishments (BVI Fishing Complex)

3. Do you actively measure/monitor the achievement of management objectives?
(a) No (*please go to question 4*) (b) Yes (*please go to question 5*).

This is neither a strict yes or no, some measures are easier to monitor than others. The response is both yes and no.

4. If you answered negatively in (3), please indicate the constraints to monitoring management objectives.

(a) Insufficient data collected to allow evaluation. ✔
(b) Officers do not have sufficient time to analyse available data and hence prepare management advice ✔
(c) Officers do not have sufficient skills and experience to analyse available data and hence prepare management advice ✔
(d) Assessment tools being used by officers are not appropriate, as these tools do not provide answers to the management questions of direct concern.
(e) Defined objectives are too broad, and so officers do not provide specific management guidance on specific issues of concern, e.g. providing advice on suitable gear restrictions and acceptance of this as an effective management tool.
(f) Other, specify:

Insufficient officers and appropriate motivational structure to get the volume of work done. Regardless of the size of the country and the number of fishermen or vessels once a party to UNCLOS the EEZ is relatively large compared to the size of the country. The ability to monitor (resources and harvesting of resources) is hampered by the institutional capacity to do so. Appropriate monitoring resources such as vessels, research equipment, surveillance systems etc. are costly and possibly cannot be dedicated to fisheries work. The variety of tasks involved in assessment and management directs that careful evaluation be made of the human resources necessary for this to be effective.

5. In table I that follows, list the management objectives for each fishery/ stock, allocate a priority rank to each of the objectives by fishery (using a scale of 1 to 5, with 1 used to indicate highest priority), then list the data collected to facilitate monitoring/measuring of the achievement of the listed objectives, and finally indicate the software tools currently used to analyse the available data (the first data input row shows an example).

Table I. Management objectives by fishery / stock

Fishery (identify specific species or stock)	Management objectives	Priority of objective	Data collected to measure achievement of objective	Sampling coverage (% total)	Analysis tools used [FISAT, prepared FAO Excel spreadsheets, SPSS, Other, specify]	Decision-making rules / reference points used, if any	Current management measures in place for each fishery / stock. Indicate if decision rule was used to establish measure
EXAMPLE. Large pelagic fishery – Spanish mackerel	1) Maximize employment opportunities 2) Maximize biological yield 3) Protect juvenile stock	1) 1 2) 2 3) 3	1) Social and economic data, catch and effort data 2) Catch & effort data 3) Catch, effort, age/size and maturity data	1) 20% 2) 30% 3) 30%, 15%	1) Excel 2) Surplus Production (ASPIC) 3) Excel spreadsheet for yield per recruit, VPA	1) Minimum net profit = 5% of costs 2) Lower limit of estimated MSY range 3) $F_{0.1}$	Mesh size limit for gill nets ($F_{0.1}$ value used).
Reef fishery - For fin fish	1) Stock and habitat recovery and maintenance of fishery at sustainable levels 2) Reef resources managed for sustainable multiple use and maximum benefits to all stakeholders	1) 1 2) 2	Catch and effort data Spatial, data (monitoring of reefs etc. there is a marine biologist dedicated to this and monitoring of other habitats)	30% 30%	Excel spreadsheets. Access database. GIS (there is a GIS Officer for mapping spatial data and staff who assist with ground truthing and digitizing)	- -	Effort control Closed seasons Size and gear limits Co management arrangements Integrated management for multiple use

Conch fishery -	Sustainable level of harvest	1) 1	Catch Data	Approx. 20%	Excel spreadsheet	-	Effort control Closed areas and seasons Co-management arrangements
Lobster fishery -	1) Maintain sustainable level of effort. 2) Protect juveniles 3) Protect berried females.	1) 1 2) 2 3) 2	Catch and some effort data Carapace Length Reproductive state data	Approxima tely 30% Approx. 20% Approx. 20%	Excel spreadsheet Excel spreadsheet Excel spreadsheet	No lobster >3.5in. to be landed No beried lobsters to be landed.	Minimum mesh size limits. No spear fishing for lobster Minimum carapace length of 3.5 inches. No capture of berried females Certain closed reserve areas.
Small coastal pelagic fish -	1) Increase yields from the fishery.	1) 1	Ad hoc unstructured socio-economic information	-	-	-	-
Large pelagic fish -	1) Increase yields in accordance with prescribed management quotas where required. 2) Reduce reliance on imported supplies.	1) 1 2) 2	Some catch and effort data Import/export data (ad-hoc)	50% 40%	Excel Spreadsheet Excel Spreadsheet	Landings at 100mt of swordfish. Virtually zero imports of swordfish and tunas	Licensing of vessels on payment of prescribed fee. No licensing of foreign vessels.

Recreational fishery	1) Rationalise recreational fishing effort. 2) Increase revenue from the recreational fishery.	1) 1 2) 2	Number of fishing licenses sold monthly/annually	80%	Excel Spreadsheet	Increasing revenue from the recreational fishery.	Licensing of vessels on payment of prescribed fee.

6. How much work time is currently allocated for data review and analysis tasks and hence also development of assessment skills by the fisheries officers so involved? (Answer is assumed to represent time for a single individual)

(a) < 5% of work time
(b) 10-15% of work time
(c) 15-20% of work time ✔
(d) 20-30% of work time
(e) > 30% of work time

7. In table II that follows, please provide information the qualifications of your officers involved in stock assessment work, and list the data analysis and assessment tools with which they are familiar (the first data input row shows an example.

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Officer (names can be omitted)	**Qualifications (include training courses)**	**Experience with analysis and assessment tools**
Example: officer 1	B.Sc., M. Phil, 1995 FAO-Danida training course in assessment	Excel, S-Plus, FISAT, ECOPATH
Officer 1	B.Sc., MPhil., (1984) MLIS, (2003) FAO training programmes in assessment and data management. CFRAMP/FAO training in assessment and data management	Excel, (require refresher FISAT ECOPATH, Access)
Officer 2	BSc.	Excel, Access

8. In table III that follows, note the top specific management questions, by fishery or stock, which currently concern management groups in your country (the first data input row shows an example).

Table III. Current management questions of highest priority.

Fishery	**Question**
Example: queen conch fishery	1) How effective are marine reserves in enhancing the spawning stock biomass?
1) Reef fishery for fin fish	What is the most appropriate methodology for conducting an assessment of the fish pot fishery? (There are variations in the dimensions of the traps)
2) Conch Fishery	How effective are closed areas/marine protected areas in improving spawning stock biomass?
3) Lobster Fishery	What is the socioeconomic value of the Fishery? How feasible is lobster farming or head-starting programme in the BVI?
4) All Fisheries	What are the best, simplest (most appropriate) methodologies for stock assessments and what are the data requirements? How can effort data be standardized for fleets with various fishing power and non standard gears?

GUYANA

1. Fishery Manager's Name (Director or CFO) **DAWN MAISON**

2. What sources of information are currently used for establishing management objectives for your fisheries?

(a) National consultations
(b) Social and economic data available from national statistics authority
(c) Stakeholder interview survey data
(d) Local/Traditional ecological knowledge (ethno-scientific information)
(e) Adopt objectives used by other countries with similar fisheries situations.
(f) International fisheries instruments
(g) Other (specify) ……..

3. Do you actively measure/monitor the achievement of management objectives?
(a) No (*please go to question 4*) (b) Yes (*please go to question 5*).

4. If you answered negatively in (3), please indicate the constraints to monitoring management objectives.

(a) Insufficient data collected to allow evaluation.
(b) Officers do not have sufficient time to analyse available data and hence prepare management advice.
(c) Officers do not have sufficient skills and experience to analyse available data and hence prepare management advice

(d) Assessment tools being used by officers are not appropriate, as these tools do not provide answers to the management questions of direct concern.

(e) Defined objectives are too broad, and so officers do not provide specific management guidance on specific issues of concern, e.g. providing advice on suitable gear restrictions and acceptance of this as an effective management tool.

(f) Other, specify ……

5. In table I that follows, list the management objectives for each fishery/ stock, allocate a priority rank to each of the objectives by fishery (using a scale of 1 to 5, with 1 used to indicate highest priority), then list the data collected to facilitate monitoring/measuring of the achievement of the listed objectives, and finally indicate the software tools currently used to analyse the available data (the first data input row shows an example).

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EXAMPLE. Large pelagic fishery – Spanish mackerel	1) Maximize employment opportunities 2) Maximize biological yield 3) Protect juvenile stock	1) 1 2) 2 3) 3	1) Social and economic data, catch and effort data 2) Catch & effort data 3) Catch, effort, age/size and maturity data	1) 20% 2) 30% 2) 30%, 15%	1) Excel 2) Surplus Production (ASPIC) 3) Excel spreadsheet for yield per recruit, VPA	1) Minimum net profit = 5% of costs 2) Lower limit of estimated MSY range 3) $F_{0.1}$	Mesh size limit for gill nets ($F_{0.1}$ value used).
Reef fishery -							
Conch fishery -							
Lobster fishery -							

Shrimp fishery -	1. Develop and increase the shrimp resources 2. Maximize employment opportunities 3. Protect juvenile stock 4. Increase the net foreign exchange earnings	1) 1 2) 2 3) 3 4) 4	1) Catch & Effort data 2) Social and economic data	1) 50% 2) 30%	1. EXCEL		
Ground fish -	1. Expand fishery using precautionary approach 2. Investigate the feasibility of a directed fishery 3. Consider traditional knowledge and interest of local communities, small-scale artisanal fishers	1) 3 2) 1 3) 2	1. Catch & effort data 2. Biological Data Collection\ length frequency	1) 80% 2) 60%	1. EXCEL		
Small coastal pelagic fish -							

Large pelagic fish -	1. Promote the development of selective fishing gear and practices that minimize waste in the catch of target species and minimize by-catch of non-target species. 2. Cooperate with member of ICCAT 3. Investigate the feasibility of directed fishery	1) 1 2) 2 3) 3	1) Catch & effort data 2) Social & economic data 3) Biological Data Collection \ length frequency	1) 60% 2) 40% 3) 50%	EXCEL		

6. How much work time is currently allocated for data review and analysis tasks and hence also development of assessment skills by the fisheries officers so involved? (Answer is assumed to represent time for a single individual)

(a) < 5% of work time
(b) <u>10-15% of work time</u>
(c) 15-20% of work time
(d) 20-30% of work time
(e) > 30% of work time

7. In table II that follows, please provide information the qualifications of your officers involved in stock assessment work, and list the data analysis and assessment tools with which they are familiar (the first data input row shows an example.

Table II. Qualifications and experience of staff conducting assessments

Officer (names can be omitted)	Qualifications (include training courses)	Experience with analysis and assessment tools
Example: officer 1	B.Sc., M. Phil, 1995 FAO-Danida training course in assessment	Excel, S-Plus, FISAT, ECOPATH
Officer 1	BSc Agriculture	EXCEL,
Officer 2	BSc Agriculture	EXCEL
Officer 3	BSc Management	EXCEL

8. In table III that follows, note the top specific management questions, by fishery or stock, which currently concern management groups in your country (the first data input row shows an example).

Table III. Current management questions of highest priority.

Fishery	Question
Example: queen conch fishery	1) How effective are marine reserves in enhancing the spawning stock biomass?
1) SHRIMP	How to restrict conflict between gears sector that is, trawlers and artisanal fishers? What is the specific time to implement closed season \closed areas? How and when to protect nursery habitat for shrimp? What is the biomass of this fishery?
2) GROUNDFISH	Whether to ban \ eliminate \ increase the mesh size of certain gear type? Query production of one species versus destruction of juvenile. What is the biomass of this fishery?
3) DEEP SLOPE	When to phase out traps? How to stop illegal fishing?

NEVIS

1. Fishery Manager's Name (Director or CFO) **Mr. Audra Barrett**

2. What sources of information are currently used for establishing management objectives for your fisheries?

(a) National consultations
(b) Social and economic data available from national statistics authority
(c) Stakeholder interview survey data
(d) Local/Traditional ecological knowledge (ethno-scientific information)
(e) Adopt objectives used by other countries with similar fisheries situations.
(f) International fisheries instruments
(g) Other (specify) ……..

3. Do you actively measure/monitor the achievement of management objectives?

(a) No (*please go to question 4*) (b) Yes (*please go to question 5*).

