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CRFM Fishery Report - 2013

Volume 1

Report of Ninth Annual CRFM Scientific Meeting - St.Vincent and the Grenadines, 09-14 June, 2013

CRFM Secretariat
Belize
2013

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Foreword

The Ninth Annual CRFM Scientific Meeting took place during 10 to 14 June 2013 in Kingstown, St Vincent and the Grenadines. During this Meeting, the five CRFM Resource Working Groups met. The CLWG, LPWG and RSWG each reviewed the relevant components of the 2013 Strategic Action Programme (SAP) for the Sustainable Management of the Shared Living Marine Resources of the Caribbean and North Brazil Shelf Large Marine Ecosystems (CLME$^+$), taking into account the need for incorporation of the precautionary approach, ecosystem and global environmental change considerations. Each Resource Working Group also developed an inter-sessional work plan. The CLWG reviewed the regional management options papers prepared and validated under the ACP FISH II Programme and proposed sub-regional regulations for the Queen Conch (*Strombus gigas*) in accordance with the request by the CFMC/OSPESCA/WECAFC/CRFM Working Group on Queen Conch. The LPWG reviewed the regional billfish conservation plan proposed by the WECAFC/OSPESCA/CRFM/CFMC Working Group on Recreational Fisheries and the sub-regional blackfin tuna management plan prepared by the CRFM under the CLME Project and provided guidance and recommendations on the way forward for implementation in the region. The LPWG also identified critical research needs to improve the quality of fisheries resource assessments and management recommendations and discussed data collection and reporting requirements for ICCAT in 2013-2014. The RSWG reviewed the regional lionfish strategy and status of implementation, as well as the performance of Marine Protected Areas in some countries and provided suggestions for the way forward. The RSWG also undertook a preliminary analysis of data on landings, effort and fishing operation costs for the fisheries in Anguilla and it prioritized data collection needs for improved fisheries management advice. The SGWG conducted separate assessments of the seabob (*Xiphopenaeus kroyeri*) fishery for Suriname and Guyana, discussed the proposed new methodological approach and the draft fisheries management plans for Guyana, Suriname and Trinidad and Tobago being developed under the ACP Fish II Programme. The SCPWG, together with the CRFM/WECAFC Working Group on Flyingfish in the Eastern Caribbean, provided guidance on the implementation, monitoring and evaluation of the sub-regional management plan and agreed management actions for the Eastern Caribbean Flyingfish and reviewed the related Draft Resolution of the respective Ministerial Sub-Committee. In addition to review of Working Group reports, the plenary session received updates on several ongoing and planned regional activities: (1) the status of the CLME SAP endorsement by countries and development of the PIF for CLME+; (2) the Caribbean Regional Strategic Program for Climate Resilience being led by CCCCC; (3) the Sanitary and Phytosanitary Project in the Fisheries Post Harvest Sector being executed in collaboration with IICA; (4) two queen conch projects supported by the ACP Fish II Programme and focused on strengthening scientific capacity; and (5) a subset follow-up project to the Study on the Formulation of a Master Plan on the Sustainable Use of Fisheries Resources for Coastal Community Development in the Caribbean completed in collaboration with JICA.

The Report of the Ninth Annual Scientific Meeting is published in one volume instead of the usual two volumes published for such meetings. This volume (Volume 1) contains the report of the plenary sessions and the full reports of the CRFM Conch and Lobster, Large Pelagic Fish, Reef and Slope Fish and Shrimp and Groundfish Resource Working Groups for 2013. Nine national reports were submitted and these are published as Supplement 1 to Volume 1. The report of the inter-sessional meeting of the Shrimp and Groundfish Working Group, which was convened in February 2013 in Georgetown, Guyana, is published as Supplement 2 to Volume 1. The report of the combined meeting of the SCPWG, and CRFM/WECAFC Working Group on Flyingfish in the Eastern Caribbean is published as Supplement 3 to Volume 1. Volume 2 usually contains part A (Overview), and the fishery management advisory summaries of

individual fishery reports comprising part B of each Working Group report. However, only one detailed assessment was conducted in 2013, and hence there was insufficient material to warrant publication of a separate Volume 2.

The covers for this volume were designed and prepared by Mr. ShaunYoung, while the photographs were provided by Mr. Junior Jarvis, Mr. Derrick Theophille, Mr. David Ramjohn and Dr. Susan Singh-Renton. These contributions are gratefully acknowledged.

CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS

ACP	-	African, Caribbean and Pacific States
ANCORS	-	Australia National Centre for Ocean Resources and Security
CARIFIS	-	Caribbean Fisheries Information System
CCCCC	-	Caribbean Community Climate Change Centre
CDS	-	Catch Document System
CERMES	-	Centre for Resource Management and Environmental Studies
CFMC	-	Caribbean Fishery Management Council
CIDA	-	Canadian International Development Agency
CITES	-	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLME	-	Caribbean Large Marine Ecosystem
CLWG	-	Conch and Lobster Resource Working Group
CPUE	-	Catch Per Unit of Effort
CRFM	-	Caribbean Regional Fisheries Mechanism
DMTWG	-	Data, Methods and Training Working Group
EAF	-	Ecosystem Approach to Fisheries
EBM	-	Ecosystem Based Management
ERAEF	-	Ecological Risk Assessment for the Effects of Fishing
EU	-	European Union
FAD	-	Fish Aggregating Device
FAO	-	Food and Agriculture Organization of the United Nations
FMP	-	Fisheries Management Plan
FORCE	-	Future of Reefs in a Changing Environment
GCFI	-	Gulf and Caribbean Fisheries Institute
GIS	-	Geographic Information System
HACCAP	-	Hazard Analysis and Critical Control Points
ICCAT	-	International Commission for the Conservation of Atlantic Tunas
IFREMER	-	Institut Français de Recherche pour l'Exploitation de la Mer
ICRI	-	International Coral Reef Initiative
IICA	-	Inter-American Institute for Cooperation on Agriculture
JICA	-	Japanese International Cooperation Agency
LPWG	-	Large Pelagic Fish Resource Working Group
LRS	-	License and Registration System
MEY	-	Maximum Economic Yield
MSC	-	Marine Stewardess Council
MSY	-	Maximum Sustainable Yield
NGO	-	Non-Governmental Organization
NMFS-SEFSC	-	National Marine Fisheries Service – South East Fisheries Science Center
NOAA	-	National Oceanic and Atmospheric Administration
OSPESCA	-	Organization of Fishing and Aquaculture in Central America (Organización del Sector Pesquero y Acuícola de Centroamerica)
PSA	-	Productivity and Susceptibility Analysis
QCMP	-	Queen Conch Management Plan
REEF	-	Reef Environmental Education Foundation
RSWG	-	Reef and Slope Fish Resource Working Group
SAP	-	Strategic Action Programme
SCPWG	-	Small Coastal Pelagic Fish Resource Working Group
SGWG	-	Shrimp and Groundfish Resource Working Group

SPCR	-	Strategic Program for Climate Resilience
SVG	-	St. Vincent and the Grenadines
TAC	-	Total Allowable Catch
TCI	-	Turks and Caicos Islands
TIP	-	Trip Interview Programme
UK	-	United Kingdom
UNU-FTP	-	United National University – Fisheries Training Programme
USA	-	United States of America
UWI	-	University of the West Indies
WECAFC	-	Western Central Atlantic Fishery Commission

1. OPENING OF THE MEETING

A short ceremony was conducted to formally open the plenary session. Mrs. Jennifer Cruickshank-Howard, Chief Fisheries Officer (Ag.) of the St. Vincent and the Grenadines Fisheries Division chaired the opening ceremony. The ceremony commenced with an offer of prayer by Mr. Reshevski Jack, Fisheries Officer of the St. Vincent and the Grenadines Fisheries Division, followed by the national anthem.

The Honourable Minister, Mr. Saboto Caesar of the Ministry of Agriculture, Rural Transformation, Forestry, Fisheries and Industry in St Vincent and the Grenadines was unable to attend. In his absence, Mrs. Cruickshank-Howard officially welcomed participants to the Ninth Annual CRFM Scientific Meeting. She noted that for the last four days participants from fisheries administrations of 15 CRFM countries and observers from JICA, UWI and IFREMER were engaged in five working groups. These were the Conch and Lobster Resource Working Group, the Large Pelagic Fish Resource Working, the Reef and Slope Fish Resource Working Group, the Shrimp and Groundfish Resource Working Group, and the Small Coastal Pelagic Fish Resource Working Group. She stated that these working groups used the available and relevant data to assess the status of the fisheries and made recommendations for management actions. She highlighted that the outputs of these groups provided management advice to the fisheries Divisions and Departments and other fisheries institutions both locally, regionally and internationally. She noted that the management advice was also necessary in order to address ongoing challenges such as climate change.

Dr. Susan Singh-Renton, the Deputy Executive Director of the CRFM Secretariat welcomed participants on behalf of the CRFM Secretariat to the Ninth Annual Scientific Meeting. She took the opportunity to inform the meeting of recent key accomplishments in the advancement of regional-scale coordination in fisheries management, in which the CRFM had played critical roles, particularly: the completion of the CLME project and CRFM Ministerial Council endorsement of the proposed follow-up CLME Strategic Action Programme, and; the establishment of a CRFM-OSPESCA MOU and Joint Action Plan intended to harmonize good practices and measures across the affected sub-regions in facing common challenges of resource management, illegal fishing and aquaculture. In addition, Dr. Singh-Renton pointed out that over the years, the CRFM annual scientific meetings have made major contributions, including: improving the international profile of fisheries management, as practiced by CRFM States, increasing the profitability of the industry, and quantifiably informing the CLME and other regional fisheries management initiatives. She further noted that the CRFM scientific meetings enjoyed a certain amount of international respect, and this had largely been achieved because of the organization and mainstreaming of the work of the scientific meeting and its supporting fishery specific working groups into the routine work of national fisheries departments and divisions in CRFM States. In closing, Dr. Singh-Renton indicated that the CRFM had recently introduced new web tools that were expected to improve communication and networking efforts in the period between annual scientific meetings, and reminded participants of the importance of each meeting's contributions in realizing the long-term fisheries management goals of the CRFM.

The Permanent Secretary, Ministry of Agriculture Industry, Forestry, Fisheries and Rural Transformation, St. Vincent and the Grenadines, Mr. Raymond Ryan provided the feature address. He noted the vulnerability of the Caribbean to the impacts of climate change and stressed the need for responsible management of fish stocks. He highlighted the need to address the current situation of declining stocks, ineffective fisheries management and the open access nature of the fisheries. He also informed the Meeting that the accessible inshore resources were coming under increasing pressure and fishing effort was being expanded to target exploitation of deep sea and pelagic resources such as tuna and dolphinfish. He reminded the Meeting that an increase in fishing effort was associated with increased costs to fishers and this needed to be addressed. The social importance of these fisheries resources was also noted as they

were an important food source for a large part of the local market. The Permanent Secretary noted the milestone of reaching the Millennium Development Goal Number 1, eradicating extreme poverty and hunger for St. Vincent and the Grenadines. He informed the Meeting that regarding the state of food security, only 4% of the population was suffering from under nourishment. He emphasised that fish was a major source of protein and should remain accessible at affordable prices. He also noted that sustainable utilisation of the region's resources must be based on the best scientific advice. This called for collaboration among the region's scientists and it was for these reasons that the CRFM Ministerial Council provided support to the technical working groups and the CRFM Annual Scientific Meeting. He stated that the Scientific Meetings not only provided inputs to regional management but also to global initiatives such as ICCAT. He also realised the difficulties in meeting the requirements in terms providing data and complying with management measures of these initiatives. The Permanent Secretary, noted that the Scientific Meeting was initiated in 2004, and congratulated the CRFM staff for their efforts particularly, Dr. Susan Singh-Renton for making the activity a fruitful one. He welcomed the participants to the meeting and looked forward to the reports of the meeting. He declared the workshop open.

In conclusion to the meeting's opening, a Vote of Thanks was delivered by Ms. June Masters, Statistics and Information Analyst, CRFM Secretariat. She thanked the Government of St. Vincent and the Grenadines for hosting the workshop eight out of the nine times, and recognised their sterling support. She recognised the participants, the Chairperson, Dr. Susan Singh-Renton, the meeting speakers, the rapporteurs, the participating fisheries officers and consultants, and participants of related organizations and institutions who provided inputs to the working group deliberations. She thanked the caterer, the CRFM Secretariat staff, particularly Ms. Pam Gibson and Mr. Henry Cyrus, the staff of the Methodist Church Hall, the API persons, Ms. Sherill Barnwell and the staff of the Fisheries Division, St. Vincent & the Grenadines for assisting with the necessary arrangements. She also acknowledged the presence of the media during the opening ceremony. She thanked the observers and consultants for their support and expertise and specifically mentioned Dr. Hazel Oxenford (UWI), Ms. Nancy Cummins (NMFS-SEFSC), Mr. Lionel Reynal (IFREMER), Mr. Nariaki Mikuni (JICA) representative, and Ms. Dawn Maison. She also wished the participants a safe flight home.

2. ADOPTION OF MEETING AGENDA AND MEETING ARRANGEMENTS

Mr. Lester Gittens, Fisheries Officer, Department of Marine Resources, The Bahamas, served as the official Chairperson of the plenary session.

The Chairperson invited the Meeting to review and adopt the Agenda.

No amendments to the agenda were made.

The adopted meeting agenda is given in ***Appendix 1***.

3. INTRODUCTION OF PARTICIPANTS

The CRFM Secretariat advised that 15 CRFM Member States were participating in this year's scientific meeting sessions. Listed in alphabetic order, these 15 Member States were: Anguilla, The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, and Turks and Caicos Islands.

The following institutions and organizations attended in observer capacity. Some of these observers participated in both working group and plenary meeting sessions: IFREMER, JICA, National Marine

Fisheries Service – South East Fisheries Science Centre (NMFS-SEFSC), University of the West Indies. Dr. Paul Medley served as the fish stock assessment consultant to the Shrimp and Groundfish Resource Working Group. Ms. Dawn Maison was attached to the Shrimp and Groundfish Resource Working Group as a resource person on behalf of Guyana.

A list of participants is provided in ***Appendix 2***.

4. PRESENTATION OF NATIONAL (COUNTRY) REPORTS

The Meeting was informed that three national reports had been received from Grenada, Jamaica and St. Lucia. The Bahamas, Dominica, Guyana, Haiti, St. Kitts and Nevis and St. Vincent and the Grenadines subsequently submitted national reports, which are included in Supplement 1 to this Volume.

5. REPORTS OF THE CRFM FISHERY RESOURCE WORKING GROUPS

5.1 Conch and Lobster Resource Working Group (CLWG)

The 2013 Chairperson for the CLWG was Mr. Mauro Gongora of the Fisheries Department, Belize. Mr. Gongora presented the 2013 report of the CLWG. The detailed report of the CLWG is given in ***Appendix 3***.

Plenary discussion of CLWG

The Chairperson clarified that a national conch survey was not planned for the Bahamas, rather small areas would be surveyed and a stock assessment utilising a dynamic biomass model would be conducted.

The Jamaica representative emphasised the need for countries to implement the recommendation to make training in diving a condition for obtaining a fishing license.

The Chairperson made reference to the recommendation for an expert to work inter-sessionally with the CLWG. The Chairperson clarified that this was necessary for verification of inter-sessional activities and also added credibility to the assessment and the region. He also pointed out that the group would request the expert when necessary. The Deputy Executive Director noted the importance of having a queen conch expert and queried the time-frame for which the consultant was expected to be available. She stated that the justification for assignment of an expert would depend on the inter-sessional activities as well as the proposed agenda for the following Scientific Meeting. She also reminded the Meeting that sufficient notice should be given to the consultant to facilitate an appropriate schedule.

The Barbados representative, Mr. Christopher Parker, queried whether the meat weight regulations for queen conch were specific to export or landings. The Belize representative indicated that the regulations were not specific to either. The Barbados representative explained that conch growth rates may be different between areas and countries and should be taken into account for regional scale standardisations.

The Montserrat representative, Mr. Alwyn Ponteen, indicated that the CRFM Secretariat was being asked to do too much regarding regulations, as work at the national levels would need to be completed in order to inform standardisations. The Jamaica representative clarified that the regulations were meant to be a suite from which countries could choose as appropriate. He gave the example where some countries landed queen conch without the shell and therefore shell length would not be available, which meant another regulation would need to be put in place.

The Grenada representative sought clarification on the fact that specific countries were mentioned and participated in the CLWG and how this would affect regional standardisations. The Chairperson indicated that each country would use national conversion factors.

The Belize representative added that the Draft resolution for management of queen conch from COP 16 stated that conch meat conversion ratios had a specific time frame for implementation by all exporting countries. Therefore studies should be completed by the end of 2015 and the results submitted to CITES and FAO. The Belize representative encouraged States to complete these studies as soon as possible.

Martha Prada, a queen conch expert, added that numerous queen conch genetic studies had been conducted in Colombia and four primers had already been identified. She stated that there was a lot of expertise in Colombia and expressed her willingness to help the region with these studies.

The Deputy Executive Director complimented the group on the work done, and shared the concerns regarding the common minimum weight and closed seasons for queen conch. She highlighted that it would be critical for the CDS to be implemented.

The Deputy Executive Director also queried the suggestion for the use of a bio-degradable panel in spiny lobster traps and the time it would take to degrade. She made reference to the Belize Act as it related to limited licensing in the spiny lobster fishery and enquired about the provisions to facilitate this approach in other fisheries. The Chairperson responded that preliminary studies on bio-degradable traps were completed in St. Lucia and agreed that more work on this was necessary.

5.2 Large Pelagic Fish Resource Working Group (LPWG)

The 2013 Chairperson for the LPWG was Mr. Jullan Defoe, the Dominica representative and he also presented the 2013 report of the LPWG. The detailed report of the LPWG is given in ***Appendix 4***.

Plenary discussion of LPWG

The Deputy Executive Director sought clarification on the two recommendations made regarding i) spatial distribution for commercial large pelagic species; and ii) determination of blackfin tuna SPAGS areas.

The Grenada representative, Mr. Crafton Isaac, indicated that several references were made to the SPAGS in the blackfin tuna management plan and catches from FADs in Martinique suggested that there was a spawning area nearby and this could be investigated. The Dominica representative, Mr. Jullan Defoe added that IFREMER was also looking into biology of blackfin tuna.

The Grenada representative indicated that the movement of large pelagic appeared to be changing both temporally and spatially and pointed out that their distribution should be studied. He also noted that changes were observed during the Sargassum event. The Deputy Executive Director suggested that catches by area could be linked to studies of size and maturity and pointed out that these would also provide indicators on distribution patterns.

5.3 Reef and Slope Fish Resource Working Group (RSWG)

The 2013 Chairperson for the RSWG Mr. Alwyn Ponteen, the Montserrat representative, presented the 2013 report of the RSWG. The Anguilla representative, Mr. Remone Johnson also presented a report on the reef and slope fishery in Anguilla. The detailed report of the RSWG is given in ***Appendix 5***.

Plenary discussion of RSWG

The Grenada representative, Mr. Crafton Isaac, sought clarification on the control of lionfish through regulations. The Montserrat representative, Mr. Alwyn Ponteen, responded that in Montserrat there was currently a ban on the use of spear guns for reef species; however it was recognised that spear guns were most effective in capturing the invasive lionfish and therefore the regulations would have to be changed to accommodate this.

The Grenada representative suggested that MPAs could also be considered as a management option for reef and slope fish and he made reference to OECS Harmonised Acts on marine reserves. The Montserrat representative noted that currently, MPAs were more geared towards tourism, and regulations would have to be updated to improve their use.

The Belize representative commented on the use of spear guns to cull lionfish and reminded the meeting that this subject was discussed during the last Scientific Meeting. He stated that from the Belize experience, allowing fishers to only harvest lionfish with spear guns was not readily accepted by fishers.

The Belize representative stated that with respect to whether the marine reserves were helping fisheries, the sustainable queen conch fishery was supported through the use of marine reserves which served as a refuge for mature queen conch. The Belize representative indicated that MPAs were significant for island states where the shelf was small and marine resources could easily be depleted. He also stated that MPAs allowed protection of nursery areas for important commercial species.

The St. Lucia representative, Ms. Allena Joseph, echoed the sentiments of the representatives of Grenada and Belize regarding the importance of MPAs. She stated that a number of MPAs had been developed in St. Lucia, but they lacked the appropriate infrastructure. She suggested that countries should look beyond the development of national MPAs and explore the development of regional MPA networks.

The Chairperson agreed with these points and suggested that work regarding the roles and functions of MPAs should be undertaken at the national levels.

The Barbados representative indicated that in order to address the lionfish invasion, it should be advertised as a food fish. He also pointed out that its behaviour lent itself to being easily caught with low damaging gear which could assist in population control.

The Chairperson stated that where spear fishing was not allowed in the Bahamas, the lionfish population proliferated. He informed the Meeting that in the Bahamas, spearing of lionfish was allowed, however only lionfish was allowed to be onboard vessels utilising spear guns and this presented an enforcement challenge. He also emphasised the need for countries to conduct eradication exercises to control the lionfish population.

The Deputy Executive Director noted that the RSWG had a great amount of work to conduct inter-sessionally regarding the lionfish and the use of MPAs in management. She indicated that management would need to be advised on which methods were most appropriate. She also stated that some detail should be provided in the RSWG report about the analyses when countries were asked to submit the data. In terms of CRFM acting as a repository for data, she stated that this highlighted the need for a data sharing protocol, the service of the Statistics and Information Programme, and an appropriate database.

The Chairperson sought clarification on the presence of ciguatera in lionfish. The Montserrat representative indicated that there was an initial report identifying it as a threat in Guadeloupe, however this was later discredited.

The Barbados representative, Mr. Christopher Parker, informed the Meeting that in some cases a false positive for ciguatera was due to lionfish venom. He cautioned that lionfish was on the US FDA list for ciguatera toxin even though there had been no reports of ciguatera poisoning. As such, it was best to assume that there was a potential risk.

The Deputy Executive Director added that there was an upcoming Meeting in Guadeloupe to address the issue of ciguatera and lionfish.

The Chairperson indicated that there was anecdotal evidence of ciguatera poisoning in the Bahamas, however it was still widely consumed and just like any top reef predator, there was a risk.

5.4 Shrimp and Groundfish Resource Working Group (SGWG)

The 2013 Chairperson for the SGWG was the Suriname representative, Mr. Zojindra Arjune. He presented the 2013 report of the SGWG, while Dr. Paul Medley presented technical details of the model. The detailed report of the SGWG is given in ***Appendix 6***.

Plenary discussion of SGWG

The Bahamas representative queried whether weight or length frequency of seabob could be used interchangeably. Dr. Paul Medley indicated that both length weight data could be incorporated simultaneously into the population model.

5.5 Small Coastal Pelagic Fish Resource Working Group (SCPWG) & CRFM/WECAFC Working Group on Flyingfish in the Eastern Caribbean

In 2013 the SCPWG met jointly with the CRFM/WECAFC Working on Flyingfish in the Eastern Caribbean. The Chairperson for the joint meeting was the representative of Grenada, Mr. Crafton Isaac. Mr. Isaac presented the 2013 report of the Working Groups. The detailed joint report of the SCPWG and CRFM/WECAFC Working Group on Flyingfish in the Eastern Caribbean is given in ***Supplement 3 to this Volume.***

Plenary discussion of SCPWG & CRFM/WECAFC Working Group on flyingfish in the Eastern Caribbean

There was some discussion on the validity of the 5000 t triggerpoint and the action to freeze fishing capacity referenced in the Draft 2012 Sub-regional Fisheries Management Plan for Flyingfish in the Eastern Caribbean. The Barbados representative informed the Meeting that this figure was decided during the 2008 flyingfish stock assessment due to stock uncertainties if catches passed this level and one of the options given was a freezing of fishing capacity. He suggested that as the total regional catches had not surpassed this level, if the trigger point was indeed reached then a more comprehensive synoptic survey should be done. In terms of freezing fishing capacity, he suggested that this should only be considered if any country planned a massive expansion of their fishery. However, given the countries feedback this was not likely to happen. He explained that the other concept of the freeze was that as flyingfish was a prey species, the freeze on fishing capacity would allow countries to put their data collection systems in place as well as develop a data sharing protocol to conduct the necessary assessments.

The Deputy Executive Director indicated that preparations for the synoptic survey should commence in addition to the data sharing protocol if it was to be presented to the Caribbean Fisheries Forum.

The Chairperson added that in addition to the issue of defining fishing capacity, the need for new technology was also needed as flyingfish was recognised as an important species for food security and it appeared that younger fishers were not as interested given the current fishing methods.

The Barbados representative indicated that buy-in from all the concerned countries was needed for the Draft 2012 Sub-regional Fisheries Management Plan for Flyingfish in the Eastern Caribbean. He noted that even though the agreement with France was still being developed, countries should still adopt the measures set out in the management plan.

Regarding the statement made by Mr. Isaac during the presentation about the TORs for the CRFM Ministerial Council Sub-committee on Flyingfish not being finalised, the Deputy Executive Director clarified that they had been finalised during the second meeting of the Sub-Committee on Flyingfish. The Deputy Executive Director informed the Meeting that the convening of the next Sub-Committee Meeting depended on completion of national consultations for the management plan and review of the draft resolution.

The Deputy Executive Director further informed the meeting that there were regional fisheries management agencies that adopted regulations on behalf of Member States, however in the region's case adoption of regulations would be voluntary unless the mode of CRFM was changed.

5.6 Data, Methods and Training Working Group (DMTWG)

The Deputy Executive Director, Dr. Singh-Renton provided an update on the DMTWG activities. She indicated that the DMTWG was scheduled to meet inter-sessionally through the D-groups, however as this did not occur there was no group report. She indicated that the agenda still held and could be used to facilitate an inter-sessional meeting.

The Belize representative, Mr. Mauro Gongora, referred to the CLWG proposal for the development of stock assessment tools in R to conduct queen conch and spiny lobster assessments. He indicated that this could not be completed during the next Scientific Meeting, and suggested that it could be done inter-sessionally through internet communication. He explained that a work plan could be developed in collaboration with countries and training could be done online.

The Chairperson referred to the need for the use of GIS methods as well as training in Excel identified by the Working Groups.

The consultant, Dr. Paul Medley indicated that the use of Excel was a misnomer but was rather data handling in Excel e.g. the use of pivot tables and organizing data. He also indicated that there was Advanced Training in Visual Basic which was very detailed and involved programming and data organisation. The Chairperson indicated that this type of training would be more appropriate for Data Managers; however, Dr. Medley indicated that it was a generally useful skill.

The Barbados representative, Mr. Christopher Parker, indicated that Excel training was no longer needed.

The Meeting agreed that there was more of a need for training in Visual Basic.

The Chairperson referred to the training completed in R during the past DMTWG meetings and highlighted the need for a basic understanding in R.

The Belize representative queried whether the stock assessment training programme under UNU-FTP had concluded. The Deputy Executive Director reminded the meeting that there were two phases of training

which covered different aspects of basic statistics and stock assessment. She indicated that this arrangement was completed between CRFM and the UNU-FTP and an upcoming training needs assessment was scheduled. The assessment would be completed by a UNU-FTP representative based at the Belize CRFM office during the summer. This would allow the situation in the CRFM membership to be determined and guide the development of an appropriate statistics course.

The Deputy Executive Director, Dr. Susan Singh-Renton, referred to the training in Visual Basic and reminded the meeting that training in R was done for three years and unless the Groups were utilising the training, it was not likely that more training would be undertaken unless an urgent request came from the Forum or Council.

The Chairperson indicated that training in basic statistics and simple data analysis techniques, sampling design would more likely be used immediately by the Groups.

In terms of training not being utilised, the Belize representative stated that this was due to the compactness of the course and limited opportunities for application. He recommended that if the training course was organised in R it should be for an extended period given the limited technical capacities of officers.

The St. Vincent and the Grenadines representative, Ms. Lucine Edwards, agreed that unless the training was tied to a specific output it was not ideal and she also found training in sampling design to be more appropriate.

Martha Prada indicated that regarding the use of GIS models, the issue was how to interpret results on spatial and temporal distribution of the queen conch and this required an understanding of GIS concepts and application of results rather than training in the use of a specific programme.

The Deputy Executive Director referred to the online D-groups and encouraged participants to become involved in inter-sessional exchanges as this would also guide the training and data needs. She indicated that the UNU-FTP had been in the Caribbean and correctly identified the area of weakness regarding statistics. She also referred to the CARIFIS D-group which was developed to guide the way forward regarding an upgraded database and advised the Meeting that the Forum gave a specific task to this group and was expecting feedback by August.

6. COLLABORATION WITH OTHER ORGANIZATIONS AND ACTIVITIES

The Deputy Executive Director, Dr. Susan Singh-Renton, provided a brief update on the progress being made in collaboration with other organizations and activities.

She informed the Meeting that the CLME SAP had received enough signatures by the Ministers to go forward and the PIF was currently being implemented in order to guide the follow-up activities from the CLME Project.

The Deputy Executive Director stated that the Caribbean Regional Strategic Program for Climate Resilience (SPCR) project being led by CCCCC was in the final stages and the CRFM Secretariat would be taking the lead role in the fisheries component.

Regarding the Phytosanitary Project in the Fisheries Post Harvest Sector being done in collaboration with IICA, the Deputy Executive Director informed the Meeting that this would most likely be implemented next year.

She referred to the conch study validation workshop which was concluded in the week prior to the Scientific Meeting in collaboration with the ACP Fish II Project and informed the Meeting that the training in underwater visual survey census methods for queen conch was scheduled to begin during the summer.

She informed the Meeting that the follow-up project to the Study on the Formulation of a Master Plan on the Sustainable Use of Fisheries Resources for Coastal Community Development in the Caribbean completed in collaboration with JICA was underway. She stated that the FAD component of the project was finalised and work on the Aquaculture and Statistics components was being done.

The Deputy Executive Director informed the Meeting about the following training opportunities:

- UNU-FTP Iceland- six month programme in:
    - Fisheries Policy and Planning;
    - Marine and Inland Water Resources-Assessment and Monitoring;
    - Quality Management of Fish Handling and Processing;
    - Management of Fisheries Companies and Marketing;
    - Fishing Technology;
    - Sustainable Aquaculture.
- ANCORS
    - Fisheries Law and Management
- University of Florida
    - HACCAP training
    - Fisheries Officers could also propose topics of interest.

The Chairperson asked about the duration of the ANCORS course. The Deputy Executive Director indicated that it was for 5 weeks and was available to national officers working in any aspect of Fisheries (e.g. Customs, the Legal System, etc.).

7. ANY OTHER BUSINESS

The Belize representative pointed out that the CRFM Newsletter was an important communication tool and suggested that a new format could be developed where the articles were concise and the circulations were on a monthly basis. He recognised that there was a formal arrangement, however he thought this should be reviewed. He suggested that a small group could be developed to work on the newsletter and the topics could include current events, projects and updates of country activities.

The Chairperson indicated that this was a good idea; however he cautioned that there were many competing activities which would make circulation on monthly basis difficult, and it was therefore important that the articles were short.

The Deputy Executive Director added that contacts in each country was needed to develop the newsletter group and indicated that the new web tools could be utilised to facilitate exchanges.

The Deputy Executive Director indicated that the quality of the newsletters needed to be improved and stressed that authors needed to prepare simple articles.

The Belize representative indicated that the editorial committee would only require 4 persons and noted that the newsletter could be vetted by the Secretariat. The Belize representative volunteered to be part of

the committee. The Chairperson indicated that the specific details for the functioning of the newsletter group/committee were not possible at this time and suggested that it could be explored further.

8. REVIEW AND ADOPTION OF MEETING REPORT

The Meeting agreed that national reports as well as working group reports would be submitted by 28 June 2013 to facilitate compilation of the final report by the CRFM Secretariat.

It was agreed that the plenary report would be circulated to the participants for final consideration.

9. ADJOURNMENT

The Chairperson thanked the meeting participants for their work over the past week and noted that this work would help to improve the lives of fishers in their respective countries.

The Deputy Executive Director, Dr. Susan Singh-Renton, thanked the CRFM Secretariat staff for arranging the Meeting. She thanked the participants for their efforts to address the items on the agenda and the Chairperson for guiding the Meeting and bringing it to a successful close.

The meeting was adjourned at 4:10 pm on 14 June 2013.

Appendix 1: Agenda

NINTH ANNUAL SCIENTIFIC MEETING
DRAFT PLENARY MEETING AGENDA

14 June 2013: 0900-1700h

1. Opening of the meeting.
2. Adoption of meeting agenda and meeting arrangements.
3. Introduction of participants.
4. Presentation of national (country) reports.
5. Working Group Reports (listed in alphabetical order):
    a. Conch and Lobster Resource Working Group (CLWG);
    b. Large Pelagic Fish Resource Working Group (LPWG);
    c. Reef and Slope Fish Resource Working Group (RSWG);
    d. Shrimp and Groundfish Working Group (SGWG);
    e. Small Coastal Pelagic Working Group (SCPWG) & CRFM/WECAFC Working Group on Flyingfish in the Eastern Caribbean;
    f. Data Methods and Training (DMTWG).
6. Activity updates by partner organizations and agencies.
7. Any other business.
8. Review and adoption of meeting report.
9. Adjournment.

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Appendix 3: Report of the Conch and Lobster Resource Working Group (CLWG)

Chairperson	:	Mauro Gongora (Belize)
Rapporteur	:	Jasmine Parker (Turks and Caicos Islands)
Group Members:		Lester Gittens (Bahamas), Ricardo Morris (Jamaica), Shawn Isles, (St. Kitts and Nevis), Wilner Romain (Haiti), Kris Isaacs and Lucine Edwards (St. Vincent and the Grenadines).
Resource persons:		Maren Headley (CRFM) and Hazel Oxenford (UWI)

1. OVERVIEW

The Conch and Lobster Working Group (CLWG) meeting had the participation of 7 CRFM member states namely: Belize, Turks and Caicos, Bahamas, Jamaica, St. Kitts and Nevis, Haiti and St. Vincent and the Grenadines. Representatives from CRFM Secretariat and the University of the West Indies (UWI) served as resource persons to the CLWG.

Consistent with the draft agenda for the CLWG meeting, the group was tasked to conduct reviews of the relevant Strategic Action Programme for the Sustainable Management of the Shared Living Marine Resources of the Caribbean and North Brazil Shelf Large Marine Ecosystems (CLME+ SAP) reports for reef-associated fisheries and to provide further guidance on proposed recommendations. The group was also tasked to review the regional management options papers prepared and validated under the auspices of the ACP FISH II Project. Also, the group was asked to propose sub-regional regulations for the Queen conch (*Strombus gigas*) in accordance with the request by the CFMC/OSPESCA/WECAFC/CRFM Working Group on Queen Conch. Finally, the group was asked to develop an inter-sessional work plan.

2. REVIEW OF INTER-SESSIONAL ACTIVITIES SINCE LAST MEETING, INCLUDING MANAGEMENT DEVELOPMENTS DURING THIS PERIOD.

2.1 CLME + SAP Reports for Reef Associated Fisheries

The CLWG also conducted a review of relevant CLME-SAP reports for reef associated fisheries. The strategic action plan for the governance of reef and associated ecosystem that included short term actions for Queen conch such as the establishment and strengthening of management of Queen conch by relevant organizations - CRFM, FAO, WECAFC and OSPESCA was discussed in detail. The development and adoption of a framework for management and conservation plan for queen conch with regional level harmonized regulations was strongly supported by the CLWG.

2.2 ACP FISH II Project – Queen Conch Regional Management Options

The CLWG conducted a detailed review of the Queen conch regional management options as presented in the report of the ACP FISH II Project. The management options were divided into three sections. These included Data Collection, Analysis and Management options.

2.2.1 Data collection

The data collection options included the development of regional conversion factors for conch meat. Belize and Jamaica indicated they had already developed studies in the past but highlighted the need to update these studies. It was noted that FAO Circular No. 1042, entitled “Conversion factors for processed Queen conch for nominal weight” provided specific guidelines on how to carry out this study. The

CLWG recommended that the FAO Circular should be followed when these studies were being done in the region. The CLWG also recommended that a minimum sample size of 200 conchs per processing type should be used to conduct this study. Samples should be collected from all fishing grounds. Fishers should be involved in the processing of the Queen conch and personnel from the national Fisheries Divisions/Departments should record the data (morphometrics, whole weight, weight of animal out of shell, weights after processing is done). In addition to the national conversion factors, the CLWG also recommended that States should make available the information on conversion factors for regional analysis.

2.2.2 Catch Document System

A Catch Document System (CDS) was proposed as a management option and was supported by the CLWG. This system was currently being utilized by the Bahamas as part of its requirements for fish exports to the European Union (EU). A sample of the Catch Certificate was presented to the CLWG and an electronic copy was given to the group. The Bahamas shared their Catch Certificate forms for consideration of adoption by other States and States were encouraged to explore the use of the CDS. Another management option presented was for improvement of data management. The connectivity of conch and lobster populations in the region as a result of current direction and long larval cycles was recognized as an important issue that needed attention. In this regard, Bahamas requested UWI Mona to assist in a conch genetic study to examine regional population structure. States were encouraged to identify opportunities to carry out genetic and non-genetic marks to identify sources of conch populations.

Mandatory reporting of data by fishers, processors, buyers and sellers was also recognized as an important step to improving fisheries management in the region. Even though provisions for data reporting existed in the legislation of most States, it was made clear that it was not enforced in the majority of States. In the Bahamas it was not mandatory, as yet, but was included in new regulations. States recommended improvement in fisheries enforcement activities. The CLWG also supported the increased trip samplings to improve catch per unit effort data. Belize indicated there was need to improve its Catch Per Unit Effort (CPUE) which presently had discrepancies in its collection. The sampling of biological data from landings was also supported by the CLWG and recommended increased monitoring of sex and size in conch and lobster landings.

2.2.3 Analysis

In the management options presented in the Analysis section, the CLWG supported the development of an "Operation Model" in the "R" program that would assist to better and quickly assess the performance and health of conch and lobster fisheries. The development of conch assessment tools such as in "R" software was considered as important for stock assessment purposes and, given the low cost of operation once the scripts had been developed, made this tool appropriate for the region. States encouraged CRFM Secretariat to make available an expert to the CLWG at its Annual Scientific Meetings once an assessment for a species was to be carried out. The CLWG recommended that members of this group should be permanent staff to avoid new persons representing States every year and thus having to train these persons every time.

The management option for spatial and habitat data collection and analysis was considered as a valuable element in fisheries management and therefore CRFM was being requested to adopt this recommendation and purchase a group license for a GIS software program for the region and to conduct a training exercise. The socio-economic analysis of conch fisheries also received good support.

The Management options presented included a draft regional CRFM regulation for conch meat weight. The CLWG recommended that standardized meat weight regulation, with an exception for Belize due to nature of fishery (shallow water fishing by free diving only) and size of conch taken. Another management option presented was a draft regional CRFM regulation for Queen conch lip thickness and

shell length. This option was supported by the CLWG. A draft regional CRFM regulations for Queen conch closed season was also supported by the CLWG.

The preparation of Fisheries Management Plans (FMP) by States was supported by the CLWG. This was important because most States had prepared drafts but they had not been finalized for a long time and were not being implemented. The formulation of National FMPs should be done before Regional FMP was prepared. The CLWG considered that Queen Conch Management Plans (QCMP) in member states had been drafted but not signed off and this action needed to be completed as soon as possible.

States were encouraged to prioritize the finalization and implementation of the conch management plans as directed by CITES CoP 16. Turks and Caicos Islands reported that there was a strong possibility that a QCMP will be developed in the short term; while Belize expressed that with the enactment of the new Fisheries Act (2013) a conch management plan was imminent. Jamaica, Haiti, SVG, St. Kitts and Nevis and the Bahamas agreed in principle that a management plan will be prepared but conceded that it was not likely to be completed by the next CRFM Scientific Meeting of 2014.

2.3 Declaration of Panama

A review of the CFMC/OSPESCA/WECAFC/CRFM Working Group on Queen Conch Declaration of Panama was done and the CLWG fully supported and endorsed it. The CLWG agreed that there was need for the introduction in the national legislation of States of harvest control rules for all commercially important fisheries. Also, States were encouraged to prioritize the finalization and implementation of the conch management plans as directed by CITES CoP 16 Meeting.

The CLWG fully supported/endorsed the recommendations for sustainable management of the Queen conch as presented/amended in the Panama Declaration. The amendments/qualifications to the original recommendations of the Queen Conch Experts Meeting (Miami, 2012) in relation to the 8% conch harvest rule and conch density of 100 adult conch/hectare were fully discussed and agreed to.

2.4 OSPESCA/CRFM First Joint Meeting of Ministers of Fisheries – Executive Action Plan

The CLWG reviewed the Executive Action Plan emanating from the OSPESCA/CRFM 1st Joint Meeting of Ministers of Fisheries that was held in Belize City in September, 2012. The specific priority activities such as research and management of fisheries of regional interest such as the Spiny lobster called for CRFM to develop similar OSPESCA lobster regulation. The CLWG therefore conducted a detailed review of this regulation known as OSP.02.09. The closed season for lobster in the CRFM States varied from mid-February to end of September (Jamaica – April to June, Haiti – April to September, SVG – May to August, St Kitts – May to August, TCI April to July, Belize – mid February to mid-June and Bahamas – April to July). The CLWG agreed that a regional lobster regulation for closed season must consider the peak spawning season and in the development of lobster closed season regulation the overlap with Queen conch closed fishing period was to be considered.