4. If you answered negatively in (3), please indicate the constraints to monitoring management objectives.

(a) Insufficient data collected to allow evaluation.
(b) Officers do not have sufficient time to analyse available data and hence prepare management advice.
(c) Officers do not have sufficient skills and experience to analyse available data and hence prepare management advice.
(d) Assessment tools being used by officers are not appropriate, as these tools do not provide answers to the management questions of direct concern.
(e) Defined objectives are too broad, and so officers do not provide specific management guidance on specific issues of concern, e.g. providing advice on suitable gear restrictions and acceptance of this as an effective management tool.
(f) Other, specify ……

*** Technical capabilities are limited due to the lack of necessary equipment and tools for assisting with the trend in harvesting; thus monitoring maximum sustainable yields.**

5. In table I that follows, list the management objectives for each fishery/ stock, allocate a priority rank to each of the objectives by fishery (using a scale of 1 to 5, with 1 used to indicate highest priority), then list the data collected to facilitate monitoring/measuring of the achievement of the listed objectives, and finally indicate the software tools currently used to analyse the available data (the first data input row shows an example).

Table I. Management objectives by fishery / stock

Fishery (identify specific species or stock)	Management objectives	Priority of objective	Data collected to measure achievement of objective	Sampling coverage (% total)	Analysis tools used [FISAT, prepared FAO Excel spreadsheets, SPSS, Other, specify]	Decision-making rules / reference points used, if any	Current management measures in place for each fishery / stock. Indicate if decision rule was used to establish measure
EXAMPLE. Large pelagic fishery – Spanish mackerel	1) Maximize employment opportunities 2) Maximize biological yield 3) Protect juvenile stock	1) 1 2) 2 3) 3	1) Social and economic data, catch and effort data 2) Catch & effort data 3) Catch, effort, age/size and maturity data	1) 20% 2) 30% 2) 30%, 15%	1) Excel 2) Surplus Production (ASPIC) 3) Excel spreadsheet for yield per recruit, VPA	1) Minimum net profit = 5% of costs 2) Lower limit of estimated MSY range 3) $F_{0.1}$	Mesh size limit for gill nets ($F_{0.1}$ value used).
Reef fishery -	***Protect juveniles to promote stock recovery***	**1) 1**	**Catch & effort data**	***60%***	***Present: training in Excel. Data compiled manually***		***- size restriction on meshed gears - dynamite, noxious substances prohibited.***
Conch fishery -	***- Reduce over-exploitation. - Protect habitat which will enhance stock recovery.***	**1) 1**	***Catch, effort, size and maturity data***	***15%***	***Present: training in Excel. Data compiled manually***		***- size restrictions - minimum shell length and meat weight - harvest only flared li conch***
Lobster fishery -	***- Protect juvenile stock - Rebuild stocks in depleted areas***	**1) 1 2) 2**	***Catch, effort, size and maturity data***	***60%***	***Present: training in Excel. Data compiled manually***		***- size restrictions - prohibition on taking berried females or molting individuals***

Deep slope fishery	***- Maximise catches within the potential yield***	**1) 1**	***Economic, catch and effort data***	***20%***	***Present: training in Excel. Data compiled manually***		***- size restriction on mesh - no specific management measures on this fishery***
Small coastal pelagic fish -	***- Maintain fish habitat which will enhance stock recovery***	**1) 1**	***Catch & effort data***	***20%***	***Present: training in Excel. Data compiled manually***		***-minimum mesh size fo beach seine and Ballahoo nets***
Large pelagic fish -	***- Promote development of this fishery. - If possible protect juvenile stock***	***1) 1 2) 2***	***Social, economic, catch and effort data Size and maturity data***	***20% 15%***	***Present: training in Excel. Data compiled manually***		***- no management measures to control harvest***

6. How much work time is currently allocated for data review and analysis tasks and hence also development of assessment skills by the fisheries officers so involved? (Answer is assumed to represent time for a single individual)

(a) **<u>< 5% of work time</u>**
(b) 10-15% of work time
(c) 15-20% of work time
(d) 20-30% of work time
(e) > 30% of work time

7. In table II that follows, please provide information the qualifications of your officers involved in stock assessment work, and list the data analysis and assessment tools with which they are familiar (the first data input row shows an example.

Table II. Qualifications and experience of staff conducting assessments

Officer (names can be omitted)	Qualifications (include training courses)	Experience with analysis and assessment tools
Example: officer 1	B.Sc., M. Phil, 1995 FAO-Danida training course in assessment	Excel, S-Plus, FISAT, ECOPATH
Officer 1: *Audra Barrett*	**Certificate in Fisheries Technology; DIP Fisheries Conservation**	***20 years of compiling fish landings***
Officer 2: Alex Percival	**Training in TIP & CARIFIS**	
Officer 3: *Shawn Isles*	**Training in Fisheries Resource Management**	
Officer 4: *Lemuel Pemberton*	**MSC in Natural Resource Management**	***6 years in Excel & SPSS***

8. In table III that follows, note the top specific management questions, by fishery or stock, which currently concern management groups in your country (the first data input row shows an example).

Table III. Current management questions of highest priority.

Fishery	Question
Example: queen conch fishery	**1) How effective are marine reserves in enhancing the spawning stock biomass?**
1) Conch & Lobster Fishery	**How efficient are marine resources in enhancing the spawning stock biomass?**
2) Reef Fishery	**What measures could be put in place to counteract the over-exploitation of the reef fishery?**
3) Sea Turtle Fishery	**To what extent can co-management help in increasing levels of conservation in Nevis?**

ST. LUCIA

1. Fishery Manager's Name (Director or CFO) **Vaughn Charles**

2. What sources of information are currently used for establishing management objectives for your fisheries?

(a) National consultations **X (on occasions)**
(b) Social and economic data available from national statistics authority **X (limited availability)**
(c) Stakeholder interview survey data **X (on occasions)**
(d) Local/Traditional ecological knowledge (ethno-scientific information) **X (informal sources)**
(e) Adopt objectives used by other countries with similar fisheries situations. **X**
(f) International fisheries instruments **X (and other multilateral environmental agreements)**
(g) Other (specify) **scientific literature when available, international seminars and conventions (participation and interaction with other participants and also proceedings of such fora).**

3. Do you actively measure/monitor the achievement of management objectives?

(a) No (*please go to question 4*) (b) Yes (*please go to question 5*). **Fish production; levels of use and revenue within marine reserves of SMMA and CAMMA; reef habitat health; sea urchin abundance and sizes over time; lobster length frequencies and sex ratios over time; also focused short term species-specific and/or gear specific assessments (biological) when project funding can be obtained for such; beach profile monitoring at select sites; water quality monitoring at select sites (in collaboration with Ministry of Health).**

Note: the section below is still relevant as it allows for indicating limitations and constraints

4. If you answered negatively in (3), please indicate the constraints to monitoring management objectives.

(a) Insufficient data collected to allow evaluation. **(true in some cases)**
(b) Officers do not have sufficient time to analyse available data and hence prepare management advice **(very true: no dedicated officers for much of our data analysis and interpretation)**
(c) Officers do not have sufficient skills and experience to analyse available data and hence prepare management advice **(true in some cases, particularly socio-economic data and information)**
(d) Assessment tools being used by officers are not appropriate, as these tools do not provide answers to the management questions of direct concern. **(limited access to up-to-date statistical programmes and training in such programmes)**
(e) Defined objectives are too broad, and so officers do not provide specific management guidance on specific issues of concern, e.g. providing advice on suitable gear restrictions and acceptance of this as an effective management tool. **(many focus areas are not examined due to manpower limitations)**
(f) Other, specify ……

5. In table I that follows, list the management objectives for each fishery/ stock, allocate a priority rank to each of the objectives by fishery (using a scale of 1 to 5, with 1 used to indicate highest priority), then list the data collected to facilitate monitoring/measuring of the achievement of the listed objectives, and finally indicate the software tools currently used to analyse the available data (the first data input row shows an example).

Table I. Management objectives by fishery / stock

Fishery (identify specific species or stock)	Management objectives	Priority of objective	Data collected to measure achievement of objective	Sampling coverage (% total)	Analysis tools used [FISAT, prepared FAO Excel spreadsheets, SPSS, Other, specify]	Decision-making rules / reference points used, if any	Current management measures in place for each fishery / stock. Indicate if decision rule was used to establish measure
EXAMPLE. Large pelagic fishery – Spanish mackerel	1) Maximize employment opportunities 2) Maximize biological yield 3) Protect juvenile stock	1) 1 2) 2 3) 3	1) Social and economic data, catch and effort data 2) Catch & effort data 3) Catch, effort, age/size and maturity data	1) 20% 2) 30% 2) 30%, 15%	1) Excel 2) Surplus Production (ASPIC) 3) Excel spreadsheet for yield per recruit, VPA	1) Minimum net profit = 5% of costs 2) Lower limit of estimated MSY range 3) $F_{0.1}$	Mesh size limit for gill nets ($F_{0.1}$ value used).
Reef fishery -	i) Promote stock recovery; ii) Ensure sustainable use	1 1	Catch and effort; %live coral cover; size and abundance of indicator reef fish species; level of fecal coliforms.	~50% (stratified random sampling of 8 of 17 fish landing sites, including majority of major and intermediate sites; beach monitoring at 9 beach sites islandwide (~10-15% coverage); water quality collected at 13 sites islandwide (~10-15%coverage); ReefCheck at x sites islandwide (~15-20% of key reef areas sampled)	TIP (possibly soon to change to CARIFIS) and analysis in Excel based programme designed to do the bumping up and calculate total landings by site per species group	Comparison of Reef Check values compared with international data in this database; degree to which water quality is in line with national/international standards.	Mesh size limits for traps and nets; limited entry to pot fishery, marine reserves, no trammel nets; no bottom-set gillnets in SMMA; co-management of SMMA/CAMMA; no spearing of lobsters or fishing of berried or juvenile lobsters; close season and size limits for turtles; monitoring of indicator species (ReefCheck)

Conch fishery -	i) Promote stock recovery (particularly near shore); ii) Ensure sustainable use	1 1	Catch and effort; sporadic biological data collection (associated with project periods)	~66% as both major landing sites are monitored	TIP (possibly soon to change to CARIFIS) and analysis in Excel based programme designed to do the bumping up and calculate total landings by site per species group (also use purchase data from fish marketing corporation in estimating bump-up)	none	Weight limit in place (flared lip restriction proposed); limited entry system; closed season and lip thickness proposed; international trade restricted consequent to listing under CITES (permits required).
Lobster fishery -	i) sustainable exploitation of stocks	1	i) Catch and effort; ii) biological data collection on sample collected each open season	i) ~20% or less (rarely made available to data collectors by fishers); ii) 300-500 individuals randomly sampled	TIP (possibly soon to change to CARIFIS) and analysis in Excel based programme designed to do the bumping up and calculate total landings by site per species group (also use purchase data from fish marketing corporation in estimating bump-up)	None: mean size and size ranges per sex are determined and monitored for change over time.	Limited entry into pot fishery; Size limit; close season; protection of berried and moulting females.
Shrimp fishery -	Not Applicable						
Ground fish -	Not Applicable						

Small coastal pelagic fish -	i) exploit at maximum sustainable yield ii) minimize land-based pollution; ii) support appropriate TURFS	3 1 2	i) Catch and effort;	~50% (stratified random sampling of 8 of 17 fish landing sites, including majority of major and intermediate sites	TIP (possibly soon to change to CARIFIS) and analysis in Excel based programme designed to do the bumping up and calculate total landings by site per species group	none	Mesh size limits; TURF system supported (informally)
Large pelagic fish -	i) sustainable exploitation of stocks ii) cooperate with other range states in managing stocks	1 1	i) Catch and effort	~50% (stratified random sampling of 8 of 17 fish landing sites, including majority of major and intermediate sites	TIP (possibly soon to change to CARIFIS) and analysis in Excel based programme designed to do the bumping up and calculate total landings by site per species group (also use purchase data from fish marketing corporation in estimating bump-up)	none	Licensing of vessels; monitoring CPUE of fishery; multi-lateral stock assessment; regulating sport fishing activities; sightings surveys for cetaceans.
Sea Turtles	i) Promote stock recovery; ii) Ensure sustainable use	1 1	i) Catch and effort	Relatively low (<50%) sampling as landings are sporadic and decentralized , nesting activities: only one large leatherback beach consistently monitored for nesting season	TIP (possibly soon to change to CARIFIS) and analysis in Excel based programme designed to do the bumping up and calculate total landings by site per species group; Access and Excel used for nesting data		Minimum size limit; close season; protection of nesting females and eggs; proposed: maximum size limit; protection of hatchlings; lighting restrictions; limited entry fishery.