The CLWG agreed that the number of lobster traps per fishing vessel needs to be further discussed before a recommendation was made. The CLWG also agreed that where lobster traps were used for fishing then an escape gap was necessary but did not agree on the size of the gap. The CLWG also recommended that inclusion of a biodegradable section on the traps needed to be incorporated in the proposed new lobster regulations.

The deployment of lobster traps prior to the opening of fishing season was not supported. For the inventory of lobster stock during the closed season, Jamaica required businesses to declare lobster stocks within their control and to get rid of the stock within 21 days. SVG had a grace period of one month after

the closure of the season. The TCI required a declaration of stocks only. States generally supported the requirement for businesses to declare their closed season stocks as well as verification of holdings and a grace period. The CLWG supported a minimum size for the carapace length and a minimum tail weight. Further discussions to agree on the finer details of the measurements were needed.

The prohibition on the catching/possession and marketing of lobsters in any reproductive state was supported by the CLWG. The CLWG supported the introduction of a prohibition on the grinding and cutting into squares of lobster tail meat as a measure to combat the illegal fishing of undersize lobsters.

The CLWG agreed with the Executive Action Plan of the OSPESCA/CRFM 1st Joint Meeting of Ministers of Fisheries. Specifically, the CLWG supported the carrying out of an inventory of major lobster works and it was proposed that the CRFM and OSPESCA work towards development of a broader regional agreement on management of spiny lobster.

2.5 New Regulations

The CLWG supported the introduction of new regulations to require lobster trap owners the mandatory removal of fishing gear as a precautionary action due to tropical storms. This directive would only be issued in emergency situations.

The CLWG agreed that there was need for a set of Spiny lobster regulations for the region. These regulations should include a robust and effective Licensing system; there was need to establish a limited entry system for lobster fishing, fishers will need to submit data upon acquisition of a special lobster fishing license.

The prohibition of fishing, possession and marketing of lobsters in any reproductive state was strongly supported. Ground lobster tail meat should also be prohibited.

The CLWG agreed that States that already prohibited the use of SCUBA or Hookah should maintain this law and where these equipments were still being used, fishers must be required to obtain minimum basic training on proper use to prevent diving accidents.

2.6 Inter-sessional Activities for 2013/14 Period

- Belize agreed to provide in the next CRFM Scientific Meeting an update on the meat conversion factors ratio; conch "spot-check" study to be carried out; improve biological and CPUE collaboration at landing sites for lobster and conch, roll-out management access in the marine resources; development of new fisheries in deep slope fish fishery and Florida-stone crab fishery; implement a new fisheries act with designation of limited entry fishery for lobster and conch fisheries.
- Haiti agreed to participate in the upcoming conch survey methodology and will look at the possibility of carrying out an underwater conch survey. No specific date was agreed on. Once the conch survey was completed, then Haiti will develop a conch harvest control rule and will possibly implement such management strategy.
- Turks and Caiços Islands agreed that there was need to carry out a conch survey but the necessary resources needed to be identified first. Turks and Caiços Islands agreed to conduct a Conch meat conversion ratio study and to possibly develop a Fishery Management Plan. A conch survey was being contemplated but no definitive date set as yet and biological and Catch Per Unit Effort data collection for conch will start at main landing sites.

- Jamaica agreed to conduct a conch meat conversion factors analysis; will conduct a conch survey in 2014; will carry out a lobster pueruli larvae settlement study in collaboration with Cuba and will also provide an update on the Fisheries Act, which was currently in an advanced stage but still required final revision and endorsement.
- The Bahamas agreed to carry out a conch underwater visual survey at the national scale; will carry out a conch meat conversion factors study. Also, a PhD dissertation on lobster biology and fishery sustainability in The Bahamas will possibly be completed by the next CRFM Scientific Meeting. A revision of the Fisheries Act, which was being funded by the ACP Fish II project was currently in progress and will continue throughout the year. A Fishery Management Plan for the Spiny lobster fishery will be developed and completed.
- Barbados, which was represented by Hazel Oxenford, agreed to provide a literature list of conch work in the Caribbean; and an update on conch meat conversion ratio study in the next CFRM Scientific Meeting; continue a project designed to enhance juvenile lobster habitats; and develop and implement a new conch management plan.
- St. Vincent and the Grenadines agreed to conduct a conch conversion ratio study and follow-up on the development of a Conch Fishery Management Plan.
- St. Kitts and Nevis agreed to conduct a conch meat conversion ratio study and will investigate SCUBA training opportunities for conch and lobster fishers.

2.7 Recommendations

General

- There is need to establish a CRFM working group to develop a regional agreement for the management of the Spiny lobster and Queen conch.
- The selection process for identification of group members will need to be further discussed.
- There is need for updated Fisheries Acts and Fishery Management Plans for member States.
- The passing into law of updated Fisheries Acts need to be prioritized by member States.
- Exchange of information on fisheries status, management and enforcement strategies need to be prioritized by member States.

Conch Fishery

- There is need to review the major conch studies in the Caribbean region.
- The Traffic conch review- 2001 needs to be considered in the revision.
- Group members need to investigate in their own countries about the status of their conch fishery.
- There is need for a regional agreement on the management of the Queen conch and working group needs to be formed to guide the implementation of such agreement.
- There is need for development and implementation of a limited entry system for the conch fisheries in member States.

Lobster Fishery

- There is need to review the major lobster studies in the Caribbean region.
- Group members need to investigate in their own countries about the status of their lobster fishery.
- There is need for a regional agreement on the management of the Spiny lobster and working group needs to be formed to guide the implementation of such agreement.
- There is need for development and implementation of a limited entry system for the lobster fisheries in member States.

Appendix 4: Report of the Large Pelagic Fish Resource Working Group (LPWG)

Chairperson :	Jullan Defoe (Dominica)
Group Members:	Christopher Parker (Barbados); Crafton Isaac, (Grenada); Allena Joseph (St. Lucia); Cheryl Jardine-Jackson and Reshevski Jack (St. Vincent & the Grenadines)
Resource persons:	Lionel Reynal (IFREMER)

A. OVERVIEW

Introduction

On 10 June 2013, representatives from CRFM member states gathered for the ninth annual CRFM scientific meeting at CRFM Eastern Caribbean office in St. Vincent and the Grenadines. The meeting commenced with an informal opening ceremony with some brief remarks by the CRFM Deputy Executive Director. By a show of hands, representatives selected to participate in various working groups of interest to their national fisheries. Due to financial constraints it was reported that only Shrimp and Groundfish analysis would be conducted and the only contracted consultant would be assigned to this working group.

The Large Pelagic Working Group (LPWG) was comprised of representatives from Dominica (chair), St Lucia, St. Vincent and the Grenadines, Grenada and Barbados and later joined by a representative from IFREMER (Martinique). This group was provided with an agenda (see Box 1 below) and tasked to review several documents to provide comments and recommendations. To achieve this task the working group reviewed individually the relevant documents and provided their comments and recommendations in group discussions set out by the working group. The group was unable to perform the task assigned at agenda number 4 due to the absence of the relevant information; however the group emphasized that CRFM member's states that were not contracting parties of ICCAT were encouraged to continue providing data to ICCAT through the CRFM Secretariat and contracted members should copy data submitted to ICCAT to the CRFM Secretariat.

Box 1: REVISED AGENDA FOR 2013 MEETING OF THE CRFM LPWG

1. Review of the relevant CLME SAP reports for Large Pelagic Fisheries, and provide further guidance on proposed recommendations, taking into account the need for incorporation of the precautionary approach, ecosystem and global environmental change considerations.
2. Review of regional billfish conservation plan proposed by the WECAFC/OPESCA/CRFM/CFMC Working Group on Recreational Fisheries, and provides recommendations on management options for application.
3. Review the sub-regional black fin tuna management plan prepared by CRFM under the auspices of the CLME project, and provides recommendations on the way forward.
4. Identify research needs necessary for the large pelagic

Appendix

1) Overview of Caribbean Fisheries Co-Management (CARIFICO) Project by JICA expert (Mikuni)

Agenda Item 1: Review of the relevant CLME SAP reports for large pelagic fisheries, and provide further guidance on proposed recommendations, taking into account the need for incorporation of the precautionary approach, ecosystem and global environmental change consideration.

Strategy 5: Enhance the governance arrangements for implementing an ecosystem approach for pelagic fisheries

Proposed Lead Organizations: *FAO-WECAFC, CRFM and OSPESCA*

Actions:

5.3. ***[Short,*** *Medium]* Develop and implement initiatives for sustainable livelihoods by building capacity for diversification, fostering and facilitating viable alternative sources of Decent Work and/or improved incomes, and creating added value (e.g. through marketing and sales)

- Has alternative "decent work" been identified under the project and will the skill sets possessed by any displaced fishermen be appropriate to the available alternative work being offered to them?

- Has a survey been conducted or is there supporting information in the CLME region that indicates the fishers' preferences for available alternative livelihoods?

Sub-strategy 5A: Enhance the governance arrangements for implementing an ecosystem approach for flyingfish fisheries

5.6 [Medium] Operationalising and further enhance an integrated, sub-regional decision-support system (DSS) for the pelagic fisheries (linking large pelagics and flyingfish fisheries, and with additional linkages to DSSs for ecosystem/environmental protection, as relevant).

Proposed Lead Organisation: *CRFM*

Actions:

5A.5. ***[Short,*** *Medium]* Implement the CRFM/FAO-WECAFC Sub-Regional Management Plan for Flyingfish Fisheries in the Eastern Caribbean

LPWG suggests that this programme should be put on hold until 5A.2., which seeks to establish and operationalise a formal agreement between the CRFM and France on the management of the flyingfish fisheries, has been achieved or both programmes be executed simultaneously.

Sub-strategy 5B: Enhance the governance arrangements for implementing an ecosystem approach for large pelagics fisheries

Proposed Lead Organisations: *FAO-WECAFC, CRFM, OSPESCA*

Actions:

5B.3. *[Medium]* Strengthen the region´s position in the ICCAT decision making process through enhanced intra-regional coordination and cooperation
5B.4. *[Medium]* Operationalise and strengthen an integrated, sub-regional decision-support system (DSS) for the large pelagic fisheries (in coordination with the flyingfish arrangements).

- 5B.3 - LWPG strongly supports this initiative and believes that it is of a high priority. Therefore recommends that it be assigned a Short term priority rating for execution.

- 5B.4 - Initiative not fully understood. Needs further clarification

Agenda Item 2: Review the Regional billfish conservation plan proposed by the WECAFC/OPESCA/CRFM/CFMC Working Group on Recreational Fisheries, and provide recommendations on management options for application.

The LPWG supports efforts for region-wide management of billfish resources and in this context supports the establishment of a consortium which facilitates the participation of a wider stakeholder base and especially as it facilitates the participation of ICCAT non-members and entities. However, after review and discussion, the LPWG made the following comments on the document.

1. The LPWG queries how many Caribbean states are to participate in the work of the steering committee and the criteria for their selection.

2. The LPWG also suggests that the CRFM should be included on the Steering Committee.

3. The LPWG notes that the ICCAT catch limits presented in the document for blue marlin and white marlin from 2013 viz. 10 t is an inaccurate generalization; given that the smallest maximum catch limit assigned to any single territory is 10 metric tons for blue marlin and 2 metric tons for white marlin and spear fish combined. In addition, in some cases other ICCAT members in the region have been assigned higher quotas.

4. While it is essential to obtain buy-in from non-contracting parties of ICCAT, the LPWG considers that membership of ICCAT is still valuable for those states that have significant investments in the fishery and therefore such states should be encouraged to become full members of ICCAT. This is especially important as it gives the Caribbean region as a whole a more significant presence at ICCAT which remains the principal management forum for billfish and large pelagic fisheries in general.

5. LPWG is cognizant of the present and growing economic importance and value of the recreational fishery especially in the context of the tourism sector. The working group welcomes the approach whereby opportunities would be sought to allow for local fishers to participate in the recreational fishery to the extent possible. However, there is concern that such opportunities for commercial fishing vessels to become involved in recreational fishing will be limited. For example, the potential recreational fishing clientele are likely to find vessels configured for commercial fishing less attractive than those configured for recreational fishing. In this regard, the commercial/recreational fishing units would find themselves at a distinct competitive disadvantage. Nevertheless given the limited client base, the competition from the commercial/recreational vessels would still decrease the amount of business available to the established game fishing operators and thus reduce profits for these operations and this in turn may lead to increased conflicts at fishing grounds. The impacts of these issues must be carefully examined.

6. The LPWG cautions that billfishes represent an important component of the national food security of several states in terms of it being a source of high quality protein at affordable prices. The reference in the document to billfish being sold at relatively low prices is testimony to this fact. Therefore, the LPWG urges that due consideration be given to this fact when formulating management objectives so that those persons who rely on billfish for their livelihoods and the wider issue of national food security are not threatened.

7. While welcoming the proposal to contribute to the World Bank's studies of the contribution of recreational fisheries to economic development, livelihoods and food security, the LPWG notes that included in the 2012 ICCAT regulation that sets catch limits on marlins also mandates that no marlins taken by recreational fisheries be sold. Consequently the proposal to convert existing commercial fishing effort to recreational fishing effort inherently diminishes the direct contribution of the billfish fishery to food security.

8. Finally, it should be noted that even though billfish is perceived as a low cost item commercially, billfish sales still contribute a significant part of the incomes derived from fishing. Without access to billfish, commercial fishers would be forced to target other species to fill the void thus directly competing with other fishers who traditionally relied more heavily on such species. As such, this may have a trickle-down negative impact on more artisanal-level fisheries. Ways to ameliorate these possible negative impacts and possible economic shocks across fisheries must be considered.

9. The working group seeks additional information concerning participation of organizations from South America noting that the Caribbean appears to be fairly well represented at the sub-regional level compared to the South American sub-region. Also, the working group thinks that it is opportune for states to initiate a national dialogue on the proposals contained in this document.

10. The LPWG wishes clarification on the definition of "large scale commercial fishery" in the Caribbean context as used in the proposal. It further queries why billfish has been considered a "Flyingfish fisheries in the Eastern Caribbean by-catch" compared to any other species taken with the non-selective commercial fishing gear used by local fishers including longline or single hook and line pelagic fisheries.

Agenda Item 3: Review of the sub-regional blackfin tuna management plan prepared by CRFM under the auspices of the CLME Project, and provide recommendations on the way forward.

In this context the LPWG:

- Endorses the blackfin tuna management plan with the following recommendations and further suggests that stakeholder consultations be undertaken in member states to finalize the plan before its adoption.
- Recommends that member states begin to collect data specifically identifying blackfin tuna landings including collection of biological data.
- Recommends assessing blackfin tuna landings - the impact of FADs on the blackfin fishery.
- Reiterates the prior recommendation that in the absence of sufficient data on blackfin tuna landings, that a precautionary approach should be taken to limit significant expansion of the blackfin tuna fishery. The LPWG recognizes that there is currently no mechanism in place to quantify or limit catch levels of blackfin tuna, further emphasizing the need to collect the relevant blackfin tuna data to inform such decisions.

- Identifies and recommends the CARIFICO CRFM/JICA project as a means of addressing the collection of blackfin tuna data including biological sampling to determine the impact of FADs on blackfin stocks.
- Is concerned over the apparent emphasis placed in the description on characterizing the regions long line fleets, which are not known to be significant participants in the blackfin tuna fishery as opposed to the sparse details provided on the artisanal fleets that are the main participants in the fishery.
- Questions the relevance of the NMFS (US Caribbean Small boat permit) mentioned in the blackfin tuna management plan in relation to management of the blackfin tuna fishery for CRFM countries especially given that a main component of the NMFS license is access to the maritime areas of a number of states and as such appears to presupposes that CARICOM states will allow open access to their EEZs to regional fishing fleets. At present, any permit system must be based on the sovereign rights of individual member states controlling fishing within their own EEZs with the inherent right to permit access to regional neighbors as they see fit.
- Recommends that edits be made to note the existence of the 2009 maritime boundary agreement between Barbados and Martinique (France) and the 2006 arbitral award defining the maritime boundary between Barbados and the Republic of Trinidad and Tobago.
- Recommends an amendment to the first paragraph on page 25 to read:
  The CRFM LPWG, at the 8th CRFM Annual Scientific Meeting (CRFM 2012a), observed that one of the biggest concerns in the interpretation of the existing data was the increase in the number of actual landings records that were included in the databases in recent years attributable to improvements in data collection programs as opposed to *bona fide* increases in landings and the fact that fishers have increasingly been fishing on FADs.

Agenda Item 4: Recommendations for research needs considered to be conducted on Large Pelagics

- Spatial distribution for commercial large pelagic species
- Determine socio economic value of large pelagic fishery in CRFM countries
- Biological data collection on blackfin tuna to determine growth and maturity of the species to guide the management plan
- Marine environmental monitoring to monitor the effects of climate change
- Determine spawning aggregation of blackfin tuna

It was noted that IFREMER (INTERREG, MAGDELESA project) had ongoing research on blackfin tuna which can be considered as very important for the blackfin tuna management plan.

- Blackfin tuna aggregation around FAD
- Genetic research on blackfin tuna in collaboration with University of Southern Mississippi (USM Eric Saillant) several other countries including (Brazil, Puerto Rico,Venezuela, USA, Martinique)
- Reproduction study

1) **Identify and develop ICCAT data and data analysis contributions for 2013-14**
   - LPWG recommends that CRFM member states which are not contracting parties to ICCAT continue to submit data to ICCAT through CRFM Secretariat and members who are contracting parties should copy data forms submitted to ICCAT to the CRFM Secretariat.

2) **Caribbean Fisheries Co-Management (CARIFICO) Project**

Project purpose
To establish real FAD fisheries co-management examples.

Outputs

Qualification for FAD fisheries ⇒Change from open access

- ✓ Registration and license
- ✓ Participation in Co-management

Rules and regulations for FAD fisheries

- ✓ Deployment
- ✓ Utilization
- ✓ Maintenance

Fisheries information to be utilized for the FAD management

- ✓ The catch and effort data, recorded and reported by the fishermen
- ✓ Evaluation of status of resources based on the data
- ✓ Management rules based of the evaluation

Fisheries Co-management mechanism for FAD fisheries

- ✓ Fishermen's organization for fisheries management
- ✓ Fishermen's meeting to discuss and agree on the management rules
- ✓ Self-governing of rules
- ✓ Collaboration mechanism between the Fisheries Division and the fishermen's organization to formulate and enforce the rules
- ✓ Legalization of the rules

Actions

Fishermen's organization

- ✓ **Consultation** with fishermen to understand their needs and share the project idea
- ✓ Confirming the **rights and duties** of the members of the organization
- ✓ Promoting the **participation**, issuing the ID card and updating the members' list
- ✓ Introducing and expanding the **incentives** to be member, such as license, duty free concessions, facility utilization, and technical training
- ✓ Formulating and strengthening the **organization**, such as by-laws, management board, accounting, general meeting, staff training, auditing, education of member
- ✓ Improving the services and facilities of the **fisheries centers**
- ✓ Planning and implementing the **business** to sustain the organization
  - Selling of fishing gear, materials and fuel
  - Marketing of members' catch (Fish Friday, Product development, Distribution of fish in ice, Tourist market, Export market)

Fisheries Division/Department

- ✓ Reviewing and strengthening the government measures for increasing fishermen's **incentives** to the co-management
- ✓ Facilitating the **consensus building** on the management rules among fishermen
- ✓ Improving **registration and licensing** system
- ✓ Improving the collection and compilation of the **catch and effort data ⇒Logbook**
- ✓ **Evaluating the status of the fish resources** based on the data and applying the findings for the precautionary approach
- ✓ Drafting fisheries co-management **rules and regulations**
- ✓ Facilitating the consensus building with **related sectors**, such as tourism, environment and marine transportation through **fishery advisory committee**
- ✓ Facilitating the **legislation** of the fisheries co-management rules and regulations
- ✓ **Monitoring, control and surveillance**

Appendix 5: Report of the Reef and Slope Fish Resource Working Group (RSWG)

Chairperson : Alwyn Ponteen (Montserrat)
Group Members: Remone Johnson (Anguilla)
Resource persons: Nancie Cummings (NMFS, SEFSC), June Masters (CRFM)

Proposed Agenda

1. Review of the relevant CLME SAP reports for reef-associated fisheries, and provide future guidance on proposed recommendations, taking into account the need for incorporation of the precautionary approach, ecosystems and global environmental change consideration.
2. Review of proposed regional lionfish strategy and implementation to date if there are data, and propose recommendations on the way forward.
3. Review and evaluation of MPA performance if there are data and propose recommendations on the way forward.
4. Develop inter-sessional work plan, taking into account the available new CRFM web tools.