6. How much work time is currently allocated for data review and analysis tasks and hence also development of assessment skills by the fisheries officers so involved? (Answer is assumed to represent time for a single individual)

(a) < 5% of work time
(b) 10-15% of work time X **(on average- based on work programme of Department as a whole, but we have a data Unit comprising two fisheries assistants and two data clerks who spend 90% of their time on data- otherwise, one Biologist normally overshadows the work of the Unit (about 40% of his/her time) and an additional Biologist, with assistance of a fisheries assistant does habitat monitoring analysis (40% of each of their time).**
(c) 15-20% of work time
(d) 20-30% of work time
(e) > 30% of work time

7. In table II that follows, please provide information the qualifications of your officers involved in stock assessment work, and list the data analysis and assessment tools with which they are familiar (the first data input row shows an example. **(The one officer we had qualified in this area to the level of MSc has recently left. We are unlikely to be able to source a replacement officer with the same level of skill- therefore, either an existing officer will have to be trained at a post graduate level or we will have to continue to try to source such expertise as and when a position becomes available. The data management staff who do the landings data collection and analysis use procedures and a programme designed internally to do that and are not trained at the degree level. One has been trying for a number of years to seek a scholarship to do a first degree- but has not been successful so far in obtaining the necessary funds). Data Unit staff are exposed to short term training as and when available.**

Table II. Qualifications and experience of staff conducting assessments

Officer (names can be omitted)	Qualifications (include training courses)	Experience with analysis and assessment tools
Example: officer 1	B.Sc., M. Phil, 1995 FAO-Danida training course in assessment	Excel, S-Plus, FISAT, ECOPATH
Officer 1		
Officer 2		
Officer 3		
Officer 4		

8. In table III that follows, note the top specific management questions, by fishery or stock, which currently concern management groups in your country (the first data input row shows an example).

Table III. Current management questions of highest priority.

Fishery	Question
Example: queen conch fishery	1) How effective are marine reserves in enhancing the spawning stock biomass?
1) Reef fishery -	1) What are changes in size frequency and relative abundance of key species over time; 2) What are the changes in relative abundance in the catch for key

	gears over time; 3) How effective are marine reserves in enhancing spawning stock biomass in reserve areas and beyond and how does this affect fish catches; 4) How are declines in reef quality related to abundance of key species; 5) What are changes in site-specific abundance and size frequency of black sea urchins over time (as key reef grazers); 5) Natural and fishing mortality rates, age at maturity for key species
2) Conch fishery -	1) What is current distribution and abundance of stock 2) Where are breeding aggregations located and when is peak breeding activity 3) Is nearshore pollution affecting resource abundance and health 4) What have been the historic levels of trade in conch over the years (legal and illegal)
3) Lobster fishery -	1) What are changes in size frequency, size at first maturity and sex ratio of key species over time; 2) What are the changes in relative abundance in the catch over time; 3) How effective are marine reserves in enhancing spawning stock biomass in reserve areas and beyond; 4) What are the levels of recruitment to nearshore habitats (seagrass; reefs, mangroves); 5) What is the level of accumulation of agrochemical and other toxic elements in the flesh and organs of key species
4) Small coastal pelagic fish -	1) Is there a correlation between water quality and abundance of key species; 2) What is the level of accumulation of agrochemical and other toxic elements in the flesh and organs of key species; 3) What level of gear selectivity for nets used and to what degree mesh size limits protect juveniles
5) Large pelagic fish -	1) What are changes in size frequency of key species over time; 2) What are the changes in relative abundance in the catch over time; 3) natural and fishing mortality rates, age at maturity for key species
6) Sea Turtles	1) What is the population abundance, sex distribution and age at first maturity for key species; 2) Location of foraging grounds for key species; 3) stock assessment (involving all range states) at the population level; 4) What levels of exploitation would be sustainable at the population level

ST. VINCENT AND THE GRENADINES

1. Fishery Manager's Name (Director or CFO) **Mr. Raymond Ryan**

2. What sources of information are currently used for establishing management objectives for your fisheries?

(a) **National consultations**
(b) **Social and economic data available from national statistics authority**
(c) **Stakeholder interview survey data**
(d) **Local/Traditional ecological knowledge (ethno-scientific information)**
(e) **Adopt objectives used by other countries with similar fisheries situations.**
(f) **International fisheries instruments**
(g) Other (specify) ……..

3. Do you actively measure/monitor the achievement of management objectives?

(a) No (*please go to question 4*) (b) Yes (*please go to question 5*).

4. If you answered negatively in (3), please indicate the constraints to monitoring management objectives.

(a) Insufficient data collected to allow evaluation.
(b) Officers do not have sufficient time to analyse available data and hence prepare management advice
(c) Officers do not have sufficient skills and experience to analyse available data and hence prepare management advice
(d) Assessment tools being used by officers are not appropriate, as these tools do not provide answers to the management questions of direct concern.
(e) Defined objectives are too broad, and so officers do not provide specific management guidance on specific issues of concern, e.g. providing advice on suitable gear restrictions and acceptance of this as an effective management tool.
(f) Other, specify ……

*** Technical capabilities are limited due to the lack of necessary equipment and tools for assisting with the trend in harvesting; thus monitoring maximum sustainable yields.**

5. In table I that follows, list the management objectives for each fishery/ stock, allocate a priority rank to each of the objectives by fishery (using a scale of 1 to 5, with 1 used to indicate highest priority), then list the data collected to facilitate monitoring/measuring of the achievement of the listed objectives, and finally indicate the software tools currently used to analyse the available data (the first data input row shows an example).

Table I. Management objectives by fishery / stock

***F*ishery (identify specific species or stock)**	**Management objectives**	**Priority of objective**	**Data collected to measure achievement of objective**	**Sampling coverage (% total)**	**Analysis tools used [FISAT, prepared FAO Excel spreadsheets, SPSS, Other, specify]**	**Decision-making rules / reference points used, if any**	**Current management measures in place for each fishery / stock. Indicate if decision rule was used to establish measure**
EXAMPLE. Large pelagic fishery – Spanish mackerel	1) Maximize employment opportunities 2) Maximize biological yield 3) Protect juvenile stock	1) 1 2) 2 3) 3	1) Social and economic data, catch and effort data 2) Catch & effort data 3) Catch, effort, age/size and maturity data	1) 20% 2) 30% 2) 30%, 15%	1) Excel 2) Surplus Production (ASPIC) 3) Excel spreadsheet for yield per recruit, VPA	1) Minimum net profit = 5% of costs 2) Lower limit of estimated MSY range 3) $F_{0.1}$	Mesh size limit for gill nets ($F_{0.1}$ value used).
Reef fishery -	**1) Reduce effort on in-shore reef resources.** **2) Shifting effort to deeper reef and slope fishery.** **3) Not increasing overall effort any further in their fishery.**	**1) 1** **2) 3** **3) 2**	**- Social & Economic** **- Catch data** **- Catch & effort** **- Biological**	**10-20%** **30-40%** **<10%** **<5%**	**Excel** **SPSS** **FISAT**	**No particular reference point.**	**- Protected areas.** **- Gear restrictions.**
Conch fishery -	**1) Introduce quota system.** **2) Reduce effort on stocks.** **3) Determine prime areas by conducting abundant studies.**	**1) 3** **2) 1** **3) 2**	**- Social & Economic** **- Catch data** **- Catch & effort** **- Biological**	**<10%** **<20 %** **<5%** **Nil**	**Excel** **SPSS** **FISAT**	**Quota system not above current harvesting levels**	**- Protected areas** **- Minimum sizes.**

Lobster fishery -	***1) Encourage artificial areas as alternative to rebuilding stock. 2) Reducing fishing pressure on national stocks.***		***- Social &Economic - Catch data - Catch & Effort - Biological***	***<10% <20% <5% Nil***	***Excel SPSS FISAT***	***Landings not to exceed current levels.***	**- Gear restrictions - Protected areas - Minimum sizes**
Small coastal pelagic fish -	***1) Reducing fishing pressure on juvenile stocks. 2) Reducing fishing pressures in protected and conservation areas***		***- Social &Economic - Catch data - Catch & Effort - Biological***	***10-20% 20-30% <10% Nil***	***Excel SPSS FISAT***	***No particular reference point developed.***	**- Mesh size limits. - Net restrictions. - Gear restrictions**
Large pelagic fish -	***1) Encouraging the sustainable utilization of large pelagics.***		***- Social &Economic - Catch data - Catch & Effort - Biological***	***10-20% 30-40% <10% <5%***	***Excel SPSS FISAT***	***No particular reference point developed.***	**- No specific measure**
Mammals	***1) Sustainable utilization of large pelagics. 2) Sustainable utilization of small pelagics.***		***- Social &Economic - Catch data - Catch & Effort - Biological***	***<5% Nil Limited***	***Excel SPSS***	***- Catch limit on humpback. - Complying with other IWC initiatives re: large mammals.***	**- Maximum of 3 humpbacks**

6. How much work time is currently allocated for data review and analysis tasks and hence also development of assessment skills by the fisheries officers so involved? (Answer is assumed to represent time for a single individual)

(a) < 5% of work time
(b) 10-15% of work time
(c) 15-20% of work time
(d) 20-30% of work time
(e) > 30% of work time

7. In table II that follows, please provide information the qualifications of your officers involved in stock assessment work, and list the data analysis and assessment tools with which they are familiar (the first data input row shows an example.

Table II. Qualifications and experience of staff conducting assessments

Officer (names can be omitted)	Qualifications (include training courses)	Experience with analysis and assessment tools
Example: officer 1	**B.Sc., M. Phil, 1995 FAO-Danida training course in assessment**	**Excel, S-Plus, FISAT, ECOPATH**
Officer 1:	***BSc.* MSc.** **Various training programmes**	***Excel, Minitab, FISAT, SPSS***
Officer 2:	**Diploma.** **Various training programme**	***Excel, Minitab, FISAT, SPSS***
Officer 3:		
Officer 4:		

8. In table III that follows, note the top specific management questions, by fishery or stock, which currently concern management groups in your country (the first data input row shows an example).

Table III. Current management questions of highest priority.

Fishery	Question
Example: queen conch fishery	1) How effective are marine reserves in enhancing the spawning stock biomass?
1) Conch	**- How successful are minimum sizes in enhancing stock distribution and abundance of stocks in our waters?** **- The effect of antropogenic activities on stocks**
2) Lobster Fishery	**- How effective are minimum sizes in enhancing stocks?** **- How effective are closed seasons in enhancing stocks?** **- The degree to which antropogenic activities are affecting stocks?**
3) Reef Fishery	**- Developing useful reference points for management.** **- Distribution ands stock abundance**

4) Small coastal pelagics	**- Developing reference points for management.** **- The degree to which atropogenic activities are affecting stocks.**
5) Large pelagics	**- To what extent is illegal foreign fishing activities affecting migrating and local stocks.** **- Is there any room for further expansion in this fishery?** **- Developing reference points for management.**
6) Marine mammals	**- Info on the current state of small mammal stocks.** **- Info on the current state of large mammal stocks.**

TRINIDAD AND TOBAGO

1. Fishery Manager's Name (Director or CFO) …**Ann Marie Jobity**……..

2. What sources of information are currently used for establishing management objectives for your fisheries?

(a) National consultations **X**
(b) Social and economic data available from national statistics authority
(c) Stakeholder interview survey data **X**
(d) Local/Traditional ecological knowledge (ethno-scientific information)
(e) Adopt objectives used by other countries with similar fisheries situations.
(f) International fisheries instruments **X**
(g) Other (specify) ……..

3. Do you actively measure/monitor the achievement of management objectives?

(b) No (*please go to question 4*) **X** (b) Yes (*please go to question 5*).

4. If you answered negatively in (3), please indicate the constraints to monitoring management objectives.

(a) Insufficient data collected to allow evaluation.
(b) Officers do not have sufficient time to analyse available data and hence prepare management advice **X**
(c) Officers do not have sufficient skills and experience to analyse available data and hence prepare management advice **X**
(d) Assessment tools being used by officers are not appropriate, as these tools do not provide answers to the management questions of direct concern.
(g) Defined objectives are too broad, and so officers do not provide specific management guidance on specific issues of concern, e.g. providing advice on suitable gear restrictions and acceptance of this as an effective management tool.
(h) Other, specify ……

5. In table I that follows, list the management objectives for each fishery/ stock, allocate a priority rank to each of the objectives by fishery (using a scale of 1 to 5, with 1 used to indicate highest priority), then list the data collected to facilitate monitoring/measuring of the achievement of the listed objectives, and finally indicate the software tools currently used to analyse the available data (the first data input row shows an example).