The RSWG made the following amendments to the proposed Agenda

1. Suggested inclusion of a new agenda item:
   Data collection needs and priorities for improved and sound fisheries management advice.
2. New agenda item 5 to be called:
   Data analysis of Anguilla Reef and Slope Fisheries
3. Revise Draft Agenda Item 4 to be Agenda Item 6.

The following Revised Agenda was accepted as amended by members of the RSWG.

1. Review of the relevant CLME SAP reports for reef-associated fisheries, and provide future guidance on proposed recommendations, taking into account the need for incorporation of the precautionary approach, ecosystems and global environmental change consideration.
2. Review of proposed regional lionfish strategy and implementation to date if there are data, and propose recommendations on the way forward.
3. Review and evaluation of MPA performance if there are data and propose recommendations on the way forward.
4. Data analysis of Anguilla Reef and Slope Fisheries.
5. Data collection needs and priorities for improved and sound Fisheries Management advice.
6. Develop inter-sessional work plan, taking into account the available new CRFM web tools.

Agenda item 1: Review of the relevant CLME SAP reports for reef-associated fisheries, and provide future guidance on proposed recommendations, taking into account the need for incorporation of the precautionary approach, ecosystems and global environmental change consideration.

The RSWG reviewed and endorsed the final version of the 2013 *Strategic Action Programme for the Sustainable Management of the Shared Living Marine Resources of the Caribbean and North Brazil Shelf Large Marine Ecosystems (CLME+ SAP),* (Anonymous 2013a).

As highlighted, the importance of fisheries to tourism and to the economies of the Caribbean is well documented and was the central theme of the SAP of the CLME. The health, productivity and sustainability of the CLME ecosystem is a critical link to the health of reef associated species. The CLME is one of the most geopolitically diverse and complex sets of LMEs in the world. Twenty-six independent States and more than ten dependent territories border or are located within the marine area covered by the Caribbean and North Brazil Shelf LMEs (Figure 1)

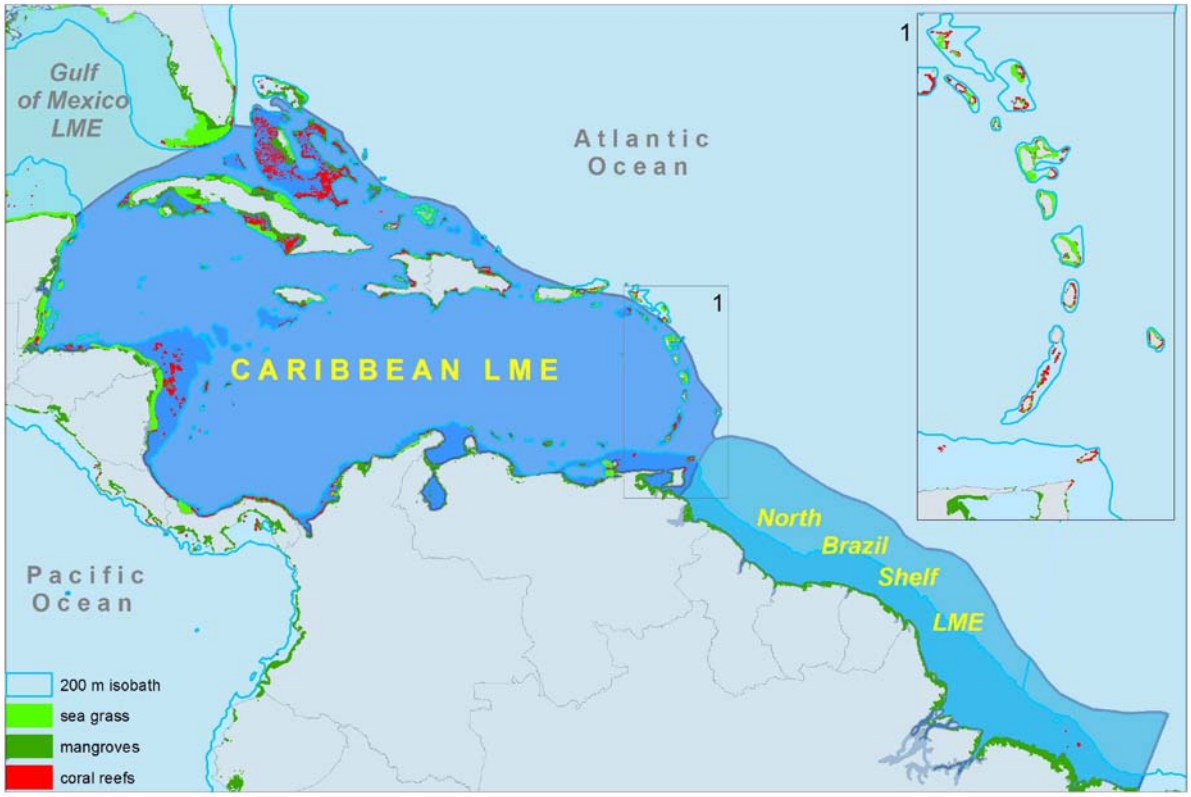

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Figure 1: Approximate distributions of the 3 key ecosystem types in the CLME. Source: CLME SAP, 2013.

Of the three key marine ecosystems in the CLME (Reef, Pelagic, Continental shelf) the reef-associated environment comprises 12% of the reef area of the world. Among the many species being fished, Caribbean spiny lobster and queen conch produced the highest revenues. Reef slopes further support important fisheries for species such as grouper and snapper. Associated systems such as mangrove forests and sea grass beds provided important nursery grounds.

The CLME SAP identified the following three (3) critical issues potentially affecting the CLME and the identified root causes of the problem (Table 1).

- Unsustainable fisheries (i.e. overfishing).
- Habitat degradation and modification of the community structure of ecosystems (human activities and natural disasters)
- Pollution (land-based and coastal and marine activities)

Table 1: Common root causes identified through the CLME Transboundary Diagnostic Analyses (TDA) Source: Table 1 CLME SAP report).

1	Weak governance (including legal & institutional frameworks, inadequate environmental quality standards and legislation)
2	Limited human and financial resources
3	Inadequate (access to) data and information (inadequate knowledge)
4	Inadequate public awareness & participation
5	Inadequate consideration of value of ecosystem goods & services
6	Population and cultural pressures
7	Trade and external dependency (high dependence on fish for income and export earnings

In discussing the precautionary approach to Ecosystems Based Fisheries Management and taking into account the global environmental changes due to climate change and sea level rise, the RSWG recommends endorsement of the following Action Items towards addressing the problems as outlined above.

Action Items:

1. Strengthen the legal framework at the national levels as a priority in enhancing fisheries ecosystems management;
2. Identify and prioritize national issues to be addressed in the short and medium term in order to develop and implement an action plan to address these issues;
3. Review and update National Fisheries Management Plans by the member states;
4. Improve sharing of data among member states through bi/tri lateral agreements for best practices to enhance adaptive management to improve the regional fisheries strategy;
5. Incorporate fisheries co-management principles into fisheries management plans to minimize over harvesting and use of detrimental fishing practices for improving overall health of marine ecosystems, fisheries performance, and sustainability of marine resources;
6. Enhance data collection therefore improving the ability to quantify and assess stock status and overfishing;
7. Implement harmonious monitoring systems (VMS) to quantify illegal, unreported and unregulated (IUU) fishing;
8. Increase training to improve technical capacity for evaluating the health of key ecosystems in the CLME; and
9. Develop research to address current and future impacts of climate change and sea level rise on the marine eco-systems.

Agenda item 2: Review of proposed regional lionfish strategy and implementation to date if there are data, and propose recommendations on the way forward.

The RSWG reviewed and endorsed the Draft Regional Strategy for the Control and Mitigation of the Invasive Lionfish in the Wider Caribbean Region (Anonymous 2013b).

The RSWG recommends that three of the five identified Objectives of the Regional Lionfish Strategy be emphasized and further recommend that prioritization of specific strategies and actions is critical in the short term and medium term:

1. Collaboration (Objective 1 Lionfish Regional Strategy):

Considering connectivity and shared resources in the Caribbean, the high colonization potential of lionfish, and limited capacities and funding available in the region, and recognizing that the efficacy of actions is dependent on them being coherent/coordinated, cooperation, collaboration and coordination are critical to achieve efficient efforts and actions to control lionfish populations.

Strategy

The lionfish invasion in the Caribbean is a trans-boundary issue which, by nature, requires a coordinated response by all parties affected and/or involved. Human and financial capacities are limited in the Wider Caribbean, and coordinating regional action by designing local action plans that feed into a regional framework; enabling the sharing of lessons learnt; and pooling resources are necessary steps to ensure that the lionfish issue is dealt with in the most cost-effective and efficient manner. The high colonization profile of the lionfish and important connectivity among lionfish populations in the region render consistency in actions all the more important to achieve a shared objective: controlling the spread of lionfish to minimize and mitigate its impacts on important ecosystems.

2. Research and Monitoring (Objective 2 Lionfish Regional Strategy). RSWG wishes to prioritize two of the Regional Strategies on the short term.
    - ***Strategy 1****: Promote the adoption of existing standardized survey methods for lionfish and incorporate into relevant monitoring programs (fisheries, reefs, etc.)*

        - *Action 1:* List and assess existing survey methods (including ecological impact studies and lionfish stomach content analysis);
        - *Action 2:* Disseminate best survey methods and encourage their use in a standardized manner at the local and national levels;
        - *Action 3:* Facilitate and support the organization of training s of trainers when still needed on these issues (especially in the Spanish speaking countries of the Caribbean);
        - *Action 4:* Identify an appropriate method and/or institution to centralize and analyze the data collected (e.g. an online database);
        - *Action 5*: identify appropriate institution to produce regular reports on the status of the lionfish invasion in the region.

    - ***Strategy 4:*** *Encourage consistency between national legislations, policies and regulations*

        - *Action 1:* Review existing, amended and projected policies and regulations and provide advice on their gaps if any, and on option to strengthen their consistency;
        - *Action 2:* Facilitate when needed by governments appropriate capacity building on this matter with the support of e.g. regional organizations.

3. Legislations, regulations and policies (Objective 3 Lionfish Regional Strategy). The RSWG wishes to prioritize the following two strategies and actions of the Lionfish Regional Strategy;

- ***Strategy 1****: Encourage government to review and/or amend existing regulations / legislation that inhibit or restrict lionfish control*
    - *Action 1:* Facilitate workshops/meetings to review existing legislation to identify gaps related to lionfish efforts, and in particular with respect to the prohibition (or not) of lionfish introduction/import
    - *Action 2:* Propose an agreement on common regulatory principles among countries and adaptation as necessary of the national regulations and laws. Two situations will be distinguished: import of lionfish from abroad, with the risk to replenish reefs with lionfish; versus possible export of captured lionfish e.g., for aquarium trade in other regions of the world, with commercial trade as a possible additional mean for control

- ***Strategy 4:*** *Encourage consistency between national legislations, policies and regulations*

    - *Action 1:* Review existing, amended and projected policies and regulations and provide advice on their gaps if any, and on option to strengthen their consistency;
    - *Action 2:* Facilitate when needed by governments appropriate capacity building on this matter with the support of e.g. regional organizations.

4. Control. The RSWG wishes to prioritize the following two strategies and actions of the Lionfish Regional Strategy;

- ***Strategy 2****: Implement efficient lionfish control programs*
    - *Action1:* Identify and allocate sustainable funding for local control mechanism (with the organization of workshops to strengthen local capacities of managers, practitioners, stakeholders, and exchange of experiences);
    - *Action 2:* Implement best practices in control amongst various stakeholder groups, as identified in the document "Invasive Lionfish: A Guide for control and management";
    - *Action 3:* Encourage and promote the use of the best equipment and tools available for control and mitigation (with the organization of workshops, trainings, exchange of experiences);
    - *Action 4:* Help countries design control and mitigation plans by selecting the best array of tools (consumption, fishing tournaments, etc) depending on their particular situation with respect to invasion and local capacities.

- ***Strategy 4****: Promote human consumption of lionfish, as a control strategy*
    - *Action:* Establish cooperation schemes between fishermen, restaurants and hotels to encourage consumption of lionfish;
    - *Action:* Designing marketing schemes in the community to encourage the consumption of lionfish.

The following CRFM member states were surveyed to provide a synopsis of their countries' lionfish management strategies: St. Vincent, Dominica, Bahamas, and Anguilla. Responses were as follows:

St. Vincent and the Grenadines

A response plan was developed that included getting the fishers involved in catching the lionfish as well as other stakeholders to include tourism organization, hoteliers, dive shop operators, restaurant owners.
To date the Fisheries Division had been concentrating on getting the fishers to bring in the lionfish to the Fisheries Division. It was recognized that trying to eradicate the lionfish will be a challenge, so instead of bringing the lionfish to the Division, the general public was being encouraged to consume the lionfish so as to develop a new fishery in St Vincent and the Grenadines.

Information reaching the Division indicated that locals were consuming the fish; even two hotels have been including the fish as part of their menu. However no training had been done on the processing of the fish. Lionfish was mostly caught in fish traps and sold at a value of $5.00 - $7.00 EC dollars per pound.

There had been some eradication operations through private sector involvement, Indigo Dive Shop which had organized a few derbies. At the completion of one of these derbies a barbeque event was held on the beach and also at a local hotel.

The Fisheries Division, through its quality control product development unit, was promoting strategies to encourage human consumption (Regional Objective 4: Strategy 4). As part of a public outreach program, the Fisheries Division would be engaged with the dive shop to conduct some underwater filming and processing of the lionfish. This filming would be promoted on the Government Information Service of St Vincent and the Grenadines (Action 2). Funding for eradication of lionfish was supported by public sector contributions only and in kind donations from fisheries. There was therefore the need to seek funding to assist with the eradication of the lionfish.

St. Vincent was doing the assessing and safe harvesting practice i.e. filleting, and removal of spines.

Dominica

The Fisheries Division has accepted lionfish as a part of the Marine Ecosystems. It was located around the entire coastline of Dominica at various depths, and was caught mostly in fish traps. The lead in the eradication of the lionfish had been taken up by the water sports association. One main area of focus was on the dive sites, this was for tourism purposes and trying to protect the reef ecosystems. Although the legislation restricted the use of spear guns, recent measures were put in place to allow the use of spear gun by the dive operators and the guides to harvest the lionfish at will. A data base was also kept which was not available at the time of reporting.

Dominica was implementing Objective 4 (Control), Strategy 4 of the Regional Lionfish Strategy (i.e., to promote human consumption) in their eradication drive. Also they were assessing and researching safe harvesting practices (Objective 2 (Research), Strategy 1 (use of best standardized survey methods). The Fisheries Department had partnered with the water sports association in the education drive through the local media in promoting the consumption of the lion fish (Action 2). Later this year the education outreach program will be taken to the school where a lionfish fiesta would take place.

One setback for the Department of Fisheries was that misleading information on the lionfish was disseminated to the population when it was first sighted in Dominica. This led persons to fear the lionfish even in consumption. However, efforts were being made to correct the information that was placed in the media, and promote its future benefits to the economy.

Bahamas

Bahamas had endorsed the lionfish strategy and in particular Objective 4 (Control). Several eradication programs were undertaken between the fisheries division and funding agencies to control the spread of the lionfish. One strategy that employed was to educate the general public concerning what should be done if they were stung by the lionfish, and to encourage a fishery consumption market. Demonstrations on the processing and preparation of the lionfish were undertaken within several funded projects. It was thought that if a viable market could be established then it would support all efforts in controlling its spread.

Discussions were undertaken to amend the legislations to allow for the use of the most appropriate gears to harvest the lionfish during fishing tournaments i.e. spear guns (Objective 3 (Legislation, Regulations,

and Policies), Strategy 3*: Encourage governments to develop specific policies and/or regulations when missing).*

As in the other islands, Bahamas was promoting public consumption of the lionfish, education and outreach programs of the species and addressing the governance issue of capturing the lionfish (Objective 4 (Control, Strategy 4, Action 1). Funding for the eradication program has been received from external agencies including the Global Environment Fund (GEF). This was done in conjunction with other countries.

One of the main concerns which had surfaced in the northern eastern Caribbean was the fear of ciguatera in the lionfish. It was thought that funding should be sourced to conduct scientific research on this product.

Agenda item 3:Review and evaluation of MPA performance if there are data and propose future recommendations.

The RSWG developed a brief questionnaire during the Ninth Scientific meeting to ascertain the performance of MPA's in the CRFM member states:

1. Does your country have any MPA? If so, which agency is responsible for the management of this area? Provide a brief description.
2. If multiple agencies exist in the management of the MPA(s), what collaborative methods are in place for information sharing?
3. Since the establishment of the MPA's are there any observed (improved) changed in the habitat, fish species, sea grass beds, corals, mangroves, recruitment and spawning aggregations?
4. What mechanism(s) are in place for education and outreach programs, monitoring, enforcing, compliance and evaluation?
5. What, if any, are some improvements that are needed in the management of the MPA's and/or for evaluation/quantification of MPA performance?

Countries interviewed during the Ninth Scientific Meeting by the RSWG and their responses regarding MPA evaluation and performance are given below:

Jamaica

Fisheries Division had established fourteen areas called *special fisheries conservation area*; most were managed by NGO's with subvention from the Government of Jamaica through the Fisheries Division. No fishing was allowed, however certain authorized activities were allowed including fishing for research and education purposes. Funding through partnership with the Government to provide for enforcement monitoring and control was underway. This was done through the NGO's on the Fisheries Divisions behalf. These NGO's included Fishermen's Organizations, Conservation Organizations and at least one managed by Sandals Foundation. At least two MPAs had been established and managed by the National Environmental Planning Agency.

Work was presently ongoing to complete the baseline survey to evaluate the level of success achieved through the establishment of the MPAs and Special Fisheries Conservation Areas. In two SFCAs, fisheries enhancement projects were undertaken where artificial habitats were established. Overtime these two areas have seen improvement in the fish stock, to include large predators (sharks). There have been reports from fishers regarding the increase in fish catch in the adjacent areas of the MPA's/SFCA.
More work was required to improve the monitoring, and baseline data. Enforcement had been effective in the protection of these areas. Data sharing was not automatic; however when required, the agencies did provide information.

Belize

The first MPA was established in 1987, and to date there were seven marine reserves, thirteen spawning delegation sites which were no take zones, and three offshore atolls. Five marine reserves were managed by the marine department, and the other two were managed through an MOU by NGO's.

In all of the reserves there was a minimum of five staff at any one time monitoring the area. This staffing included manager, biologist, two data collectors and a caretaker. The marine reserves were divided into different zones, to include multiple use areas, no take zones and preservation zones. Monitoring, enforcement and control was very effective through the use of the appropriate legal instruments.

Data sharing was effective, as all information collected within the marine reserves was the property of the Government of Belize. The MPAs were key to fisheries education research programs in terms of fishing regulations. The MPAs were seen to be very effective in enhancing fish biomass.

St. Vincent and the Grenadines

There was one established marine park, Tobago Cays Marine Park, located in the southern Grenadines. This was managed by an NGO. Little was known on the operation of the park by the Fisheries Division on the main land. It was therefore recommended that improved collaboration between the Fisheries Division and the management of the Marine Park was needed.

Anguilla

There were seven marine parks all managed by the Fisheries Division. There was uncertainty in the changes that had occurred within the marine park since their establishment. There was some outreach and education programs locally aimed at sensitizing the general public about the marine parks; however going forward there was a need to continue to grow these programs.

Monitoring, enforcement and compliance was legal under the regulations and was the responsibility of the National Police.

Grenada

Grenada had three MPAs; two of which were established by law in 2001, and the other was declared in 2012. Effective management only began in 2010, when management structures were put in place to facilitate this. Although, regulations were in place before, no efforts were made at that time to implement them. There was an advisory body for the management of the MPA's in place.

Efforts were now being made to incorporate co-management in managing the MPAs through communities in collaboration with the Fisheries Division. Monitoring activities had been put in place at two of the areas. Reef and fish surveys had been undertaken in recent years. In one MPA there had been positive observation in the quantity and sizes of the fish stock.

There was evidence of negative impact on the marine ecosystem due to land based actives i.e. agriculture, pollutants, *inter alia*. Management structure of the MPAs was being formalized and legislations and regulations were being reviewed. Funds were presently available from external agencies to finance the management and development of the area. Several outreach and education programs had been undertaken. Limited information was available on the effectiveness of the MPAs as a fisheries management tool. The MPAs were thought to be managed as a tourism product.

Agenda item 4: Technical Analysis of Anguilla Reef and Slope Fisheries

A. Introduction

The national scientist from Anguilla provided some summary landings information by species and fishing method categories for the Reef and Slope Fisheries from 2009-2012. The RSWG examined these preliminary data for the Ninth Annual Scientific Meeting. The Working Group focused on initial summaries of the Anguilla statistics for the meeting. Specifically, the WG considered preliminary summaries of the annual trends in sampling by resource group and by method of fishing. The RSWG examined the summary landings by year and fishing method and prepared summary by species group sampled and fishing method (Tables 2 – 4 and Figures 2-5).