Table I. Management objectives by fishery / stock

Fishery (identify specific species or stock)	**Management objectives**	**Priority of objective**	**Data collected for assessment purposes**	**Sampling coverage (% total)**	**Analysis tools used [FISAT, prepared FAO Excel spreadsheets, SPSS, Other, specify]**	**Recommendations / reference points used in assessments**	**Current managemen measures in place fo each fishery / stock. Indicate if decision r was used to establis measure**
THE SOFT-SUBSTRATE DEMERSAL (SHRIMP & GROUNDFISH) FISHERY							
Trawl fleet (Artisanal, Semi-industrial, Industrial trawlers) Shrimp – *Farfantepenaeus subtilis, F. notialis, F. brasiliensis Litopenaeus schmitti, Xiphopenaeus kroyeri*)	Full utilization of the resource consistent with adequate conservation and minimal conflict between the artisanal and non-artisanal components of the fishery		1) Social and economic data 2) Landings and effort data 3) Biological data- size	*Ad hoc* surveys 75% 50%	1) Prepared FAO/Consultant Excel spreadsheets: • Length-based cohort analysis • Length converted catch curve • Bio-economic dynamic model • Virtual population analysis 2) ASPIC – Surplus Production 3) BIODYN – Surplus Production 3) Excel • Length-based Thompson and Bell • Beverton and Holt Biomass per Recruit and Yield per Recruit	25% of virgin biomass (*F. subtilis)* 40% virgin biomass *(F. notialis, X. Kroyeri)* MEY - reduce effort of the Trinidad fleet to 61% and effort of the Venezuelan fleet to 82% MSY - effort should not be increased	Controls on entry of industrial and semi-industrial trawlers ba on 1988 Cabinet note Zoning of the areas o operation of each of t trawl fleets Use of TEDs by the industrial and semi-industrial. Minimum cod-end m size.

Table I. Management objectives by fishery / stock

Fishery (identify specific species or stock)	**Management objectives**	**Priority of objective**	**Data collected for assessment purposes**	**Sampling coverage (% total)**	**Analysis tools used [FISAT, prepared FAO Excel spreadsheets, SPSS, Other, specify]**	**Recommendations / reference points used in assessments**	**Current managemer measures in place fo each fishery / stock. Indicate if decision r was used to establis measure**
Trawl fleet Artisanal multigear fleet Croaker (*Micropogonias furnieri*) Salmon (*Cynoscion jamaicensis*) Lane snapper (*Lutjanus synagris)*			1) Social and economic data 2) Landings and effort data 3) Biological data -size	*Ad hoc* surveys 75% 50%	1) Prepared FAO Excel spreadsheets: • Bio-economic dynamic model 2) Excel • Depletion modeling • Beverton and Holt Yield per recruit	Limit effort for all fleets catching groundfish Increase the age of first capture of species	
THE HARD-SUBSTRATE DEMERSAL FISHERY							
Artisanal multigear fleet Semi-industrial multigear fleet Recreational fleet Snapper Plumhead (*Rhomboplites aurorubens*) Redfish (*L. purpureus*) Yellowedge Grouper (*Epinephelus flavolimbatus*)	Sustainability of the fishery		1) Economic data –ex-vessel value 2) Landings and effort data 3) Biological data – size	30% 30% *Ad hoc* surveys	1) Beverton and Holt Yield per Recruit analysis (Institute of Marine Affairs; snappers)	Restrict fishing Increase the age of first capture of species Limit effort and increase mesh size of fishpots. Restrict effort, increase mesh size of fish traps	

Table I. Management objectives by fishery / stock

Fishery (identify specific species or stock)	**Management objectives**	**Priority of objective**	**Data collected for assessment purposes**	**Sampling coverage (% total)**	**Analysis tools used [FISAT, prepared FAO Excel spreadsheets, SPSS, Other, specify]**	**Recommendations / reference points used in assessments**	**Current managemen measures in place fo each fishery / stock. Indicate if decision r was used to establis measure**
Sweetlip (*Mycteroperca interstitialis*)							
THE COASTAL PELAGIC FISHERY							
Artisanal multigear fleet Carite (*Scomberomorus brasiliensis*) Kingfish (*Scomberomorus cavalla*) Sharks (*Carcharinus porosus*) Fyingfish (*Hirundicthys affinis*) Herrings, anchovies, sardines	Sustainability of fisheries resources		1) Economic data 2) Catch & effort data for all species listed 3) Biological data –size, maturity, age (carite, kingfish, sharks, flyingfish) 4) Biomass estimates from RV Fridtjof Nansen surveys in 1998	30% 30% *Ad hoc* surveys *Ad hoc* surveys	1) Excel • Length-based Thompson and Bell • Beverton and Holt Yield per recruit 2) ASPIC - Surplus Production	MSY No increase in fishing effort; gillnet mesh size should not be less than 4 3/4" stretched mesh. Gillnet stretched mesh size limit Line fishing should be encouraged over the use of gillnets. Size limit re: capture, sale of specified species. Harvesting of sardines as foodfish is prohibited by law.	Size/gear regulatio

Table I. Management objectives by fishery / stock

Fishery (identify specific species or stock)	**Management objectives**	**Priority of objective**	**Data collected for assessment purposes**	**Sampling coverage (% total)**	**Analysis tools used [FISAT, prepared FAO Excel spreadsheets, SPSS, Other, specify]**	**Recommendations / reference points used in assessments**	**Current manageme measures in place fo each fishery / stock. Indicate if decision r was used to establis measure**
THE OCEANIC (HIGHLY MIGRATORY) PELAGIC FISHERY							
Semi-industrial pelagic longline fleet Semi-industrial multi-gear fleet Recreational fleet Yellowfin tuna (*Thunnus albacores*) Bigeye tuna (*Thunnus obesus)* Skipjack tuna (Katsuwanus pelamis) Albacore (north Atlantic stock) (*Thunnus alalunga)* Albacore (south Atlantic stock) (*Thunnus alalunga)* Swordfish (north Atlantic stock) *Xiphias gladius)*	Cooperate with ICCAT to assess, protect and conserve resources		1) Landings and effort data (longline fleet) 2) Technological and economic characteristics of the longline fishery	100% *Ad hoc* survey	1) Excel (FAO methodolody)		ICCAT measures to take effect upon promulgation of ne fisheries manageme legislation

6. How much work time is currently allocated for data review and analysis tasks and hence also development of assessment skills by the fisheries officers so involved? (Answer is assumed to represent time for a single individual)

(a) < 5% of work time
(b) 10-15% of work time
(c) 15-20% of work time **X**
(f) 20-30% of work time
(g) > 30% of work time

7. In table II that follows, please provide information the qualifications of your officers involved in stock assessment work, and list the data analysis and assessment tools with which they are familiar (the first data input row shows an example.

Table II. Qualifications and experience of staff conducting assessments

Officer (names can be omitted)	**Qualifications (include training courses)**	**Experience with analysis and assessment tools**
Example: officer 1	B.Sc., M. Phil, 1995 FAO-Danida training course in assessment	Excel, S-Plus, FISAT, ECOPATH
Officer 1	• Master of Marine Management, • BSc (General) with major in Zoology & minor in Math, • CFRAMP/FAO/DANIDA Regional Training Course on Fish Stock Assessment (3 wks, 1996), • MS Excel & Access 2000 Visual Basic for Applications Fundamentals (5 days, 2004), • Microsoft Access 2000 (Introduction to Advanced) (4 days, 2003), • Introduction to Oracle: SQL and PL/SQL (5 days, 2001) • Introduction to Generalized Linear Modelling (GLM), Maximum Likelihood Techniques, Monte Carlo Modelling and their application in Fisheries Assessment (7 days, 2003) • Training in SPSS (few days, 2003/4)	MS Excel
Officer 2	• MS Marine Policy, in progress • BS, Natural Science, Zoology major • JICA, SPSS (2004) • MS Excel & Access 2000 Visual Basic for Applications Fundamentals (2004) • Introduction to Oracle: SQL and PL/SQL (5 days, 2003) • Microsoft Access (Introduction to Advanced) (1998) • CFRAMP, Shark Stock Assessment including Ageing using vertebrae (1997) • CFRAMP/FAO/DANIDA, Tropical Fish Stock	MS Excel, FISAT

	Assessment Training Workshop (1996) • CFRAMP, Biological Data Entry, Quality Control and Reporting using Trip Interview Program (TIP) (1996) • CFRAMP, Fish Ageing using Otoliths (1996) • Ministry of Agriculture, Land and Marine Resources - Fishery Management; Tropical Fish Stock Assessment (1992) • Ministry of Agriculture, Land and Marine Resources, Age and Growth Study of Carite (*Scomberomorus brasiliensis*) using otoliths (1991)	
Officer 3	• M.Phil in Zoology • BSc (General) with major in Zoology, • CFRAMP/FAO/DANIDA Regional Training Course on Fish Stock Assessment (1996), • CFRAMP Regional Training Course in Fisheries Statistics (1998) • MS Excel & Access 2000 Visual Basic for Applications Fundamentals (2004), • Microsoft Access 2000 (Introduction) Introduction to Oracle: SQL and PL/SQL (2001) • Training in SPSS (Fundamentals) (2003/4) • IICA/CARDI Abstracting Agricultural Information (1995) • Bibliographic database development using CDS/ISIS (UNESCO) (1994)	MS Excel

8. In table III that follows, note the top specific management questions, by fishery or stock, which currently concern management groups in your country (the first data input row shows an example).

Table III. Current management questions of highest priority.

Fishery	Question
Example: queen conch fishery	1) How effective are marine reserves in enhancing the spawning stock biomass?
1)	What is the appropriate level of fishing effort to avoid over-exploitation of the resources and attain economic efficiency in the operation of the fleets?
2)	What impact does pollution have on the status of the stocks?
3)	What is the role of fisheries in the socio-economic well being of coastal communities?

NB: The CRFM is grateful for your time and attention in completing this questionnaire

Appendix 5

Report Of The Working Group
On Management Objectives And Communications

Membership: Yolanda Babb, Paul Fanning, Dan Hoggarth, Crafton Isaac, Kristin Kleisner, Louanna Martin, Joshua Sladek Nowlis, Hazel Oxenford, Susan Singh-Renton, (also Lara Ferreira and Suzette Soomai for case study stages)

As a step towards defining its key tasks, the working group initially discussed key elements in the overall process of fishery management and stock assessment, as listed below.

Identifying operational objectives (managers telling scientists what they want)

- considering trade-offs between objectives
- unpacking loosely specified goals and objectives into more quantified and measurable statements

Monitoring the achievement of objectives

- selection of indicators and reference points
- selection of tools and methods
- data requirements for each

Communication of assessment results back to managers to guide decision making

- e.g. using a 'traffic lights' system to summarise multiple indicators for multiple objectives (both quantitative and qualitative)
- allowing for uncertainties in assessments

Assuming that Step 2 above would be covered more in the 'methods' working groups, this working group proposed to focus on the communication aspects of steps 1 and 3. Primary focus this year was given to Step 1. Step 3 may be more likely to be specific to individual fisheries.

The key tasks of the working group were thus defined as:

1a Provide working definitions of 'operational objectives' and other key elements of the management process.

1b Examine the available managers' questionnaires (as submitted prior to the meeting) to attempt to 'unpack' the stated objectives, and provide examples of the unpacking process.

1c Develop a format or guide for managers, scientists and other stakeholders in each CRFM country to unpack their own fishery goals during the inter-sessional phase (as far as suggestions for indicators and reference points). Such unpacking should clarify the stock assessment needs of different countries as key elements of the management feedback process, taking into account any trade-offs between objectives, and thereby guide the activities and priorities of the working group in future years.

1d An additional task was requested during a plenary progress review, to consider any needs for training in applying the unpacking process or guide, either via the Fisheries Forum, or with CRFM assistance at national consultations.

1e Review and/or develop methods for scientists to communicate assessment results back to managers

For each task, the working group was requested to cover definitions and approaches, and a framework for support and planned follow up (e.g. over the intersessional period and at the next Ad Hoc Methods WG).