B. Technical Analysis Summary

1. Summarize Preliminary Anguilla Data

From 2009-2012 the reef fish species category comprised 56% of the sampled reef and slope landings followed by snapper category (16%), lobster (13%) and conch (13%). The main type of fishing gear used in Anguilla was traps. From 2009–2012, 60% of the sampled landings were from fishing trips utilizing traps and 10% were from trips using scuba only. Eight percent (8%) of sampled landings were from trips using drop lines and 6% from handline trips. The remaining sampled landings were from trips using a combination of one or more fishing methods (e.g. handline/spear, scuba/spear, scuba/crawl, snorkel/hand, traps/handlines, traps/trolling).

1.1 Management Objectives: Anguilla

Anguilla's fisheries were primarily artisanal; managers would like to focus more on increasing fishing effort in the deeper waters off the coast targeting the pelagic resources.

1.2 Status of Stock

The status of the Anguilla reef and slope species was currently unknown. More detailed and comprehensive information was needed on catch and effort by species to determine stock status.

1.3 Management Advice

Although the status of the reef and slope fish stocks was currently unknown, managers wished to ensure that future fish catches did not decline and wished to improve fish stock status as far as possible, so that fishers can maintain a livelihood from the industry.

1.4 Statistics and Research Recommendations

Several tasks were identified which, if completed during the 2013/2014 inter-sessional period, should improve the Anguilla data quality significantly and the management advice generated from analyses of these data.

1. RSWG recommends that going forward Anguilla prioritize computerization of all of the catch statistics by individual trip insuring that species specific catch by trip data are recorded and archived for analysis;
2. Additional effort should focus sampling resources according to the distribution of fishing effort (days fished, trips, etc.,) by gear (e.g., fishing method) by area and by time period (week, month);
3. Implement quality control (QC) edits for data on a routine basis (as data are collected, as data are keypunched);
4. Develop summary QC computer routines to identify data outliers.

Table 2: Summary of Positive trips and Sampled Pounds for Anguilla Reef and Slope Fishery 2009-2012 by Species Category. All data are preliminary.

Year	Metric	Lobsters	Crayfish	Conchs	Reef - Fish	Snappers	Deep Slope Grouper
2009	Number Trips	22	4	11	69	10	
	Total Pounds Sampled	1669	73	840	4807	733	
2010	Number Trips	32	4	18	84	28	0
	Total Pounds Sampled	2550	320	1712	6871	2825	0
2011	Number trips	33	6	19	95	24	3
	Total Pounds Sampled	3261	314	5038	21335	7322	401
2012	Number trips	8	0	8	39	5	0
	Total Pounds Sampled	623	0	1115	4670	420	0

Table 3: Summary of Number of trips sampled and Variable Operating Costs for Anguilla Reef and Slope Fishery 2009-2012, $ EC. All data are preliminary.

Year	Metric	Bait	Fuel	Ice
2009	Number of observations	78	96	54
	Total Cost $ EC	8,336	20,848	1,596
2010	Number of observations	85	139	84
	Total Cost $ EC	8,886	45,284	3,272
2011	Number of observations	102	172	111
	Total Cost $ EC	23,795	133,150	12,454
2012	Number of observations	31	87	39
	Total Cost $ EC	3,991	38,234	1,225

Table 4: Summary of sampled pounds by year, fishing method and species group for the Anguilla Reef and Slope Fishery for 2009-2012 combined. All data are preliminary. Table reflects sampling effort across all gears.

		Species Group Sampled																		
		Lobster		Crayfish		Conch Trips		Reeffish		Deep Slope		Snapper		Small Pelagics		Large Pelagics		Reef and Slope		All Species
Year	Fishing Method	Trips	Pounds	Trips	Pounds	Trips	Pounds	Trips	Pounds	Trips	Pounds	Trips	Pounds	Trips	Pounds	Trips	Pounds	Trips	Pounds	Trips
2009	Diving					11	840	1	30									12	870	12
2009	Drop Line							1	45			1	156			1	46	2	201	3
2009	Handlines							12	679			3	78			7	1,631	15	757	22
2009	Nets													2	1,950			-	-	2
2009	Traps	22	1,669	4	73			48	3,723			6	499					80	5,964	80
2009	Traps / Handlines							7	330									7	330	7
2009	Trolling															6	1,010	-	-	6
2009	2009 Total	22	1,669	4	73	11	840	69	4,807			10	733	2	1,950	14	2,687	116	8,122	132
																		-	-	-
2010	Drop Line											2	750			2	250	2	750	4
2010	Handlines							6	340			5	182			2	170	11	522	13
2010	Nets													2	3,000			-	-	2
2010	Rods																	-	-	-
2010	Scuba					17	1,642											17	1,642	17
2010	Spear Gun							3	190									3	190	3
2010	Traps	27	2,020	4	320			68	5,471			15	1,073					114	8,884	114
2010	Traps / Handlines							2	360			1	250					3	610	3
2010	Traps/Trolling							1	20									1	20	1
2010	Trolling							2	165							1	150	2	165	3
2010	-	5	530			1	70	2	325			5	570	3	1,480	2	500	13	1,495	18
2010	2010 Total	32	2,550	4	320	18	1,712	84	6,871			28	2,825	5	4,480	7	1,070	166	14,278	178
																		-	-	-

2011	Drop Line	11	-	11	-	11	-	11	300	11	200	11	2,340	11	-	11	-	66	2,840	88
2011	Handlines	24	20	24	-	24	-	24	905	24	-	24	435	24	-	24	80	144	1,360	192
2011	Nets	27	-	27	-	27	-	27	2,000	27	-	27	-	27	29,140	27	-	162	2,000	216
2011	Scuba	17	-	17	-	17	2,330	17	-	17	-	17	-	17	-	17	-	102	2,330	136
2011	Spear Gun	2	-	2	-	2	-	2	240	2	-	2	100	2	-	2	-	12	340	16
2011	Traps	92	1,545	92	155	92	-	92	7,090	92	-	92	275	92	-	92	24	552	9,065	736
2011	Trolling	4	-	4	-	4	-	4	-	4	-	4	500	4	-	4	190	24	500	32
2011	Scuba & Spear	1	-	1	-	1	270	1	40	1	-	1	-	1	-	1	-	6	310	8
2011	-	4	50	4	-	4	-	4	100	4	-	4	-	4	-	4	-	24	150	32
2011	2011 Total	182	1,615	182	155	182	2,600	182	10,675	182	200	182	3,650	182	29,140	182	294	1,092	18,895	1,456
																		-	-	-
2012	Handlines	4	-	5	-	5	-	6	275	5	-	6	60	5	-	5	750	31	335	41
2012	Nets	23	-	23	-	23	-	23	-	23	-	23	-	33	35,580	23	-	138	-	194
2012	Rod and Reel and Traps											1	80			1	20	1	80	2
2012	Scuba	6	-	6	-	7	1,030	6	-	6	-	6	-	6	-	6	-	37	1,030	49
2012	Scuba/Crawl	2	63	2	-	2	-	2	-	2	-	2	-	2	-	2	-	12	63	16
2012	Snorkel and Hand	1	-	1	-	1	85	1	-	1	-	1	-	1	-	1	-	6	85	8
2012	Traps	32	560	32	-	32	-	40	4,345	32	-	32	280	32	-	32	100	200	5,185	264
2012	Hand-lining /Spear-Gun	1	-	1	-	1	-	1	50	1	-	1	-	1	-	1	-	6	50	8
2012	2012 Total	69	623	70	-	71	1,115	79	4,670	70	-	72	420	80	35,580	71	870	431	6,828	582
																		-	-	-
All Years	Grand Total	305	6,457	260	548	282	6,267	414	27,023	252	200	292	7,628	269	71,150	274	4,921	1,805	48,123	2,348

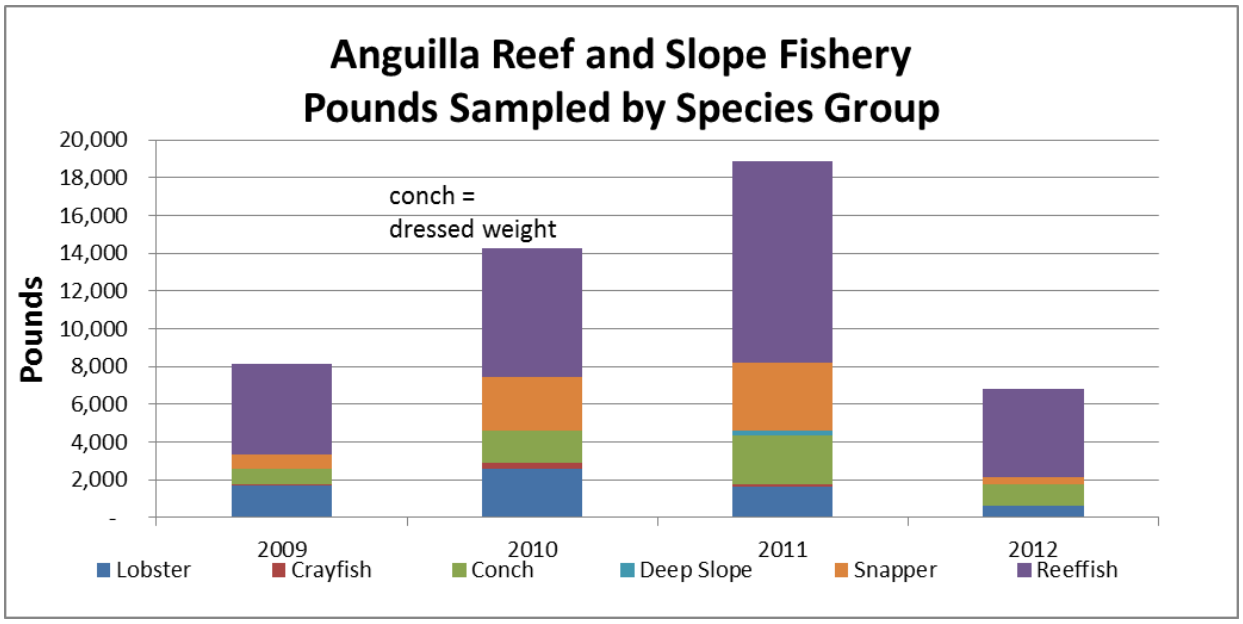


Figure 2: Summary of Pounds sampled by species group and year Anguilla Reef and Slope Fishery. All data are preliminary.

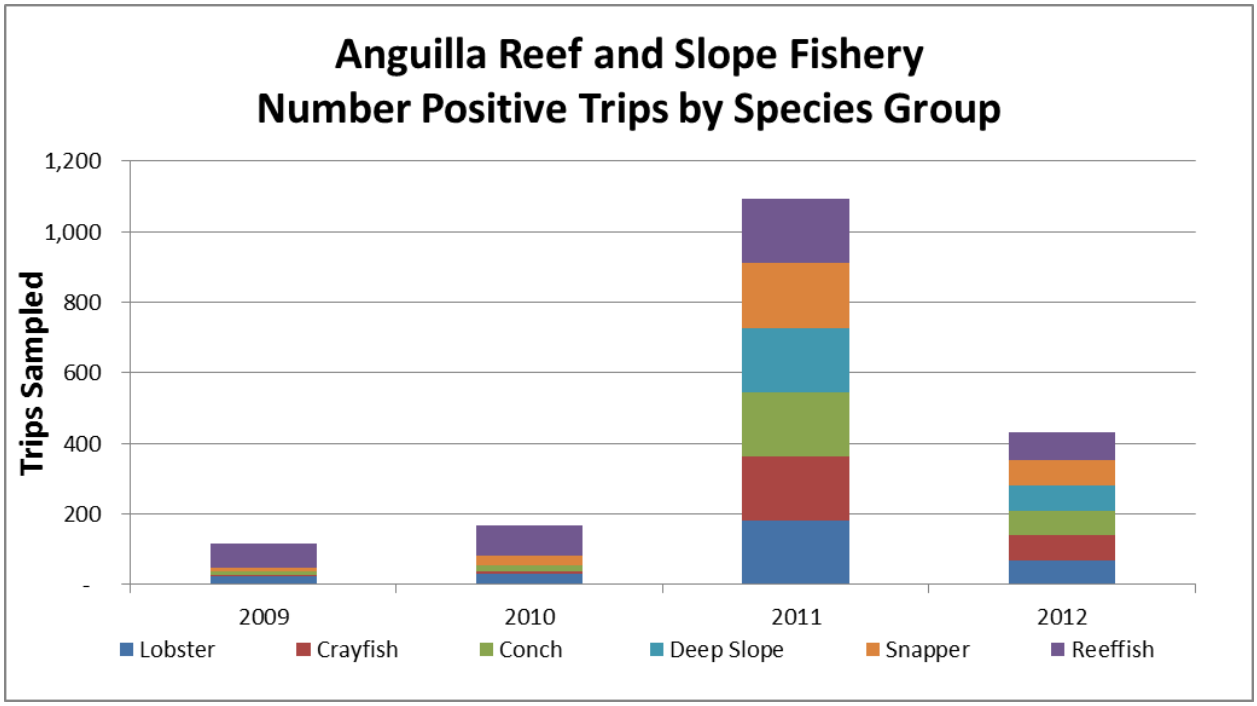


Figure 3: Summary of positive trips by species group and year Anguilla Reef and Slope Fishery. All data are preliminary.

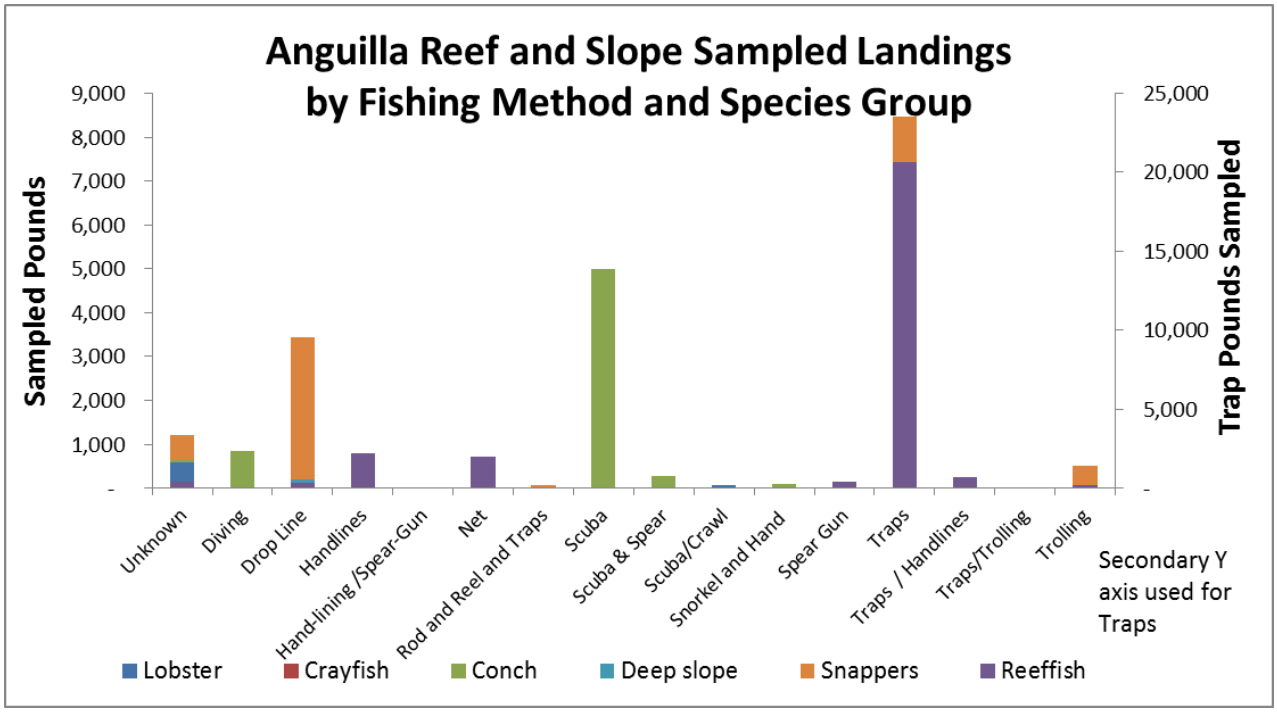


Figure 4: Summary of sampled pounds by fishing method and species group for the Anguilla Reef and Slope Fishery for 2009-2012 combined. All data are preliminary.

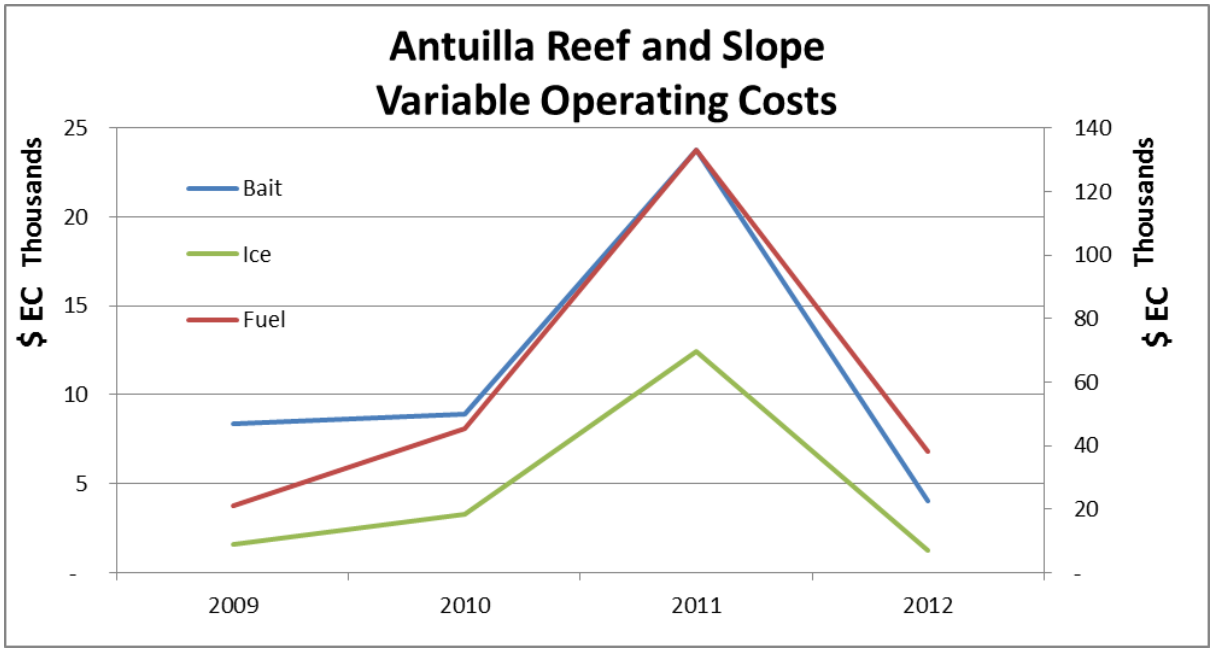


Figure 5: Summary of Variable Operating Costs for bait, ice, and fuel for the 2009-2012 Anguilla Reef and Slope Fishery. All data are preliminary.

Agenda item 5: Data collection needs and priorities for improved and sound Fisheries Management advice.

The RSWG discussed the available data for the Ninth Scientific Meeting of the CRFM. Summary information was made available for the Anguilla reef associated fisheries. Comprehensive stock assessments were needed throughout the region in order to quantify the stock status. Optimal data collection objectives and approaches were critical to producing minimal data input needs for stock assessments and providing management advice. Data collection activities should be prioritized at the local national level and efforts made to centralize data collection across the region. Immediate needs were to develop local sampling plans to collect minimal fisheries data elements on catch, landings, effort, catch per unit of effort, and size frequency samples. Sampling objectives should aim to collect all statistics on a trip specific level and to record species specific catch, landings. Long term sampling goals (10+ years) should aim to include further biological sampling (e.g., age and growth, maturity) into local national sampling plans.

Agenda item 6: Develop inter-sessional work plan, taking into account the available new CRFM web tools

Anguilla and Montserrat

1. Work towards computerization of catch statistics on a trip specific basis and archive in a database.
2. Continued computerization of detailed catch and effort statistics for Montserrat fisheries which began in 2011.
3. Collection of lionfish data as a new fishery resource in the Caribbean.

References

Anonymous, 2013. The strategic action programme (SAP) for the sustainable management of the shared living marine resources of the Caribbean and north Brazil shelf large marine ecosystems ($CLME^+$ SAP). March 2013.

Anonymous, 2013. Draft Regional Strategy for the Control and Mitigation of the Invasive Lionfish in the Wider Caribbean Region. March 2013.