Task 1a. Definitions

The group recognised that visions, goals, sub-goals, general objectives, specific objectives, operational objectives, and a whole host of other terms are currently used to describe desired attributes of a fishery. These terms lie on an often poorly-specified continuum from broad statements about the distant future without specific steps to achieve them, to specific statements about attributes that are anticipated to be achieved in the near future through defined processes.

While general statements are important for defining what a country wants from its fishery, the key for effective communication between managers and scientists are well-defined operational objectives. Such operational objectives should be specific to particular fisheries or fish stocks, and should be quantified to enable monitoring of achievements over time. It was noted that a suite of operational objectives will often be incompatible in the sense that they cannot all be maximized at the same time in the same fishery. Illustrating the trade-offs inherent in the fishery will however provide managers with useful advice in balancing competing wants and needs. It was also observed that some country goals may be prioritised as operational objectives in one fishery (e.g. supporting the artisanal fleet), while others are achieved in another fishery (e.g. providing foreign exchange earnings).

A number of alternative definitions for operational objectives were examined or proposed, including:

- 'A target that is actively sought and provides a direction for management action' (from Cochrane, 2002, FAO Fisheries Technical Paper 424).
- A statement defining who or what will be affected, what behaviour one wants to maintain or change, including not only a reference point, but what behaviour around it would be preferred, and a measurable criteria to identify how far away we are from the objective and allow ongoing monitoring of our progress.
- Statements defining and quantifying the aims of a specific fishery or target in terms of three key elements: 'verb' – 'characteristic' – 'reference point'.

Examples of the second and third definitions were developed as:

- To maintain (behaviour) the stock (who or what will be affected) at all times above (preferred direction) 50% of its mean unexploited level (reference point)
- To maintain (verb) the stock (characteristic) at all times above 50% of its mean unexploited level (reference point)

Other definitions from Cochrane (2002) were listed as below.

Indicator:
A specific state, or variable, which can be monitored in a system e.g. a fishery to give a measure of the state of the system at any given time. In fisheries management, each indicator would be linked to one or more reference points and used to track the state of the fishery in relation to those reference points.

Reference point:
An estimated value derived from an agreed scientific procedure and/or an agreed model, which corresponds to a state of the resource and/or of the fishery and can be used as a guide for fisheries management. Some reference points are general and applicable to many fish stocks, others should be stock-specific.

Further definitions of the process elements were considered in Task 1c (also see Explanation Box at end of this Addendum).

Task 1b. Attempt to unpack objectives from managers questionnaires

Of the countries that had submitted the manager's questionnaires prior to the meeting, only Trinidad & Tobago was represented among the participants of this working group. The group therefore agreed to attempt to unpack one or more of the stated objectives for this country as a case study.

The management objective for Trinidad's soft-substrate demersal shrimp and groundfish trawl fishery was stated in the questionnaire as:

'Full utilisation of the resource consistent with adequate conservation and minimal conflict between the artisanal and non-artisanal components of the fishery'

The group recognised three key elements in this statement, each of which should be clarified as operational objectives, and considered a number of possible interpretations for these words, as listed below:

Words used	Possible interpretations
'full utilisation'	High catches; high profit; high employment; high living standards; minimising discards of bycatch species; many others possible, involving the maximisation of benefits within the limits imposed by the resource (as indicated by the word 'full')
'adequate conservation'	High stock size; maintaining minimum sustainable stock size; avoiding stock collapse (e.g. for weak links/most vulnerable species in multi-species stocks); maintaining natural species composition; protection of spawning stock / breeding individuals and habitats; ecosystem and biodiversity aspects – minimising bycatches / protecting habitats etc
'minimal conflict'	This element was seen as being defined more clearly than the others (i.e. specified by the sub-text as 'intra-fishery', 'inter-fleet' conflicts). It could still be further clarified as e.g., physical interactions between gears or boats; conflicts at markets; conflicts over inshore/offshore grounds; seasonal interactions; separation of fleet activities either spatially or seasonally, or over different life stages on different grounds etc

Following these 'possible interpretations' made by the group as a whole, efforts were made by the three Trinidadian representatives to agree the actual meanings of the terms, as stated below:

Objectives:	Country representatives' interpretations
'Full utilisation'	A. Maximise numbers of participants in fishery (and avoid need for layoffs of existing fishers, both artisanal and non-artisanal, using attrition to reduce numbers, if needed).

	B. Maximise catches
	C. Maximise individual profits (all within sustainability constraints)
'adequate conservation'	D Minimise risk of stock collapse
	E Minimise bycatch of undersized fish that are discarded
	F Maintain biodiversity
'minimal conflict'	G No further definition needed as an objective, but further quantification needed to make operational (e.g. to reflect the distribution, abundance and migrations of stocks, to maintain viable fishery for both artisanal and non-artisanal vessels, by restricting access of non-artisanal vessels in inshore grounds (artisanal vessels are unable to access offshore grounds)

Definition of the control rule system would require prioritisation of the objectives to guide decision making. Of the above seven Trinidadian objectives, the representatives identified D, E and F as equally important conservation objectives. The utilisation objectives A, B and C were ranked 1, 2 and 3 by the group. No further progress was made in unpacking possible the control rule system.

To assist with considering the operational objectives, attention was first given to the feasibility of different management controls for this fishery, agreed as below:

Feasible management controls	Non-feasible management controls
1. Number of vessels (in both fleets) 2. Closed seasons 3. Gear controls (mesh size regulations, TEDs, 4. Zonation (currently used but poor enforcement)	5. Catch quotas

Decisions on which of the above management controls should be used, or about explicit levels of the controls (e.g. the numbers of artisanal and non-artisanal vessels to be allowed) should be agreed by a stakeholder consultation process, and informed by scientists' advice on the costs and benefits of the different management options, as measured against the objectives A to G. This may involve the use of simple population and/or bioeconomic models based on existing assessments; more complex add-ons to those assessments (e.g. for turtle by-catch in the shrimp fishery); and/or interviews or opinions of key stakeholders.

To facilitate the evaluation of the different management options, operational objectives should be specified as quantifiable indicators and reference points by which the feasible management options (and their future performance, if selected) can be judged. Due to time constraints, the working group was unable to identify specific operational objectives for each of the identified objectives for the Trinidad fishery. It was agreed that further work on this issue should be delayed until agreement is reached on the unpacking process to be followed (note initial progress made below).

Task 1c. Guidance on unpacking fishery goals

'Unpacking of goals/objectives' is needed to (1) quantify managers' aims to enable long-term monitoring of achievement of goals, and (2) define the management strategy by which the goals/objectives will be achieved. A fully 'unpacked' management control system could include specification of:

- Goals – the overall statement for each fishery.

- Objectives (this term was seen as equivalent to 'criteria', as used by FAO, 1999, TGRF No. 8, but was preferred by the group for the Caribbean region).
- Operational objectives – one or more per fishery, specified as indicators (or 'characteristics') and reference points, thereby quantifying the objectives and resolving implicit trade-offs and specifying targets or limits.
- Stock assessment tools and data needed for the estimation of the indicators and reference points included in each operational objective
- Decision control rules recognising trade-offs and defining the priorities of different operational objectives, e.g. specified as harvesting strategies (constant harvest rate, constant stock size, or constant catch) and conceptual reference points (targets, limits, precautionary).
- Management measures by which the decision control rules will be applied.

The working group recognised that actual unpacking of fishery goals in each country would require a lengthy and complex stakeholder consultation process. Such an exercise could be undertaken as part of the regular review process for fishery management plans, e.g. as conducted 3-yearly in some countries.

One possible process for incorporating fishery objectives into fishery management systems is given in the Explanatory Box at the end of this Addendum (provided by J. Sladek Nowlis). The group agreed that this process could be effective, but recognized the existence of other possible frameworks and requested further time to finalize a detailed guide for use in the CRFM situation. The group agreed that such a process for unpacking should include the following elements:

- Consideration of biological, ecological, social and economic performance criteria or objectives
- Where objectives conflict (as will usually be the case), a quantitative process may be needed to assist the weighting or prioritising of objectives. For systems with few operational objectives, a simple 'if-then' process may be defined. For systems with multiple objectives and competing stakeholder priorities, 'traffic lights' or other decision making processes may be used.
- Clarification is needed on the relative roles of managers, stock assessment scientists, fishers and other stakeholders in defining the management system and making decisions

Recommendations

- Request those countries that have not yet submitted manager's questionnaires to submit.
- Provide feedback on submitted questionnaires, including attempts made to unpack Trinidad case study and problems found, and request countries to comment on observations and working group objectives.
- Prior to the next WG meeting, request Trinidad participants to continue case study as far as operational objectives, for further evaluation of stock assessment methods and management measures at next WG (for further feedback to managers).
- Prior to the next Ad Hoc Methods WG, examine existing guidance on the selection and/or unpacking of fishery goals and objectives (e.g. in the references listed below), to assist with developing a CRFM process. Consider inviting any recognized experts on this process, e.g. those involved with assessment of 'ecosystem risk assessment' or 'management system evaluation' in Canada or Australia.
- Considering the incongruity between management ambitions, the data actually available within the region, and fisheries departments' capacity for future data collection, ensure that any unpacking or management process is realistic and feasible.
- The plenary group confirmed the need to develop a guide including useful examples for widely contrasting situations (especially for data-poor and data-rich fisheries).

- The plenary group also requested training in the setting of quantifiable operational objectives in CRFM countries, based on the guide developed. Such training could initially be conducted at national or regional levels to develop process skills. It should focus initially on setting operational objectives for national fisheries (leaving objectives for any regional, shared fisheries until later). Stakeholder consultations linked to updating of management plans should be conducted in national workshops to ensure participation of all relevant stakeholders.

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Explanation Box: Process for Incorporating Objectives into Fisheries Management

Below is described one possible process for incorporating objectives into fisheries management. While the Objectives and Communications working group believed this process could be effective, it also recognized that other processes may also be suitable. Interest was expressed in identifying and considering other methods (e.g., FAO, Canada) during the intersession.

1. **Specify Objectives/Performance Criteria.**
2. **Create Operational Objectives.**
3. **List Feasible Management Controls.**
4. **Prioritize Operational Objectives.**
5. **Develop Control Rules.**
6. **Identify Management Measures.**
7. **Monitor and Report Progress towards Operational Objectives.**
8. **Fine Tune Management Measures.**

- **Repeat steps 7-8 frequently, particularly when new monitoring data become available.**
- **Review steps 3-8 periodically, particularly when new controls or new data about existing controls are generated.**
- **Review steps 1-8 occasionally, particularly when societal preferences may have shifted.**

Virtually all of these steps, but especially 2, 4, and 5, are inherently political. However, science can facilitate good choices by providing advice about how various alternatives would influence the trade-offs among objectives. For example, selection of a target landings level will influence not only the maximization of landings but also the maximization of standing stock biomass and the minimization of catch variability or risk of stock collapse, and many others. The trade-offs inherent in the selection among alternatives define the art of good policy-making but can be improved through scientific advice.

Definitions:

Objectives/Performance Criteria are statements from managers of desired benefits and undesired costs. Their specification can be facilitated by putting them in the context of, "All else being equal, we would like to maximize/minimize …" Most of these statements will be non-controversial, although prioritization among them will be. They should be specific enough that progress towards them can be quantified in simulation models and from empirical data.

Examples—Maximize: landings, employment, profits, standing stock biomass, enforcement; Minimize: risk of stock collapse, catch variability, bycatch of selected species, habitat damage.

Operational Objectives are objective/performance criteria for which we have specified targets and desirable behavior around the targets. All else is not equal, and these statements represent compromises among the objectives/performance criteria. Their specification can be facilitated by ensuring they include an action/verb, a measurable indicator, a reference point, and the desired behavior around that reference point.

Examples—Maintain average landings at or above 2004 levels; Always maintain annual landings above 75% of 2004 levels; Limit to 10% or less the chance that a stock drops below 25% of unfished abundance.

Management Controls are a list of properties of the fishery system that have the potential to be controlled by managers. It is useful to focus on the most feasible of these, but may also be useful to identify

properties that might be manageable with additional investment, particularly if those controls would be especially effective at achieving objectives.

Examples—Total landings, trip landings, vessel permits, gear types and configuration, open and closed seasons or areas.

Prioritize Operational Objectives is the process of deciding which operational objectives need to be satisfied first and which should be satisfied only contingent on others. Consideration should be paid not only to the trade-offs among objectives, but also to what attributes can be most effectively monitored and controlled.

Example—A minimum stock biomass threshold may be selected as top priority. In this case, if the stock dropped below this level, management actions would focus on rebuilding it and only secondarily consider other objectives.

Control Rules represent a set of rules that govern the management of a fishery. They should be based on aspects of the fishery that can be monitored and controlled and are most often specified with respect to stock biomass or abundance.

Example—If a stock is above MSY abundance level allow fishing at MSY levels, if it is below 25% of unfished abundance close the fishery, if it is in between allow fishing at a fraction of MSY specified by the stock's abundance along this interval.

Management Measures are the tools with which managers exert control on the fishery. Ideally the measures would be direct controls (e.g., if we want to limit catches to a certain level, the management would ideally set individual or collective catch limits), but sometimes indirect controls will be necessary or desirable.

Example—In the control rule example, catch limits are specified based on the current stock abundance. These catch limits might be achieved through one or more of the following: annual quotas for the whole fishery; individual trip limits; limiting the participants in the fishery (indirect); or many others.

Steps 7-11 are self-explanatory. Due care should be given to the method of reporting (step 7) to ensure it is clear, comprehensive, and concise.

Note also that it is quite common for management systems to skip the first five steps of this process. The specification of operational objectives and development of control rules can be especially challenging as they require detailed policy consideration of a wide range of opinions and commitment to future actions without knowing the political climate that will exist at that time. Nonetheless, these steps are likely to be of enough value that they are worth taking. However, if they are just unfeasible, effort should be made to take as many of the other steps as possible. For example, biomass-based control rules have been established for many fisheries without creation or prioritization of operational objectives or the enumeration of management controls. While these efforts might have benefited from taking these additional steps, it was nonetheless valuable to develop control rules.

Appendix 6

Report Of The Working Group On Data Issues

Membership: Elizabeth Brooks, Lara Ferreira, Lester Gittens, Patricia Hubert, Kathy Lockhart, June Masters, Paul Medley, Mauricio Ortiz, Clay Porch, Suzuette Soomai.

The CRFM participants present in the group described the current situation regarding data collection and existing data sets in their respective countries. The group established that there were several types of motivation driving official data collection. These were divided between external and internal causes. External motivations are where data are collected and submitted or used for assessments based on obligations to international management initiatives. Countries in the region regularly submit catch and effort data on tunas and highly migratory species to ICCAT. In addition, countries with conch fisheries such as Jamaica and the Turks and Caicos Islands, are required to conduct regular conch assessments to determine conch abundance to be able to set TACs in accordance with CITES requirements. Also on a regular basis, countries submit national statistics to the FAO on annual landings by species or species groupings on request.

Motivations for data collection also operated at the national level where countries stated that the basic catch and effort and vessel/fisher census data were collected to be able to prepare internal reports in response to administrative/government needs such as annual statistics on total landings and numbers of fishermen. A driving force for national data collection was also the fishers, particularly those involved in lobster and other reef fisheries where they demand justifications for closed areas and seasons since these management strategies directly affect current operations and potential new entrants into the fisheries. Fishermen often request that research be conducted into the effects of coastal development activities and pollution due to industrial activity. However Fisheries Departments generally do not have the capability to collect the appropriate data for this type of research.

In addition to national data collection, there was collection of a 'non-official' nature through international research programmes, such as through GEF, UNESCO and US-AID. A substantial amount of relevant academic data and research is believed to be housed in universities throughout the region.

CRFM participants each described varying levels of data collection based on the commercial importance of the particular fishery. It was observed that all countries were able to collect catch and effort data and were able to provide estimates of total landings. Most countries collected catch and effort data through trip interviews (TIP) and effort units by gear and vessel were obtained from periodic census of vessels/operations in each country. In a few countries, total catch broken down by commercial category were derived from processing plants data. Biological data collection, mainly length frequency data, was patchy since collection of biological data in the past was facilitated under FAO and CFRAMP projects. At the end of these projects data collection was unable to continue due to financial and human resource constraints.

In most countries there was an absence of a legal framework for data collection from the fisheries sector and it was not mandatory for fishermen to co-operate or provide data to Fisheries Departments. In the few cases where there was a legal framework, for example through a licensing regime, there was inadequate monitoring and enforcement. Through the discussions, the data collection system in Jamaica was given particular attention since it was considered a case of a data-poor situation.

Conclusions and Recommendations

1. The group decided that there was a need to develop an inventory of the Caribbean fisheries databases and research. The inventory should document all the types and sources of data on fisheries in the region. It was proposed that this should be treated as an inter-sessional activity which will address the issue of identifying where and how fisheries data is catalogued, stored, and managed. The information could be sourced through questionnaires to be completed by each country. In many cases, countries had already completed such questionnaires to FAO, in which case copies could be supplied to CRFM. There is also the need to inventory fisheries auxiliary data and information.

2. To address the issue of discontinuity with data collection it was recommended that a framework for harmonized sampling programmes in the region be developed. This framework will establish the minimum biological sampling required to be able to characterize the catch composition of the main commercial fisheries. There was also a recommendation to develop a framework for establishment of a centralised repository for regional fisheries data and information.

3. It was considered valuable to develop a regional database of life history parameters following the format used by FishBase. The database would cover crustaceans as well as finfish, and include grey literature.

4. Given the existing situation regarding data issues, the group focused on what can be done in the short-term using current sources of data as well as data that can be made readily available in a short period of time. Passive data collection, for example the ongoing collection of catch and effort data, may not by itself be sufficient to produce robust assessments. In addition, many countries may often be unable to reliably reconstruct historical landings and effort or generate life history parameters. The group recognized that in spite of the limited catch and effort data sets there was considerable auxiliary data that were available for incorporation into assessments. Examples of auxiliary data were local consumption surveys which identify the channels of flow for fishery products involving main distributors, trans-shipments and restaurant purchases, which can be used to supplement catch-effort data collection. Length frequencies for at least one year can be very useful when combined with the limited catch and effort data to indicate the state of the stock.

5. With regard to socio-economic aspects, traditionally, there were generally few directed attempts to collect socio-economic data, however social data such as information on education levels of fishermen and related social indicators can be derived from the licensing and registration system for fishing vessels. The group noted that socio-economic reference points could be established when conducting assessments. Scoring methods, such as RAPFISH could be useful in this regard. The group also recommended recruiting someone specializing in socio-economic analyses to advise the Working Group.

   The underlying factor affecting the monitoring of fisheries through data collection and assessment is that in most of the CRFM countries the social priority of the fisheries sector is very low. The group identified the need to re-evaluate the importance of fisheries as an industry in the Caribbean and the need for governments to re-assess their support to Fisheries Departments. Support for the fisheries sector should also come from other local industries, such as tourism, often incorrectly considered as competitors. Co-operation with environmental NGO's on conservation issues and stakeholder support can also assist. Consultation with these groups can be used as a tool to help guide data collection and research in fisheries.

6. The group agreed that managers need to direct the fisheries scientists on the type of advice that they need. This would help guide data collection, particularly with regards to the type of data and frequency of collection and analyses. The group identified how the different data that is collected might be used, and potential problems such data might present for the assessment methods (Table 1).

7. With regard to training requirements to assist with analysis, the group identified that staff in each country should build skills, ensuring a sound foundation before advanced techniques are taught. All staff should be comfortable with using advanced features in MS Excel and receive training in data management and manipulation in EXCEL if necessary. This training will allow for more efficient and quicker conduct of analyses since the fisheries scientists will be better able to understand their data sets and the use of data in developing indices for fisheries monitoring. It was recommended that the countries would benefit most from immediate training in the use of Pivot Tables in EXCEL and Solver and in the methods used for standardizing CPUE.

Table 1: Overview of data sources and usage. ***This table was not fully reviewed by the working group.***

Data Source	**Data Type Generated**	**Data Used For**	**Method**	**Problems**	**Solutions**
Licence / Register	Maximum effort Catch estimate	Total catch estimates Socio-economic indicators	Catch raising	Records may not be up-to-date	Field verification of records More frequent surveys
Census / frame survey	Maximum effort (vessel, gear, fishermen)	Total catch Update register of vessels Socio-economic indicators	Catch raising	Infrequent	More frequent surveys Develop methods to extrapolate/interpolate missing data
Fishing Trip Interviews	Catch and effort samples	Total catch Abundance indices	CEDA ASPM ParFish	Missing data Small data sets Lack of contrast	Robust methods must deal with data problems while extracting maximum information
Processing facilities	Total catch by commercial category	Total catch Size composition	Methods using total catch Length based VPA/cohort analysis	Missing data Small data sets	Robust methods must deal with data problems while extracting maximum information
Landing port facilities	Size frequency	Length frequency	Length based methods	Missing data Small data sets	Robust methods must deal with data problems while extracting maximum information
Fishing community surveys	Socio-economic	Social/ economic indicators, Importance of fishing industry: subsistence, recreational, commercial Poverty alleviation	Bioeconomic simulation models Rapfish-type approach	Infrequent	More frequent surveys Develop methods to extrapolate/interpolate missing data

Data Source	Data Type Generated	Data Used For	Method	Problems	Solutions
		Food security			
Cost and earnings surveys	Economic	Economic performance indictors	Bioeconomic simulation models	Infrequent Small data sets	More frequent surveys Develop methods to extrapolate/interpolate missing data
Consumption surveys	Subsistence catch	Total catch	Methods using total catch	Infrequent surveys	More frequent surveys Develop methods to extrapolate/interpolate missing data
Meteorological Services	Environmental data	Environmental indicators	Methods allowing changes in production Recruitment index methods	Need to be compiled Small data sets Lack of contrast	Develop methods to extrapolate/interpolate missing data
Acoustic surveys	Habitat maps	Biomass reference points	Unexploited reference point	Infrequent surveys	
Biomass Surveys	Conch surveys	Current Biomass	Catch/biomass F MSY estimates	Infrequent	More frequent surveys Develop methods to extrapolate/interpolate missing data
Adaptive management	Marine reserves	Stock rebuilding rate Unexploited stock density	Unexploited reference point Stock growth		
Project based species - length frequency	Species and length composition of landings	Length based methods Species composition indicators Selectivity	LFDA Mean size indicators	Missing data Small data sets	Robust methods must deal with data problems while extracting maximum information
Fishing	Length frequencies	Length based methods	Abundance index	Data not	

Data Source	Data Type Generated	Data Used For	Method	Problems	Solutions
tournaments	Catch rates Age and growth parameters		LFDA	representative of all gears	
Imports to USA	Exports data	Total catch	Methods needing total catch	Incomplete data sets Subject to reporting errors	Verification of records

Appendix 7

Summaries of Method Tests Performed and Preliminary Findings

I. Re-scaled age-structured production model:

Case Study: Assessment of Groundfish Fishery of Trinidad and Tobago

Background

The groundfish fishery of Trinidad and Tobago is a multispecies, multigear fishery operating in the Gulf of Paria and Colombus Channel of Trinidad. This is a shared fishery with Venezuela. Groundfish species are considered bycatch in the trawl fishery for shrimp and in the gillnet and line fishery for mackerels. In 1999, under the FAO/WECAFC *ad hoc* Working Group on Shrimp and Groundfish Resources of the Brazil Guianas Continental Shelf, assessments were conducted for several main groundfish species and included national as well as joint analyses with Venezuela. Monthly catch and effort data for the period 1989-1997 for Trinidad and Tobago artisanal gillnets, lines and trawl fleets were used in a depletion model and the data were also combined with catch and effort and biological data from the Venezuelan industrial trawl fleet in a BIODYN model. Recommendations were to refine these assessments including catch and effort data from the TT industrial trawl fleet and to implement a biological sampling programme for groundfish.

Following on these recommendations, monthly catch and effort data for all gear types and the fishing area are available for the period 1989-present. Length frequencies have been collected for one year for two species, *Micropogonias furnieri* (Whitemouth croaker) and *Lutjanus synagris* (Lane snapper). Biological parameters for the species are available from the literature for the Brazil-Guianas continental shelf and specifically from previous work conducted in Trinidad and Tobago using otoliths and length data. Data preparation for analysis is particularly difficult since the catch and effort data is recorded at fish landing sites both at the species level and in sorted categories where several groundfish species are combined. There are also instances of missing data such as total landed catch when samples are obtained for length measurements.

The meeting decided to consider the application of the 'Re-scaled Age Structured Production Model" to analyse the available groundfish data.