Appendix 6: Report of the Shrimp and Groundfish Resource Working Group (SGWG)

Chairperson: Zojindra Arjune (Suriname)
Rapporteurs: Seion Richardson, Dawn Maison, Guyana (Shrimp)
Zojindra Arjune, Suriname (Shrimp)
Consultant: Paul Medley (Fisheries Consultant, UK)

A. OVERVIEW

1. Report of Work Progress since the last Meeting

At the Ninth Annual CRFM Scientific Meeting in 2013, Guyana and Suriname each initiated a separate assessment for the seabob (*Xiphopenaeus kroyeri*) using data from their respective national fleets. Trinidad and Tobago did not participate in the SGWG in 2013. The following summarizes the progress of work by the two countries since their last meeting in 2012.

An inter-sessional meeting was held in Guyana in February 2013. The purpose of the meeting was to provide guidance on the development and completion of a new stock assessment approach that will take advantage of the size information available from the seabob fishery. The new assessment was considered by the SGWG to be particularly important for Guyana which may be applying a higher level of exploitation than Suriname. The report of the inter-sessional meeting provides details on the TOR and the outputs.

Guyana
Data were obtained and utilized from the four (4) main processing plants in Guyana namely; Noble House, Pritipaul Singh Investment, Guyana Quality Seafoods and BEV Processors Inc. A mixture of hard and soft copy data submitted by the aforementioned companies was used to formulate the data base. Both catch and effort and biological data were collected, including size composition, maturity, as well as quantity landed and the number of days fished. However, although the ideal objective would have been to assess data from companies between years 1985 to 2012, this was not possible. This was primarily as a result of three out of the four companies not being in existence as far back as 1985 and, in a few instances, because of a failure of existing companies to produce consistent monthly data.

The Department of Fisheries in Guyana also obtained new rainfall and river outflow data for the period 1980 to 2012, which were obtained from the Hydro-meteorological Department of the Ministry of Agriculture, Guyana.

Suriname
The Fisheries Department in Suriname obtained landings by size category and effort data from the two seabob processing companies, namely Heiploeg Suriname (previously Guiana Seafoods), and Sail. Landings data (peeled weight in pounds) by size category for 1997 to 2012 were obtained from Heiploeg Suriname with days at sea for 2001 to 2012, and landings data (live weight in kilogrammes) by size category for 1999 to 2012 were obtained from Sail with days at sea for 2003 to 2012. Recent biological data collected by Heiploeg Suriname were also made available to the Fisheries Department. The catch data series extended as far back as 1989 for the seabob fishery.

Concerning the estimation of the artisanal catch of seabob, a survey was carried out in 2012 by the Department of Fisheries. Based on this survey it was estimated that the annual catch of seabob by artisanal fishermen totaled 939 tonnes. The SGWG welcomed this improvement in the available data to help manage this resource. Considering that this catch was consistent and was a small proportion of the

total catch, the SGWG considered that the harvest control rule in operation should be sufficiently precautionary to allow for the artisanal catch. However, this view should be formally tested when the HCR was evaluated.

In 2008, the Suriname seabob industry, particularly the Heiploeg Group, initiated the MSC certification process (www.msc.org), which was supported by the government (Ministry of Agriculture, Animal Husbandry and Fisheries), through the establishment of a special seabob working group. This was a management advisory group comprising the Government of Suriname, the two seabob processing companies, a Non-Government Organisation (Worldwide Fund for Nature WWF) and other relevant stakeholders. The MSC certification was successfully obtained in November 2011 and the HCR was being reviewed monthly to monitor the status of the fishery using data provided by the seabob processing companies.

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

ACP Fish II

In accordance with the Regional Action Plan of the ACP Fish II program the project "Support to formulate fisheries management plans for Guyana, Suriname and Trinidad and Tobago" was approved and launched in May of 2012. These projects commenced in the aforementioned countries in early 2013 and were currently nearing completion. Presently, the draft management plans of Guyana and Suriname were under review and will shortly be validated by the stakeholders.

The SGWG was in broad agreement with the draft plans and urged the Governments of Suriname and Guyana to endorse and implement the plans as soon as possible. However, it was likely that updates of the plans will be required in the near future as the harvest strategies for their fishery resources developed, so a procedure for frequent reviewing and updating of the plans should also be implemented.

3. Tasks to be addressed at 2013 Meeting.

Guyana & Suriname

- Review of inter-sessional activities and management developments since last meeting, including report of inter-sessional meeting held in Guyana in February 2013.
- In accordance with the agreed work plan coming out of the inter-sessional meeting held in Guyana February 2013, review of data and information on fisheries for Atlantic seabob - i.e. review and document available historical and new data and information, including data on catches and fleets. The review should also consider the information provided in national reports, and information on fisheries trends, and management developments.
- Updated assessments of Atlantic seabob (*Xiphopenaeus kroyeri*) are to be conducted for Guyana and Suriname separately as well as jointly.
- Brief introduction of the new stock assessment modeling to the participants.
- Review of relevant CLME SAP reports for continental shelf fisheries and ecosystems, and provide further guidance on proposed recommendations, taking into account the need for incorporation of the precautionary approach, ecosystem and global environmental change considerations.
- Review of management objectives and possible management strategies for fisheries being analysed – i.e. review of fisheries management plans, stated management objectives and agreed, practical management strategies in order to agree on the approaches to data analyses and assessments for the present meeting.
- Fishery data preparation, analysis and assessment planning and implementation, and report preparation.
- Review and adoption of working group report, including species/ fisheries reports for 2013.

- Develop an inter-sessional work plan, taking into account the available new CRFM web tools.

4. Relevant Policy/Management Objectives, Fishery Characteristics/Trends and Available Data for Fishery Analyses/Assessments Identified.

Guyana

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

Since 2011, the Guyana Fisheries Department had been negotiating a capacity reduction of 20% of vessels that were targeting seabob. The Department of Fisheries, Ministry of Health Veterinary Public Health Unit, trawler operators and seafood processors met regularly to discuss IUU fishing and MSC certification. There were new measures in place to reduce opportunities to fish illegally due to the implementation of a catch documentation scheme for exports to the EU.

Fisheries Management Plan

Guyana was in the process of updating their draft Fisheries Management Plan of 2002-2007 to be functional within the periods of 2013-2018. This initiative was being conducted primarily through the Guyana`s Fisheries Department and the ongoing EU-funded ACP FISH II project. To date all preliminary consultations with the relevant stakeholders had been held, after which an updated plan was drafted by the project consultant. Policies and objectives within the updated plan were constructed based on results from consultations and consensus with regional fishermen to ensure relevance. This plan will be revised and scrutinised by key stakeholders at a validation workshop to be held on the 13th June 2013. After this exercise the document was expected to be finalised by the project team for approval by the Government of Guyana and subsequent implementation.

Legal and institutional framework

The Fisheries Department was also in the process of ensuring that all trawling vessels were equipped with Vessel Monitoring Systems and By-catch Reduction Devices. These devices will serve to improve Monitoring, Control and Surveillance capability, reduce IUU as well as enforce area closures that were proposed.

Another issue which was currently being addressed was the demarcating of an inner line to be obliged by fishing both industrial and artisanal vessels, with the aim of reducing gear conflicts, protecting habitat and generally enhancing management. Guyana was currently working on their legislation to support this initiative which was expected to be amended as a new licensing requirement for trawling vessels in 2014. Harvest control rules were expected to be generated along with other general management recommendations succeeding this stock assessment exercise.

Suriname

Fisheries Management Plan

The new Fisheries Management Plan (FMP) was drafted in close consultation with the fishing industry. A large number of policies contained in the plan are based on the experience of the people who are actually engaged in fishing practices. The plan aims at applying the ecosystem approach and therefore focuses on minimizing the effects of fishing on ecosystems.

Some important general measures to keep the fishing pressure within sustainable limits include a limit on the number of licences per fishing category, technical measures regarding fishing practices and zoning.

The determination of fishing zones was important for managing specific fishing gear categories and fish stocks as it enabled better MCS, deterrence of IUU fishing as well as the decrease of conflicts between different fishery methods.

The FMP included policy measures that target specific fisheries, but also provided for the development of separate management plans for the different segments of fishery. The plan also takes into account the internationally accepted principles for responsible fisheries, which Suriname subscribes to. The FMP also sets out means for MCS, national, regional and international cooperation and the procedures for decision making, annual update and evaluation.

Legal and institutional framework

A new fisheries law has been drafted to further improve the regulation of marine and inland fisheries. This law sets out the rules and the responsibilities of different institutions that are involved in the fisheries, including the Ministry of Agriculture, Animal Husbandry and Fisheries, (Department of Fisheries and the Fish Inspection Institute) The Ministry of Defense (The Navy), The Maritime Police and the Council for Sea Fisheries. The law states that the Minister, after hearing the Council, will publish the General Conditions under which the licenses will be granted. These terms and conditions include the allowable catch, means and trapping methods, mesh sizes, the seasons and the areas which may be fished, the minimum sizes of fish to catch, the quotas of the catches allowed, and the method of reporting of catches. The Fish Inspection Act was published in 2000 and enables the Fish Inspection Institute to inspect and take measures to ensure fish quality.

The VMS decree is dated January 30, 2008 and stipulates that every licensee of an eligible vessel is required to have installed a tracking system based on the Argos satellite navigation network system on board.

Available Data for Assessments

Guyana

- Annual catch of seabob 1985-2001 (no size grade information) with 1985 to 1997 from FAO FIGIS database.
- Monthly catch by size grade 2002-2012 received from the four seabob processing companies were considered relatively complete, but not all of the catch data collected had the corresponding effort applied.
- Catch and effort for 2002 to 2012.
- Biological data consisting of random sampling of landings at processing facilities (Pritipaul Singh and Noble House).

Suriname

No stock assessment was conducted for Suriname at this meeting. However, on completion of the Guyana assessment, it was planned to apply the same model to the Suriname fishery data, and to report on this assessment in 2014.

5. Fisheries Statistical and Assessment Analyses Conducted

A new stock assessment model had been prepared inter-sessionally to make use, not only of the catch and effort information, but also size composition data which had not been used previously. The model was random sampling better. However, the primary task was to develop a harvest control rule based on the current assessment with stakeholders, taking full account of the uncertainty.

Table 1: Deliberations of the working group to decide upon the base case and lower and upper credible bounds for the model structure.

Structure/ Assumption	**Decision** introduced at the meeting so that the SGWG participants could discuss the model configuration in order that the stock status could be determined.	Justification	Scenarios
	The Guyana stock assessment model was able to use the following information: • Annual catch before 2002: only total annual landings were available for the period 1985-2001. • Total catch by month, broken down by commercial size grade 2002-2012 • Catch and effort (days at sea) by month for Noble House, broken down by commercial size grade 2002-2012 • Average counts per pound estimated from sampling within commercial size categories for Noble House. • Random sampling of shrimp before processing for size, sex and maturity for Noble House and Pritipaul These data were considered adequate for stock assessment. Although the random sampling time series were very short (sampling started in 2010, but was not complete through all years), the group believes that they provide an important source of information on sex, maturity and gear selectivity. Therefore, it is strongly recommended that such sampling is continued. The sampling may be reduced in the processing plants carrying it out, but should be expanded to other processing plants which have not undertaken it yet. It will be important to continue such sampling in the longer term, but it should be possible to reduce the intensity of sampling to reduce costs. In considering the options for model configuration, a number of decisions were made to define a base case (Table 1). The SGWG believes that the final "base case" assessment represents the best scientific evidence for stock status at this time. The results indicated that the stock was fully exploited, but not overfished relative to appropriate precautionary reference points. Not all parameters could be estimated and in many cases had to be fixed at reasonable values based on information in the scientific literature. It may be these parameters might be estimated in future		

	as data becomes available and the model structure improves. In considering the sensitivity analyses (Table 1), it was found that the resulting estimate of stock status was relatively robust to parameter values chosen. Therefore, the working group endorsed the stock assessment model and agreed that it could be used to develop a harvest control rule. In considering possible scenarios to bracket uncertainty, the working group was unable to make a clear choice. It was suggested that the worst case would be estimated steepness. However, given that the value is unrealistically low, the working group decided to focus development on the base case, ensuring uncertainty was captured in the MCMC simulations. The working group plans to review the MCMC results inter-sessionally, and if it believes that the simulations do not adequately capture uncertainty, further scenarios would be developed. The working group agreed on further work to improve the assessment. This included obtaining catch data from before 2002 and additional exploration of alternative selectivity models to explain the observed trend.		
Sex ratio	The sex ratio will be set at 50:50, and will not be fitted.	There is no known reason why the sex ratio of recruits will be other than 50:50. When fitted, the estimated proportion of females was 0.43. Improvements to the fit were not large, so this parameter was fixed at 0.5.	Estimated proportion female in the recruits
Recruitment Variation	Rsig=0.5	Results were insensitive to reasonable values for the recruitment variation parameter (Rsig). The parameter could not be fitted without a strong penalty function. 0.5 was chosen as a reasonable fixed value, although variation in estimated recruitment deviations suggested a higher figure. Higher values for this parameter (Rsig>1.0) could not be fitted.	Rsig=0.2, 0.5, 0.8
Recruitment	No explicit seasonality was added to the recruitment model.	Although there may be seasonality in	None

Seasonality		recruitment, it is uncertain what shape function should be used or how many recruitments there are each year. The recruitment deviations should show up any seasonal pattern which can be investigated at a later date.	
M	M=0.18	Estimates from longevity reported in scientific literature depend on growth estimates. In general, they imply low natural mortality which is not consistent with the catch data (i.e. poor fit if M<0.1 $month^{-1}$). Estimates in the model are too high to be credible (M>0.6 $month^{-1}$). Available direct estimates of natural mortality suggest 0.1-0.2 $month^{-1}$. Estimates from Soomai *et al*. (2012) were used.	Estimates from longevity reported in scientific literature depend on growth estimates. In general, they imply low natural mortality which is not consistent with the catch data (i.e. poor fit if M<0.1 $month^{-1}$). Estimates in the model are too high to be credible (M>0.6 $month^{-1}$). Available direct estimates of natural mortality suggest 0.1-0.2 $month^{-1}$. Estimates from Soomai *et al*. (2012) were used.
K, t0	Females: K=0.216; t0=0 Males: K=0.246; t0=0	K cannot be fitted. The estimate from the fit (K>0.6 $month^{-1}$) is too large to be biologically realistic. Indications suggest males grow faster than females. All published estimates found are less than 0.3 $month^{-1}$. Higher estimates fitted the data better. Ribeiro De Campos, *et al*. (2011) were used as the higher estimates available.	K=0.08, 0.15, 0.2, 0.3, 0.22/0.25
SSB survival after 12 months	No extra mortality after 12 months.	It was considered possible that survival after 12 months or after spawning could be low. There is no evidence in the data for this, however, so a standard plus-group for 12 month olds is applied.	None
SSB delay before spawning	Use 2 month delay, as opposed to 1 month	There is a very small improvement in log-likelihood for 2 months as opposed to 1 or 3, so for the current model it makes very little difference. 4-8 week larval stage would seem reasonable for this species.	Delays of 1, 2, 3, 4
Domed	A logistic curve was used.	The “domed shaped” selectivity will	Estimated domed parameter

selectivity		make the perception of the stock much more positive. There is no evidence that a domed-shaped selectivity is appropriate, although it does fit the data better. The logistic should be more precautionary.	
$S_{50\%}$ Sex selectivity	The same selectivity curve was used for both male and female.	There was no significant difference in selectivity between males and females when selectivity was based on length.	Estimated separate $S_{50\%}$ by sex
SR Steepness (h)	h=0.8	Estimated steepness very low (h=0.314), but gave the worst case for stock status. There is no evidence of a stock recruit relationship (possible obscured by seasonality). It was concluded that steepness cannot be estimated and the default h=0.8 was considered relatively precautionary for this stock.	h=0.9, 0.8, 0.7, 0.6, Estimated

6. Other Tasks Conducted.

The group composed a list of proposed additions to the current agenda to be used at the succeeding meeting in 2014. These are as follows:

- General review of the Fisheries Management Plans.
- Evaluate, and suggest adjustments if necessary, to the Harvest Control Rules for the Seabob fishery in Guyana.
- Stock assessment of a few selected groundfish species, based on data availability and importance of species.

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

Reports on the assessments of the seabob (*Xiphopenaeus kroyeri*) fisheries of Guyana and Suriname will be completed inter-sessionally, but reviewed and adopted at the next scientific meeting.

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

- The SGWG recommends basic training in data manipulation and management, starting with the use of Excel items such as: look up functions, data query tools, pivot tables, and then moving on to Visual Basic programming, database management and introduction to SQL or Microsoft Query. This training should be targeted at officers in the region involved in stock assessment work and who attend the CRFM Scientific Meetings. Such training would facilitate improved data preparation and analysis during the inter-sessional period.

- Book and/or training manual for the instruction on the use of R.

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

9. Inter-sessional Work Plan

General

- The SGWG recommends greater interaction among its members during the inter-sessional period to facilitate the work of the group. This can be done with little cost via electronic mail, Skype, net meeting site or video conferencing. In this regard we appreciate the organisation and facilitation by the CRFM and Dr. Paul Medley of the inter-sessional meeting which was held in Guyana in February.

- Training on data collection and analytical methods should be undertaken by members of the local working groups and other technical fisheries staff as described under section 8. Also the process applied to the Seabob Fishery can be adopted and integrated into the management of other species where applicable.

Guyana & Suriname

- Complete the MCMC simulations for the new model and develop projections for HCR development.
- Development of HCR for Guyana
- Improve the model selectivity in the stock assessment
- Complete stock assessment for Suriname with the new model

- Extend time series of seabob catches for Guyana back from 2002
- Collection and preparation of data in both Suriname and Guyana on the red snapper (Deep Slope Red Snapper Fisheries), the sea trout, the grey snapper, butterfish and the bangamary for future assessment.
- Develop a standardized data collection sheet for seabob and other species to be assessed.
  The working group will assist in devising standard input data base formatting (soft copy) for companies to use. This is aimed at simplifying analyses of entered and submitted data and also the stock assessment process. Although this data entry sheet is expected to be simple and easy to use, it is recommended that a consultation and possibly training on its use should be conducted before it is actually implemented.
- A standardized computer entry data sheet database should be developed for the catch and effort and size composition and other relevant data including by-catch for both countries. Countries also require databases to manage the increased amounts of these data they will receive from the processors and other sources.

Research plan

- Develop and adjust an observers program for Guyana and Suriname to look at sour discards and review current observer data to see level of discard.

- Develop research plans for Guyana and Suriname to look at size composition of the artisanal catch.

- Mapping of fishing grounds in relation to f habitat mapping study is being done by the PhD student for Suriname. Given the vulnerability of the elasmabranchs taken as bycatch in the seabob fishery (Longnose stingray *Dasyatis guttata* and the smooth butterfly ray *Gymnura micrura*), it is recommended that data are gathered on these species adequate for a risk assessment. This would include, but not be limited to, total catch (estimated) and the catch and effort over at least one year, size and sex composition, and data from the tagging program.

Recommendations

- It is recommended that the final estimate of the Suriname survey which was conducted in 2012 should be formally submitted to the SGWG for inclusion in the stock assessment as soon as possible. This will allow for testing of its significance in terms of the determination of stock status and scientific advice.

- Further improvement of the co-operation and communication between the fisheries departments of Guyana and Suriname, since they have the same types of fisheries. This would be especially profitable for joint and comparative analyses of the seabob and other stocks, and joint review and update of the assessments conducted for Suriname and Guyana at the scientific meetings, including sensitivity analyses and projections.

- The SGWG greatly appreciates the efforts that were made with the random sampling by Noble House and Pritipaul in Guyana and Heiploeg in Suriname. This information was critical in completing the recent assessment. The SGWG would like to see the other companies follow this good example.

- There has been progress towards better management and data collection in Guyana, since a seabob working group was established in 2012. The SGWG recommend further efforts to improve the system for Guyana fisheries department to have access to data from the processing facilities.

10. General Recommendations

- A comparative study between the Suriname and Guyana seabob fishery and management regimes to allow the fishery management to adapt and to improve.

- For Guyana, prepare data for a re-evaluation of a potential closed season 1 – 2 months. This was conducted in 2007, but more and better data has become available since then.

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

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

- Participation by the fishing industry in Guyana provided technical support for the working group. This should be continued since the participant provided the industry perspective.

11. Review and Adoption of Working Group Report.

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

12. Adjournment.

The meeting of the SGWG adjourned at 5.30 pm on 13 June 2013.

B. FISHERY REPORTS

1.0 GUYANA SEABOB STOCK ASSESSMENT

Paul A Medley paulahmedley@yahoo.co.uk

1. SUMMARY

1.1 Stock Status

Currently, the stock is close to a default precautionary target level and can be considered "fully exploited" (Figure 1). The assessment suggests that the stock has recovered somewhat from a state where it might have been considered over-exploited, that is the stock was at greater risk of recruitment overfishing.