Illustration of "Re-scaled Age Structured Production Model"

In lieu of performing an assessment, the group discussed the available data and how that might be used to fit the model. In so doing, it was noted that the assessment would require inputs that were not available during the meeting and, for the sake of progressing with the example, they were only roughly estimated. The inputs reviewed are discussed below by category (biological/fishery/history).

Biology. Several estimates of von Bertalanffy growth parameters were available, as well as parameters to convert length to weight and to predict fecundity from length. Full information on the proportion mature at age was not available, and it is recommended that this receive attention prior to the assessment. A number of studies provided an estimate of M in the range of 0.36-0.4 $year^{-1}$. An examination of these studies and the resulting estimates of M could be developed into a prior on natural mortality. In the model, the stock-recruit function is parameterized in terms of α, the maximum rate of reproduction at low stock sizes. This parameter is not easy to measure directly, but an estimate can sometimes be calculated from other life history parameters, or a Bayesian prior can be constructed from α estimates of related species that have similar life histories.

Fishery. This case study focused on the artisanal-trawl and the industrial-trawl. It was noted that there are other artisanal gears that would need to be accounted for in order to perform a complete assessment. Catch rates for croaker were available for these two fleets from the 1999 assessment, but they appeared to be nominal, i.e. calculated as the ratio of total catch divided by total effort. It is recommended that standardized indices derived from sampled trips be calculated before the next meeting. A spreadsheet chart with the length frequency distribution was studied to get an idea of sizes selected, but a more formal analysis should be attempted to estimate selectivity at age by fishery and gear. In addition, the shape of the selectivity function should be estimated (i.e. whether it is an asymptotic or dome-shaped selectivity curve).

History. Since croakers are landed as bycatch in the shrimp fishery, the development of the shrimp fishery could provide insight into the historical trajectory of the croaker fishery. In particular, a year when croaker might have been at unexploited conditions would be the year that the shrimp fishery was initiated, which was probably in the 1930s. At the meeting, this subgroup reviewed a document (The Trawl Fishery of Trinidad and Tobago, Fisheries Information Series No. 9) that provided estimates of the number of artisanal and industrial vessels that were active for several points in the time series of the shrimp fishery's operation.

Summary of recommendations for data analysis.

1. Determine proportion mature at age
2. Survey literature to determine how estimates of M were obtained
3. Review metadata to identify species similar to white croaker so that a prior distribution for α may be constructed. Two pertinent references are Myers et al. (1999) and Rose et al. (2001).
4. Develop standardized catch rates from sampled trips
5. Analyze length frequency distributions by gear to determine gear selectivity and (attempt to) determine whether selectivity is logistic or dome-shaped.
6. Derive an effort series for each fleet

Criteria for evaluating the performance and suitability of the model (from the Terms of Reference, point 4):

a) Scientific accuracy and validity of the model – The model has been checked by comparison with simple spreadsheet to replicate calculations. The model is based on well-founded population dynamics models. Changes have been added to account for limitations in data. However, the model can undergo normal diagnostic testing in each assessment to measure accuracy and ensure validity.
b) Ability of tools to incorporate uncertainty and provide advice on risks – The state space framework of the model allows the accommodation of both process errors in the state variables and observation errors in the data variables. Uncertainty in process parameters related to mortality and reproduction, for example, can be reflected by specification of Bayesian priors. Advice on risk can be given based on estimates of current status relative to management benchmarks along with associated probability statements. Similar risk statements can be made based on projections of the population into the future under scenarios related to various management actions.
c) Data requirements and the ease of collecting such data – The required data are listed earlier in Table 2 of the meeting report.
d) Skills required by users – A fairly high level of skill is required.
e) The availability of these skills within national fisheries administrations – In general national fisheries officers and scientists are not adequately trained in running mathematical models and interpreting results. Development of the model would require collaboration with someone familiar with the modelling framework. Training would be

required for the national participants to understand the model and allow it to be updated regularly.

f) Level of usage of tools by fisheries officers and scientists within CRFM countries (or ease of presentation and understanding of the concepts/reference points/outputs) – the model output is in the form of a simple text file that can easily be pasted into a spreadsheet application such as EXCEL. Annual population status (relative to unexploited levels) and annual total fishing mortality can be plotted and compared with reference points. Fits of model predicted values versus observed indices could also be plotted.

g) Advancement of the management process, i.e. level of understanding and usage by management groups - The model addresses three key points needed for management: it provides reference points, estimates of current status, and the ability to make projections that reflect management actions (in this case, only effort control scenarios). The reference points and status estimates tell a manager if a management action is needed (similar to a traffic light); the projections allow advice to be given on likely outcomes for a given action (risk advice in the form of probability that the stock will be above/below the reference point after x number of years). Additional model outputs will probably need to be developed to meet management needs and provide reference points to simple CPUE or mean length indicators.

II. ASPIC Method Test

Catch and effort data was available for the lobster fishery of St. Lucia for the 1995 to 2004 year. Data review, indicate that there are three main fishing gears catching lobster; pots (baited chicken-wire traps), loop (hand operated stick-wire with a loop at the end), and gillnet (monofilament bottom gillnets). A Trip-interview program started in 1995 collecting catch and effort information in several landing sites. From the TIP data, proportion of catch by gear is shown in figure 1, other gears used include deep-nets and cast-nets, with relative minor catches.

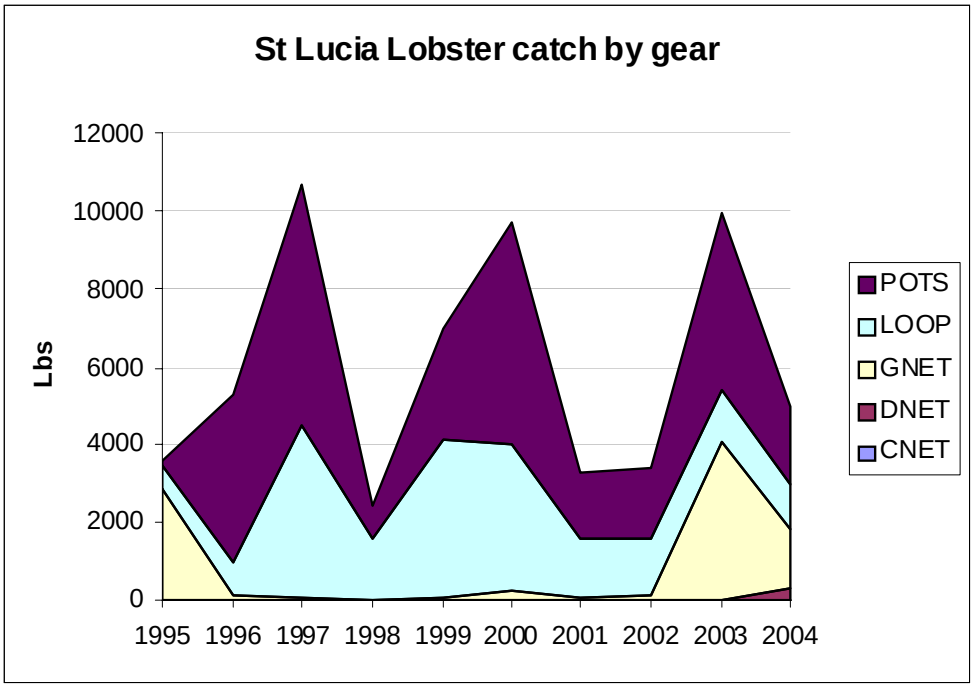


Figure 1. Proportional observed catch by gear lobster fishery St Lucia from the trip interview program 1995 to 2004.

The Trip interview records effort units in terms of hours of soak time. For the pot gear, the soak-time represents the number of hours (days) that the pot was in the water. However, in some instances when effort is recorded at less than 24 hours the soak time represents the trip duration of the boat in a single day. Figure 2 shows the annual trend of fishing effort for the pots gear, for interviews were soak time was 24 hours or greater.

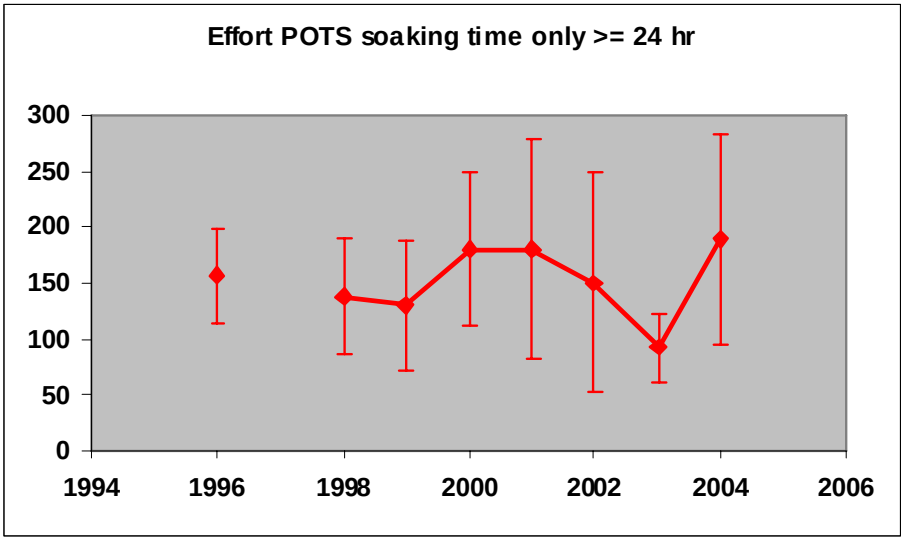


Figure 2. Annual trend of fishing effort for the pots gear including only observations with soak time of 24 hours or greater. Bars represent ± one standard deviation.

For the gear loop the soak-time reflects the hours the divers were fishing. Commonly the diving operations are for both conch and lobster, however scuba gear is not allowed to catch lobster. Figure 3 shows the annual trend of the loop gear

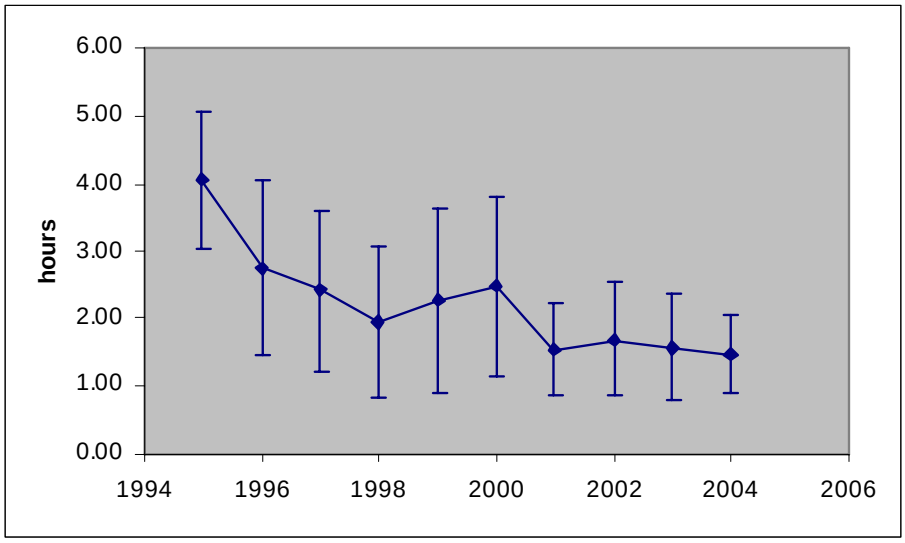


Figure 3. Fishing effort as hours diving for catching lobster using the loop gear

For the gillnet gear the soak time is recorded as the duration of trip, and not the time the gear was fishing in the water particular in latest years (2003/04) (see Figure 4). Since the gillnet is mainly a multi-species fishery it was consider that fishing effort units of gillnets catches are non-informative for the lobster fishery.