Based on the current assessment, fishing mortality has only rarely exceeded fishing mortality at maximum sustainable yield (MSY), so overfishing has rarely taken place (Figure 2). However, F_{MSY} is poorly estimated as it depends on a parameter in the stock-recruitment relationship, which had to be assumed. Therefore, it should represent an upper limit until more information on an appropriate fishing mortality can be obtained. An appropriate MSY based reference point for fishing mortality still needs to be determined.

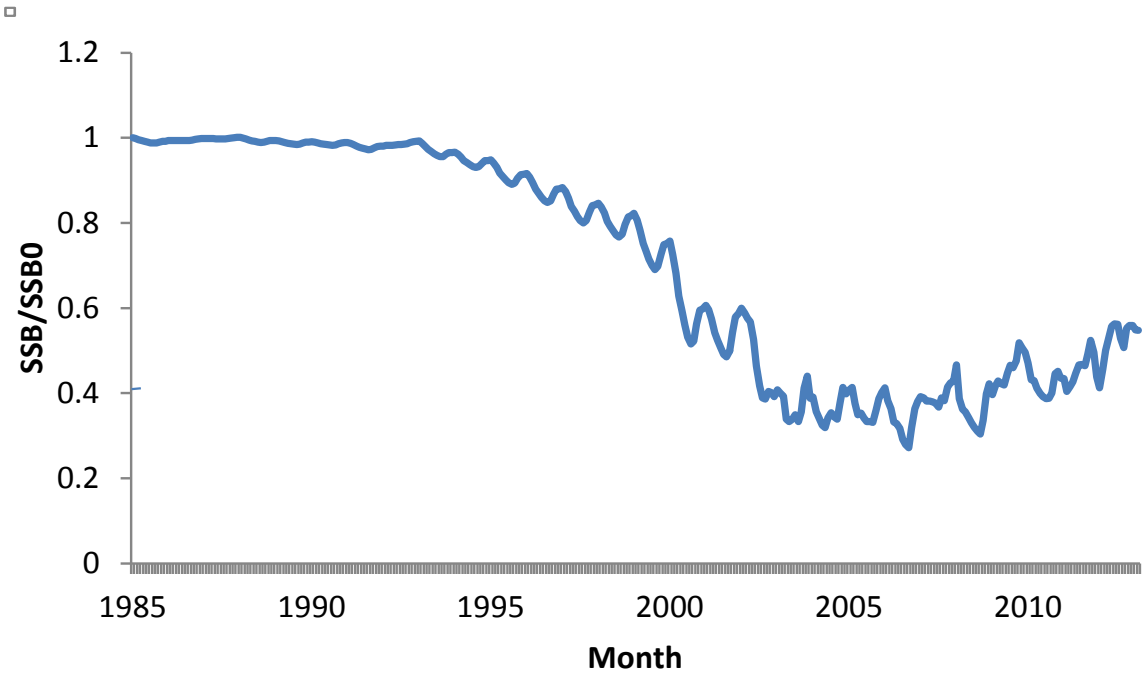


Figure 1: Spawning stock biomass by month estimated from the stock assessment model. The horizontal line is a default provisional target reference point (40% SSB_0). Spawning stock biomass at or above this line would suggest that the stock is not overfished.

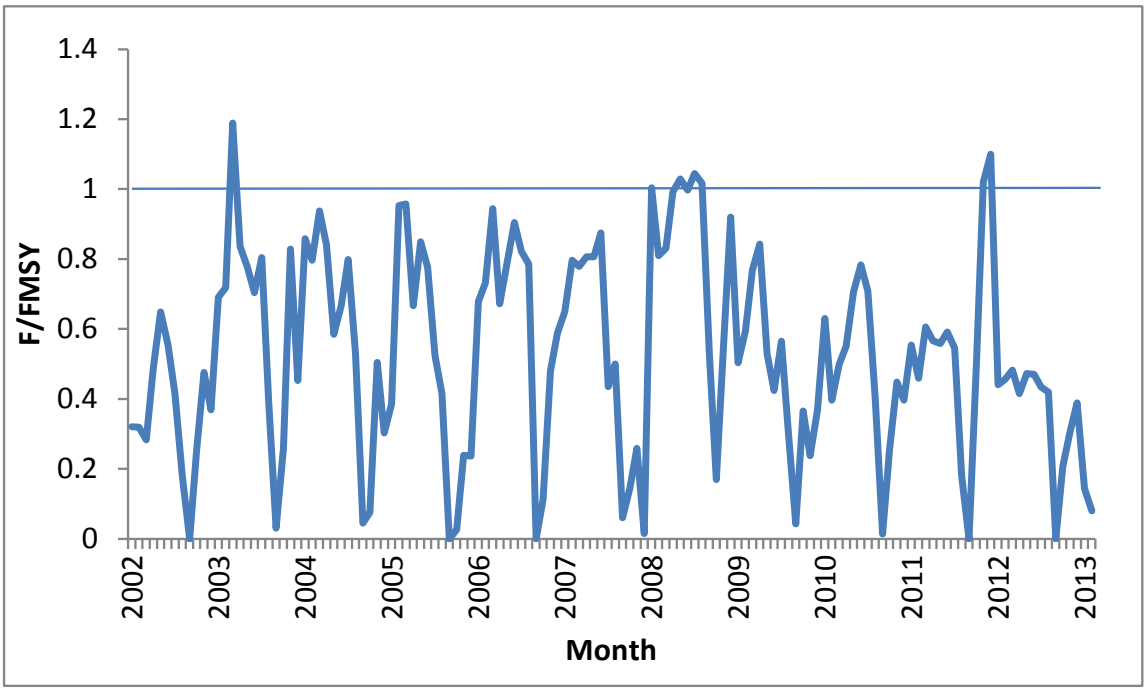


Figure 2: Fishing mortality as a proportion of the estimated fishing mortality at MSY.

2. DATA PREPARATION

2.1 Commercial Size Category

The processing facilities routinely collect average count data from the commercial categories. This should monitor the average size within each category. This information should be useful within the stock assessment model to fit to changes in mean size within the category if such changes are significant. One processing facility provided average counts recorded by the quality control staff.

The change of shrimp size in the population and changes in selectivity will cause not only changes in the landings recorded as change in the amounts of each commercial categories, but may also change size within categories over time. A simple analysis of variance estimating the average count data dependent on the Year term as a factor suggested that Year has a significant effect on within-category size (Table 1). This would indicate that average count data should be included in some form in the stock assessment model.

Table 1: Analysis of variance for average counts in commercial category for a standard log-linear model.

	Residual degrees of freedom	Residual Deviance	Degrees of freedom	Deviance	Pr(>Chi)
AvgCount ~ Category	105404	99057335			
AvgCount ~ Category + Year	105394	97897240	10	1160095	< 2.2e-16
AvgCount ~ Category * Year	105312	90699966	82	7197274	< 2.2e-16

Average count data can also be used to interpret commercial size category in terms of the size composition. In using commercial size categories, it will be necessary to allocate the estimated catch to each category based on individual tail weight. Ostensibly, each category has an upper and lower count which can be used to define the lower and upper bound on the tail weight to be allocated to that size category. This seems reasonable for all size categories to the 150-200 category (Figure 3, Figure 4). However, it appears that some categories may be combined as they contain very similar sized shrimp. Note that combining categories only loses relative size information, which, if not significantly different, should not be a problem for the model. There is a strong indication that 100-200 and 200-300 categories can be combined, as could all categories 250-350 to 300-500 BK. The broken category "BK" appears smaller, but this might be because they are in pieces, and these could also be combined into a single "small" category.

It is important that the boundaries in allocating the shrimp to their size category are as close to reality as possible. Incorrect boundaries will produce bias in the resulting growth parameters and assessment. Based on the available count and tail weight information (Figure 3, Figure 4, Table 2), each category was allocated a tail weight range (Table 3). All catches within the same size range were combined and these size ranges were then used to reference the estimated catch in each size category in the model. These size allocations may require further adjustment based on model diagnostics (see Section 4).

Table 2: Mean and standard deviations for the average counts per pound for the named categories from Heiploeg Suriname and Noble House Seafoods (Guyana) processors.

	Guyana		Suriname	
Name	Count/lb	Std. Dev.	Count/lb	Std. Dev.
70-90	78.14	4.02	79.87	5.75
90-110	97.05	4.57	100.80	3.40
110-130	120.84	4.65	121.66	6.05
130-150	140.92	2.90	141.34	5.40
150-200	182.43	4.75	179.96	6.77
100-200	285.99	7.84	252.51	21.26
200-300	292.59	57.27	309.74	62.83
250-350	342.13	18.73		
300-400	344.11	8.86	356.40	10.77
300-500	382.28	30.21	359.81	30.12
300-500BK			345.36	19.64
BK	585.35	17.92	208.78	158.54

Table 3: Commercial category allocation and size definitions used in the stock assessment model. ID refers to the identification number for the category, so all categories with the same ID are combined. See section 4 for the interpretation of these categories.

Categories		Limits from Commercial Count Names		Limits assumed from average counts		Peeled Tail Weights (g)	
Name	ID	Min	Max	Min	Max	Min	Max
41/60	1	40	60	0	90	5.04	10.00
70/90	1	70	90	0	90	5.04	10.00
BK41/60	1	40	60	0	90	5.04	10.00
BK51/60	1	50	60	0	90	5.04	10.00
116BK	2	110	1000	0	1000	0.00	10.00
2/3 J	2			0	1000	0.00	10.00
8-3BK	2			0	1000	0.00	10.00
BK	2			0	1000	0.00	10.00
BK1 LB	2			0	1000	0.00	10.00
BK1LB	2			0	1000	0.00	10.00
BK2/3J	2			0	1000	0.00	10.00
L/R	2			0	1000	0.00	10.00
LARGEPCS	2			0	1000	0.00	10.00
LP	2			0	1000	0.00	10.00
MM	2			0	1000	0.00	10.00
Other	2			0	1000	0.00	10.00
PCS	2			0	1000	0.00	10.00
S/W	2			0	1000	0.00	10.00
S/WATG	2			0	1000	0.00	10.00
SM	2			0	1000	0.00	10.00
SOUR	2			0	1000	0.00	10.00
SP	2			0	1000	0.00	10.00
WB	2			0	1000	0.00	10.00
90/100	3	90	100	90	100	4.54	5.04
90/110	3	90	110	90	100	4.54	5.04
100/120	4	100	120	100	130	3.49	4.54
100/130	4	100	130	100	130	3.49	4.54
100/150	5	100	150	100	150	3.02	4.54
110/150	5	110	150	110	150	3.02	4.12
110/130	6	110	130	110	130	3.49	4.12
130/150	7	130	150	130	150	3.02	3.49
130/150−	7	130	150	130	150	3.02	3.49
150/200	8	150	200	150	200	2.27	3.02
120/200	9	120	200	150	300	1.51	3.02
150/OP	9	150	1000	150	300	1.51	3.02
180/200	9	180	200	150	300	1.51	3.02
180/210	9	180	210	150	300	1.51	3.02
OVER 150	9	150	1000	150	300	1.51	3.02
100/200	10	100	200	200	400	1.13	2.27
100/200BK	10	100	200	200	400	1.13	2.27
130/200	10	130	200	200	400	1.13	2.27
200/300	10	200	300	200	400	1.13	2.27
200/300BK	10	200	300	200	400	1.13	2.27
900	11	900	1000	300	1000	0.00	1.51
250/350	11	250	350	300	1000	0.00	1.51
300/350	11	300	350	300	1000	0.00	1.51

300/400	11	300	400	300	1000	0.00	1.51
300/500	11	300	500	300	1000	0.00	1.51
300/900	11	300	900	300	1000	0.00	1.51
400/600	11	400	600	300	1000	0.00	1.51
BK300/900	11	300	900	300	1000	0.00	1.51
OVER 400	11	400	1000	300	1000	0.00	1.51
OVER 500	11	500	1000	300	1000	0.00	1.51
OVER 900	11	900	1000	300	1000	0.00	1.51

2.2 Catch and Effort

Catch and effort data were obtained from spreadsheet forms used by Noble House Seafoods and Heiploeg Suriname to record landings and processing operations. The spreadsheets are used for internal monitoring of their business. Data were extracted from these forms and held in a database for further manipulation. Using the database, it was possible to match trip information (trip dates of departure and return) with processed landings weight, fuel used and commercial size grades produced.

The landed catch is recorded as pounds of processed shrimp, representing about 43% of the live weight. Effort might be measured in two ways: as days-at-sea and as fuel used. Basing effort on fuel use has significant advantages in costs and real effort (trawl time), but may vary from vessel to vessel with engine size and other characteristics, and will not be available for all trips.

Plots of effort against catch reveal an asymptotic relationship with catch for both measures of effort (Figure 5). The variation in catch at higher levels of effort may be related to abundance, but could also be explained by other factors. Although ideally any standardisation to account for these factors would be included in the stock assessment model, this would become too complex at this stage, although it might be considered for later development. Instead, standardisation was considered externally using generalized linear models.

The aim of standardisation is to adjust abundance indices to account for variation in the index that might be attributed to fishing power (catchability) rather than changes in abundance, which apart from reducing noise of the index potentially removes bias. In this case, the only covariate data available with the catch and effort is the vessel name. The aim of the standardization is not to affect any trends in the index which could be related to abundance, since this might introduce bias as well as eliminate it. For example, standardization based on vessel name should remove noise related to fishing power without affecting abundance trends as long as vessels have landings over significant periods of the time series.

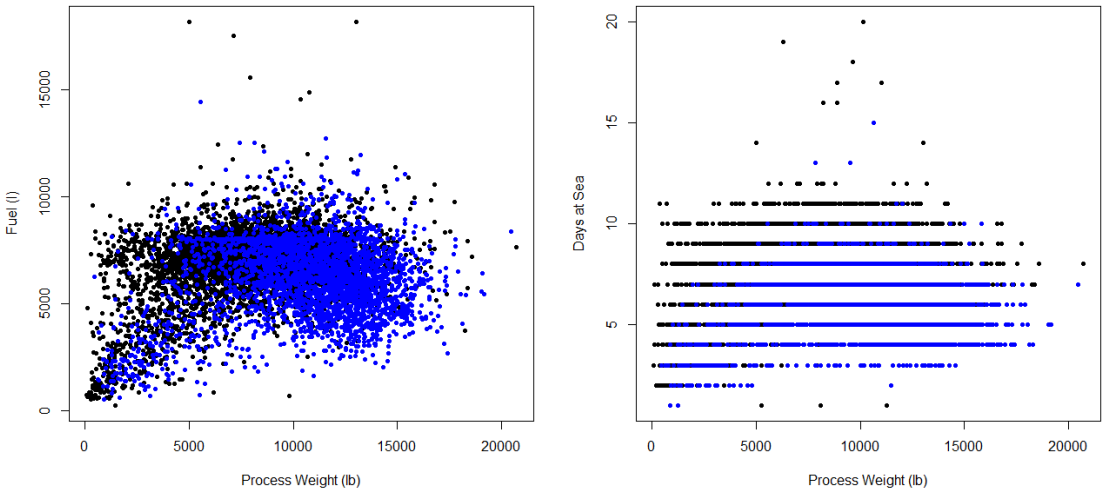


Figure 5: Catch (lb) plotted against the two raw measures of effort: fuel used in litres and days-at-sea for Guyana (black) and Suriname (blue).

A log-linear model was used to estimate the catch on each trip with the available data:

$$C_i = e^{P_i+V_i+M_i+ld_i+lf_i+P_i:M_i} \quad 1)$$

where C_i is the catch of vessel V_i in year/month M_i using (log) days-at-sea ld_i and (log) fuel lf_i landed at processing facility (country) P_i. Parameters fitted to explain month and month: country interaction should capture any trends in biomass abundance and is therefore required in the base model.

To test which effort variables should be included in the measure of effort and whether the vessel explained significant differences in catch rate, a simple analysis of variance was carried out comparing the three main models (Table 4). All parameters were highly significant and therefore the full model with all main terms should be used for any standardisation. This includes an argument for the inclusion of both measures of effort (days-at-sea and fuel).

To understand seasonal patterns better, a model with separate year and month terms was fitted and alternative models tested (Table 5). There was a clear seasonality which showed a significant difference between countries, but the general pattern of the seasonality was very similar (Figure 6). It should be noted that whereas the time series covers 2001-2011 for Guyana, data only covered 2001-2007 for Suriname, so any differences may reduce with more data. Annual changes in catch rates show weak annual trends for both countries, with Guyana increasing slightly and Suriname showing a small decrease (Figure 7).

The seasonal peak in catch rate coincides with the period when most large, mature females are caught and it is likely that there is a peak in biomass at this time. The implication is that the standardised catch rates are likely to be tracking biomass.

The results also indicate that the monthly change is also significant (Table 5), which suggests that changes in abundance are unlikely to follow a simple seasonal pattern each year. Because some recruitment is likely to be occurring throughout the year, the seasonal pattern has only a limited capability in explaining abundance changes. This would justify including full interaction terms for year and month in any standardisation model.

There is clear evidence of diminishing returns of trip length when days-at-sea are fitted as a factor rather than covariate (Figure 8). While this might include issues such as increased travel time, weather and so on, it might also include increased time taken to catch seabob due to lower abundance. The data also suggested that longer trips over 12 days resulted in greater variation in catches, partly because there are fewer such trips, but also because the cause for the length of such trips are dominated by factors other than stock size.

Table 4: Analysis of variance for the possible catch-effort standardisation models. P*M indicates full interaction terms for country and month factors, making it the base model.

	Residual degrees of freedom	Residual Deviance	Degrees of freedom	Deviance	Pr(>Chi)
C ~ P * M	8937	9235804			
C ~ P * M + ld	8936	7860938	1	1374867	< 2.2e-16
C ~ P * M + ld + lf	8935	7419680	1	441258	< 2.2e-16
C ~ P * M + ld + lf + V	8883	6989686	52	429994	< 2.2e-16

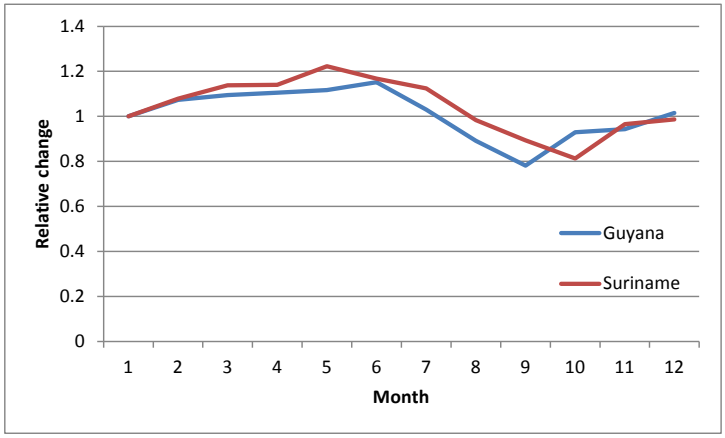


Figure 6: The relative change in seasonal catch rates after accounting for vessel, effort and annual trends. Guyana and Suriname have significantly different catch rate changes but follow very similar patterns.

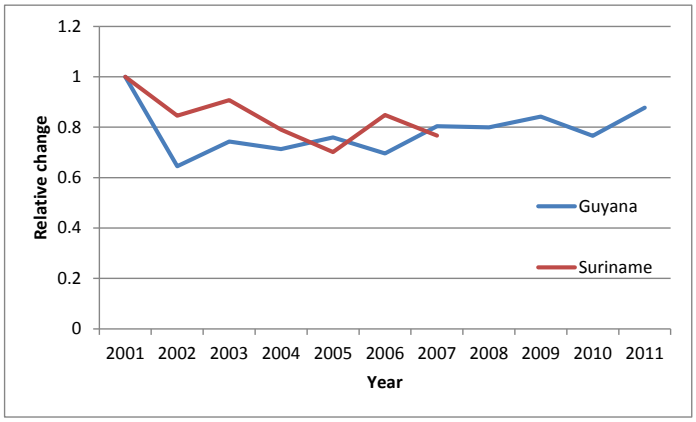


Figure 7: Relative annual change in catch rates.

Table 5: The analysis of variance for time series terms consisting of average season across countries (M), different seasonal trends across countries (P*M) and inconsistent seasonal changes across the whole time series (Y*M).