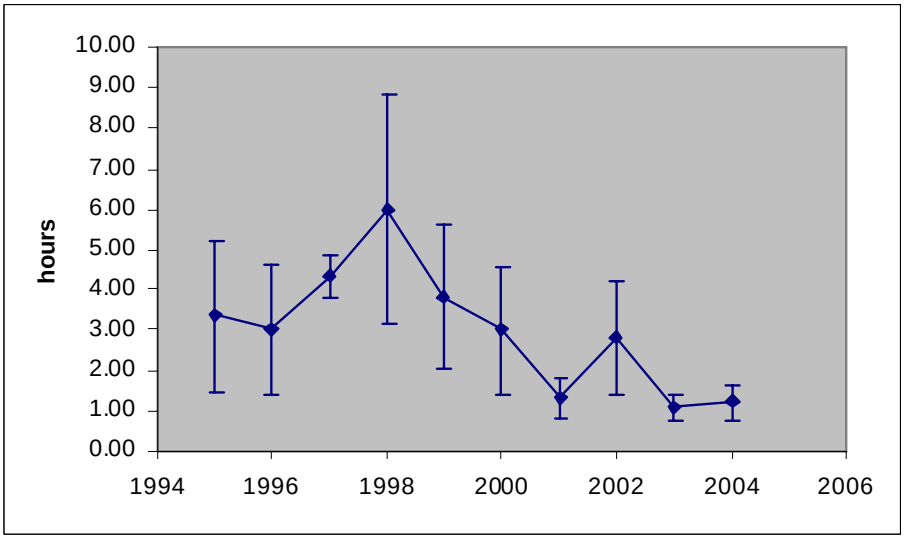


Figure 4. Annual trend of reported duration of Gill Net trips that reported catches of lobster.

Nominal catch rates were calculated from the trip-interview data as pounds of lobster landed per hour of fishing effort. In the case of pots gear, only records with soak time of 24 or more hours were included. Records of pots that were lost and recovered after a long period were not included. Figure 5 show the

nominal catch rate trends for the main gears. It was concluded that the gillnet catch rate trend is not useful as index of relative abundance for lobster, given the multi-species character of this gear. The loop gear is considered a gear-fishery targeting lobster and a relative index of abundance can be obtained from the nominal CPUE trend. The pots gear can also provide an index of relative abundance for assessment models.

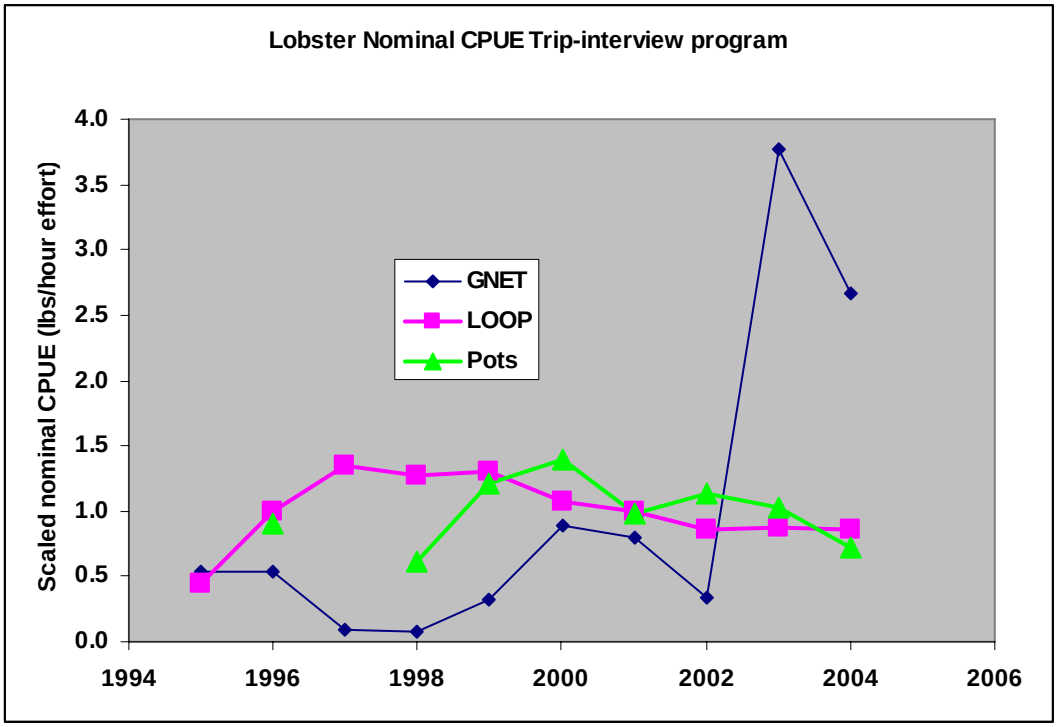


Figure 5. Nominal catch rates (CPUE) of lobster observed catch from the trip interview program. CPUE is calculated as pounds of landed lobster per hour of fishing effort, and indices are scaled to their respective mean.

In 1996 CFRM sponsored a program for the collection of biological data of lobster. The gear used during this project was pots. The information collected include; length frequency (carapace length mm), sex and spermatophore. Figure 6 shows the number of samples per year by sex.

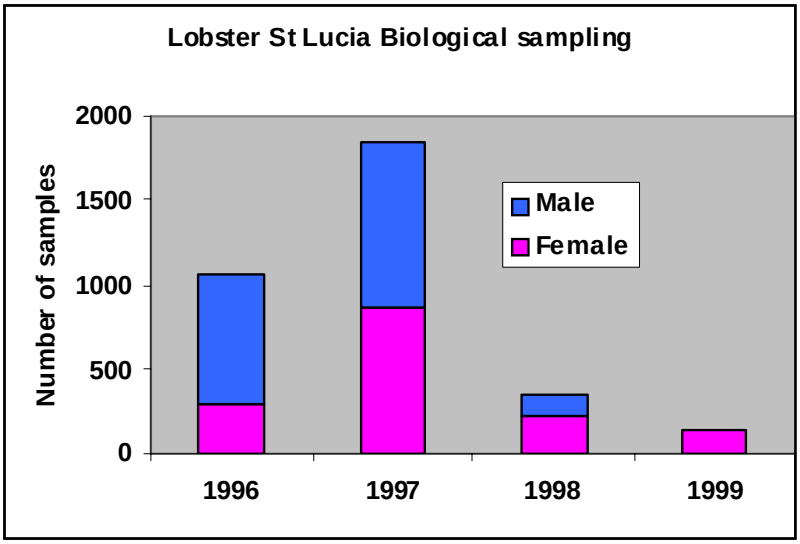


Figure 6. Distribution of biological samples collected from the lobster pot fishery between 1996 and 1999 of St Lucia.

Samples were collected at the two different landing sites for the lobster fishery; one was where pots were set in the Atlantic ocean and the other in the Caribbean Sea. Analysis of size length frequency, by sex indicated not difference in size by sex or year, Figure 7 presents the mean size (standard carapace size mm by sex) by year $\pm$ one standard deviation.

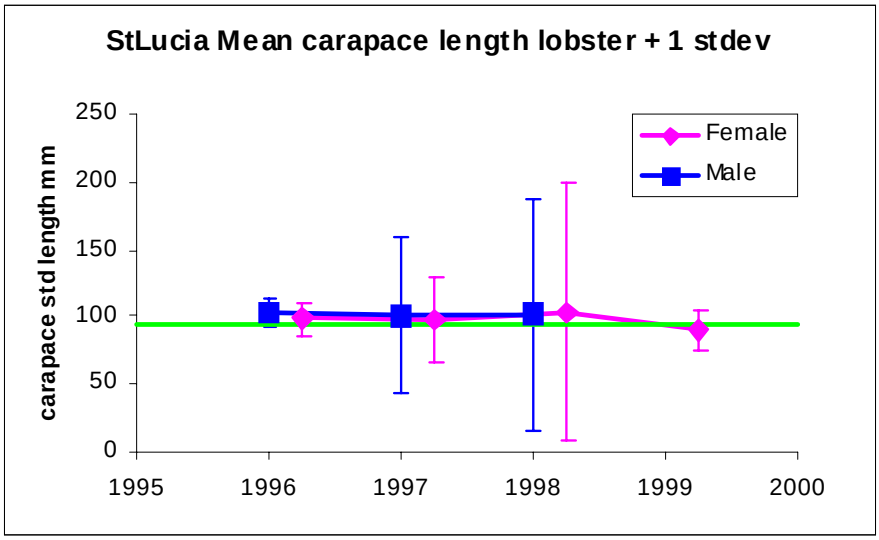
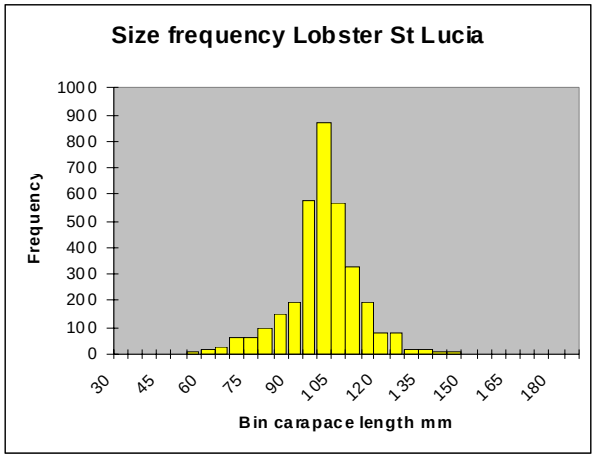
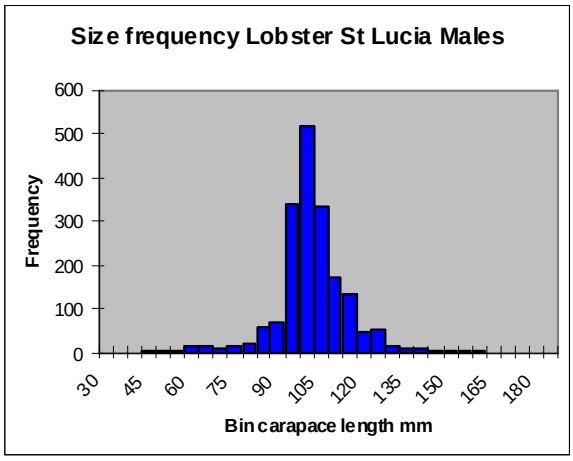


Figure 7. Trends of mean size (carapace length mm) of lobster caught with pot gear by sex and year. Bars represent one standard deviation.

The size frequency of caught lobster range from 35 mm to 180 mm, however most of the catch (90%) is between 75 and 125 mm carapace length. Sex specific frequency distribution (Figure 8) shows that the mean and mode of catch is between 100-105 mm for both males and females.





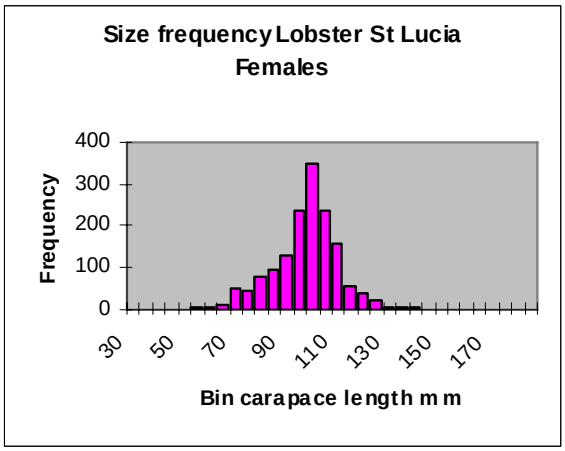


Figure 8. Histograms of size frequency (carapace length mm) of combined, male and female lobster caught in pots of the St Lucia fishery.

The review of the catch and effort, and biological data for the lobster fishery of St Lucia suggest that sufficient information is available to evaluate alternative methods of assessment. During the meeting an attempt was carry out with a production model (ASPIC), although with partial data of the total lobster landings. The group recommended the continuation of the evaluation during the inter-sessional period, with standardization of nominal catch rates.

III. Z estimator from mean length

The fraction of the population killed by the fishery was estimated from mean length data collected in the Bahamas and St. Lucia using the simple Beverton-Holt estimator and a more comprehensive estimator developed at the meeting that allows for variations in selectivity with age and populations whose length structure may not yet have reached a stable equilibrium. The results suggested that the level of mortality associated with fishing exceeded that associated with natural causes. However, further exploration of the data is required before estimates can be developed that are suitable for generating management advice. Nevertheless, the exercise demonstrated for the group that rough estimates of mortality rate could often be gleaned from length data that have already been collected by many countries. It also demonstrated that

small variations from knife-edge selection or mis-specification of the age/size at first capture could lead to large biases in the Beverton-Holt estimator. The alternative estimator can account for selection patterns that are not knife-edged and therefore will be less biased if the selection pattern is known. Accordingly, it is important for data to be collected that will elucidate the selectivity patterns of different fisheries. It was pointed out in discussion that the mean length associated with a given fishing mortality reference point could be determined essentially by the reverse of the above procedure. In that case, national scientists might simply monitor mean length relative to the reference length.