Model	Residual degrees of freedom	Residual Deviance	Degrees of freedom	Deviance	Pr(>Chi)
C ~ P*Y + M + lf + ld + V	9055	8532917			
C ~ P*Y + P*M + lf + ld + V	9044	8473048	11	59869	1.11E-10
C ~ P*Y + P*M +Y*M + lf + ld + V	8944	7330849	100	1142199	< 2.2e-16

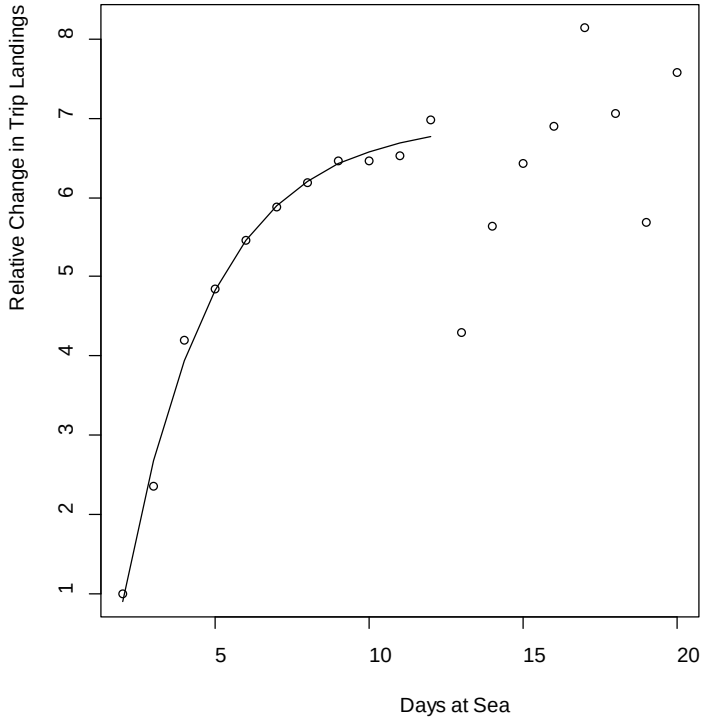


Figure 8: Relative change in catch for days-at-sea fitted as a factor in the standardisation model.

The asymptotic effect of trip length (Figure 8) can be described as:

$$S = a\left(1 - e^{-b(f+c)}\right)$$

with parameters:

a	b	c
6.955081	0.348347	-1.60215

Catch effort data were retained from only two processors (BEV and NHS). PSI and GQS catch and effort data were rejected as CPUE seemed to be on a different scale and inconsistent (Table 6). Processors GQS and PSI report much higher landings per day than NHS and BEV. NHS CPUE is based on processed weight from internal production reports, suggesting BEV is reported in much the same way. GQS and PSI is likely reported as whole weight, so processed landings are multiplied by some constant. Data from these processors needs to be investigated to ensure that they are consistent with other reported landings.

Fishing effort was calculated on a per-trip basis. NHS data was derived from internal production reports. Other processor data was derived from reports submitted to the Fisheries Department.

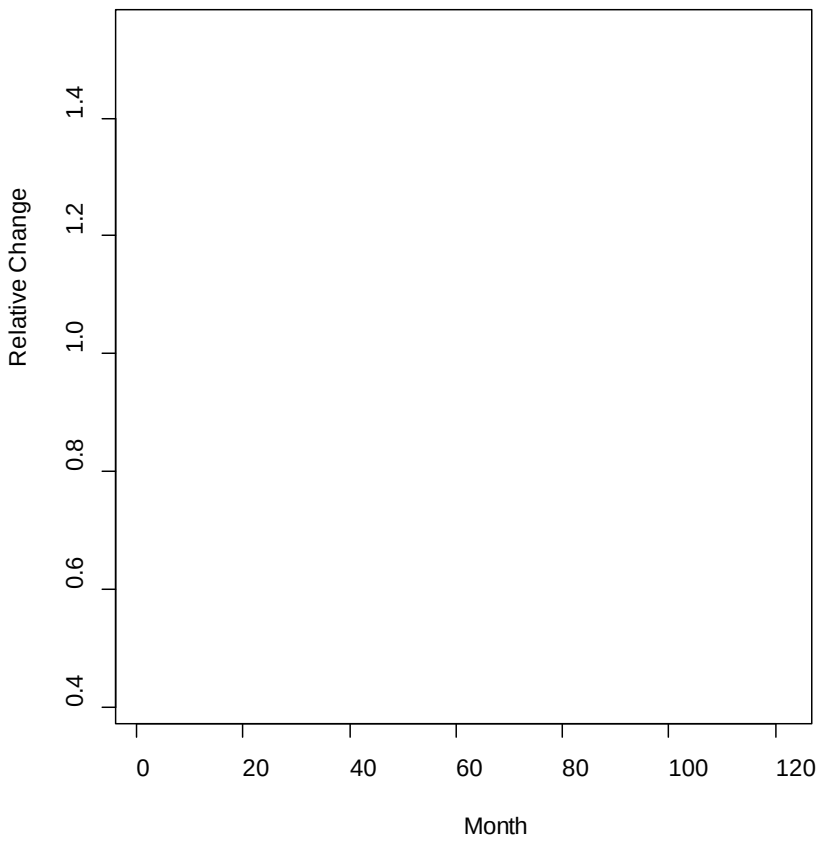
Categories were not entirely consistent within each month. In particular, the largest category was rarely 70-90, so the next category (90-100, 90-110, 100-150, etc.) would most likely include all larger shrimp. This could be taken into account where no 70-90 category was recorded within a month, but otherwise was not directly addressed, although effort was correctly adjusted for the 70-90 category. It could be addressed by grouping trips into the set of size categories they report within each month. However, ignoring this difference should only lead to a small decrease in precision.

Table 6: Reported average CPUE in kg per standardised day-at-sea by year and processor.

Year	BEV	GQS	NHS	PSI	Total
2001			43.25		43.25
2002		163.43	32.60		60.79
2003			41.61		41.61
2004			38.56		38.56
2005			52.02		52.02
2006			35.88	159.43	36.24
2007		90.76	41.61	217.55	74.42
2008			41.59	244.09	42.27
2009	48.29	315.05	43.97	248.72	63.55
2010	49.55		38.97	213.47	59.82
2011	58.60		43.09		46.71
2012	61.18				61.18
Total	53.24	162.41	41.80	224.12	52.40

For standardisation, various options from the analyses above were possible. An adjustment can be made on the basis of the average catch rate of each vessel to the effort measure. Furthermore, a nonlinear adjustment to fuel and days-at-sea effort measures was considered in developing a better measure of effort. In applying an adjustment specific to vessel effects, the index would remain unchanged with respect to average monthly change. However, various options would reduce the data available, while contributing little to the precision of the index.

Four possible indices were considered: a full GLM standardised CPUE model (Table 5), nominal catch per day-at-sea, nominal catch per litre of fuel, and catch per day at sea adjusted for trip length using the asymptotic catch model (Figure 8). All indices follow the same trend (Figure 9), but the standardised indices and indices based on fuel generally were more closely related than the ones based on days at sea.


Relative Change
0.4
0.6
0.8
1.0
1.2
1.4
0
20
40
60
80
100
120
Month

Variations in selectivity among vessels were only cursorily considered. All vessels ostensibly apply the same gear, so consistent variation in shrimp size could only be the result of fishing practice (fishing location, time of fishing, discarding etc.). While there is significant variation in the landed size among vessels (Figue 10), the reason for this is unclear. Many vessels have reported very few trips, so whether this is due to attributes of the vessel rather than variations in fishing time or location is unclear. This would be worth further investigation, but more and better data would be required from individual vessel operations before a full understanding might be obtained.

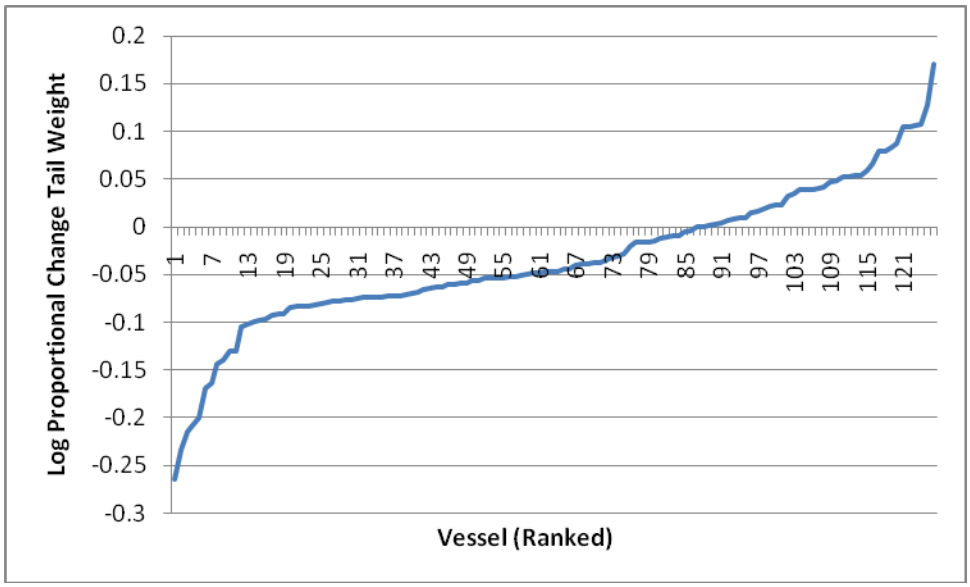


Figure 10: Variation in mean tail weight across all vessels.

2.3 Maturity

There is now a considerable data set linking female size (tail weight in grams) to maturity (presence of a "green vein") in females. This allows the maturity ogive to be estimated, which can be used to estimate spawning stock biomass within the stock assessment model. Because these data are the only data relevant to estimating the maturity ogive, this can be done separately outside the main assessment. In this analysis, a fixed ogive is estimated. Since the status reference points will be based on the ratio of current SSB to unexploited SSB, the final results should be robust to errors associated with these estimates, and therefore errors are not carried forward into the main assessment, but a fixed ogive is used.

Tail length was a much better predictor of maturity than tail weight due to the shape of the curve (Table 7). Therefore tail weight, which was part of the stock assessment model, was converted to length within the logistic model.

Maturity may also change over time, by season for example. The available time series was short, and a clear seasonality was not obvious in the data. However, there was a significant change in the proportion of mature females over time (Table 8), which appeared to follow no time-dependent pattern, but varied in the catches from month to month (Figure 11). The time variation in maturity suggested a random effects model was appropriate (Figure 12) to account for these changes. However, random effects had very little influence on the final maturity model (Figure 13). The final model was used to estimate the expected mature proportion by tail weight (Table 9, Figure 14).

Table 7: Analysis of variance comparison between a model explaining maturity based on tail weight and one based on tail length.

	Residual Degrees of freedom	Residual Deviance	Degrees of freedom	Deviance
Intercept	1964	38207		
Tail Weight	1963	8487	1	29720.7
Tail Length	1963	7155	0	1331.7

Table 8: Analysis of variance comparison between time series factors on maturity.

	Residual Degrees of freedom	Residual Deviance	Degrees of freedom	Deviance	Mean Deviance
Tail Length	1963	7155.1			
+Year.Month	1938	3987.9	25	3167.2	126.688
*Year.Month	1913	3629.5	25	358.4	14.336

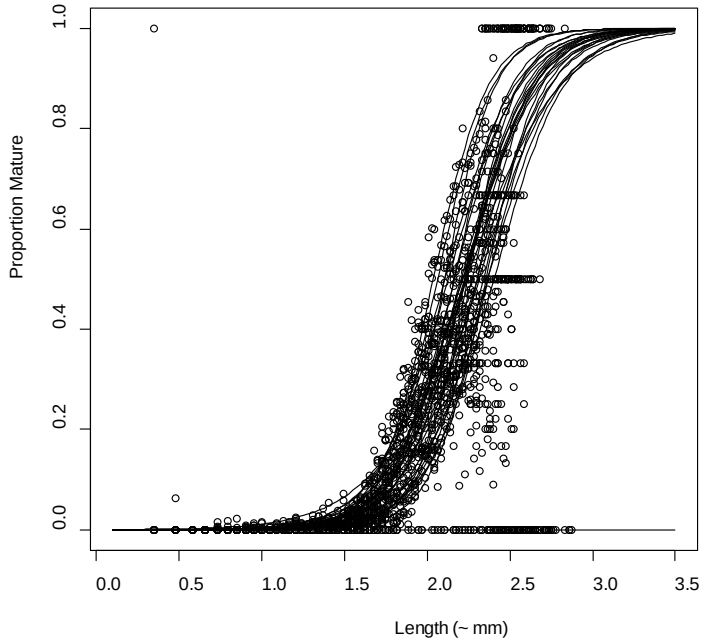


Figure 11: Different maturity ogives (solid lines) for year.month showing some variation in the ogive between months with the observed proportion mature (dots).

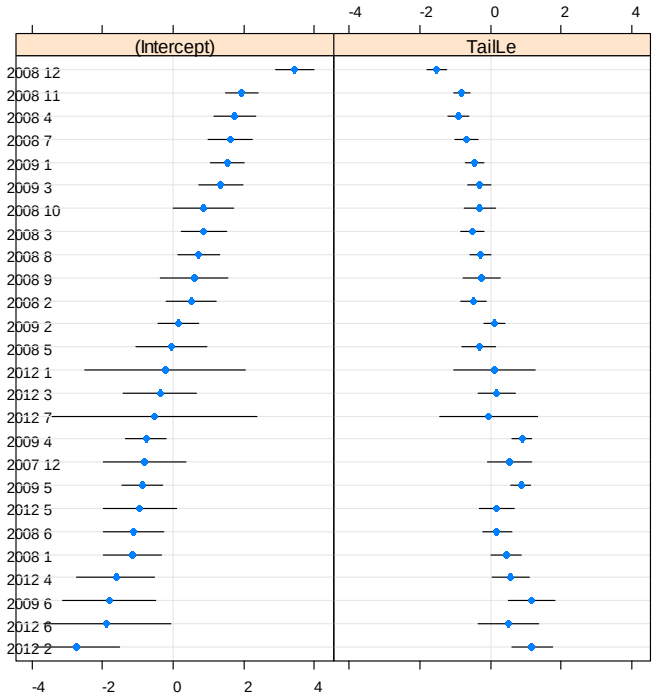
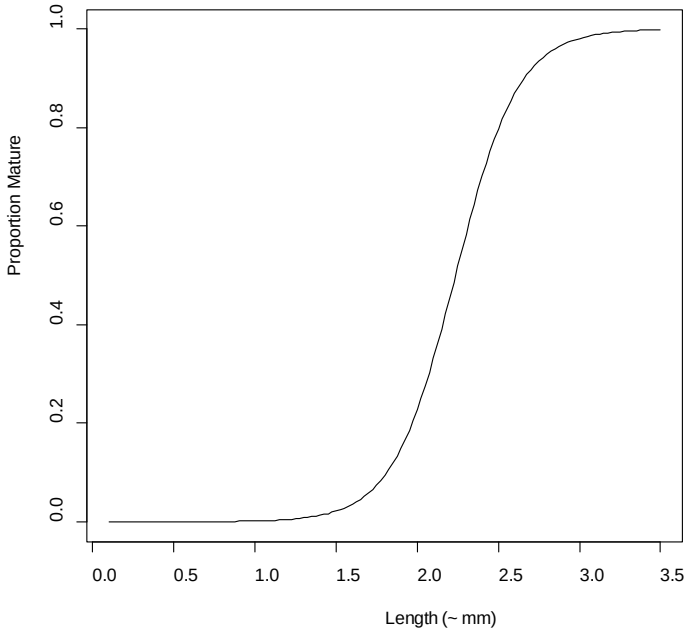


Figure 12: Random effects on the intercept and tail length slope. The blue dots are the conditional modes with error bars for each month.



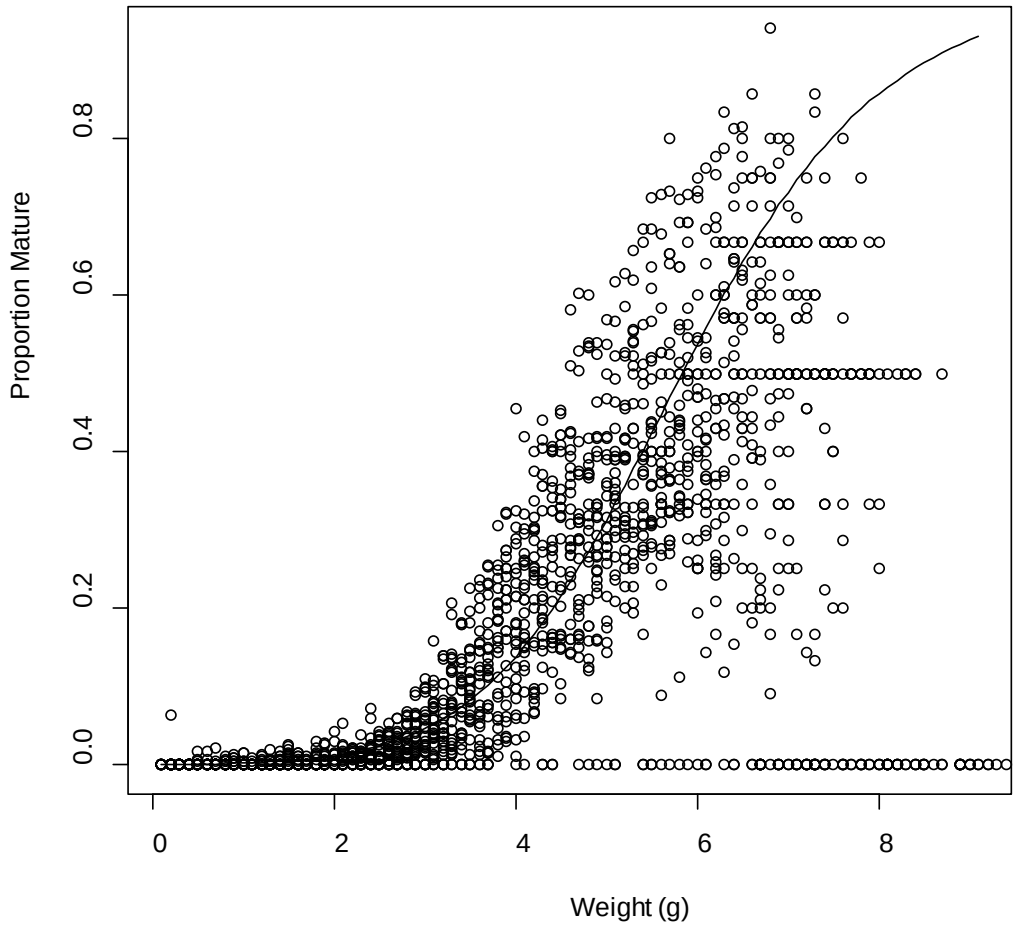


Figure 14: Final ogive estimated from the mixed effects model used in the stock assessment.

Table 9: Logistic model fitted to the proportion mature dependent on tail weight after accounting for random effects.

	Estimate	Std. Error	z value	Pr(>|z|)
Intercept	-11.5937	0.3224	-35.96	<2e-16
Slope	5.1863	0.1516	34.21	<2e-16

$$M_p = \frac{1}{1 + exp\left(-Intercept - Slope\left(TailWt^{1/2.19276}\right)\right)}$$

Tail Weight (g)	Proportion Mature	Tail Weight (g)	Proportion Mature
0.1	5.66267E-05	4.7	0.251723231
0.3	0.000184316	4.9	0.291542624
0.5	0.000404286	5.1	0.333857028
0.7	0.000756563	5.3	0.378048224
0.9	0.001291439	5.5	0.423404858
1.1	0.002072341	5.7	0.469167776
1.3	0.003178355	5.9	0.514579832
1.5	0.004706915	6.1	0.558933439
1.7	0.006776598	6.3	0.601609862
1.9	0.009529931	6.5	0.642106256
2.1	0.013135987	6.7	0.680048978
2.3	0.017792455	6.9	0.715194071
2.5	0.023726779	7.1	0.747417507
2.7	0.031195785	7.3	0.776698581
2.9	0.040483112	7.5	0.803099827
3.1	0.051893654	7.7	0.826746288
3.3	0.065744206	7.9	0.847806165
3.5	0.082349609	8.1	0.866474078
3.7	0.102004049	8.3	0.882957442
3.9	0.124957739	8.5	0.897466006
4.1	0.15139014	8.7	0.910204282
4.3	0.181381927	8.9	0.92136641
4.5	0.214889078	9.1	0.931132996

2.4 Tail Weight: Random Samples

The random samples needed to be converted from unpeeled tail weight to processed tail weight to be used in the assessment. The tail weights were multiplied by 0.78 to adjust for peeling based on morphometric data collected in 2007 (CRFM 2009, Table 5 p.115). Unpeeled tails are measured on electronic scales to within 0.01 of a gram. Within the database, these are held as whole numbers (integers) and compiled into 0.2g class frequencies.

2.5 Total Catch

Total landings are reported to governments by each processor. Information reported has not always been consistent, but has improved over the years. There are initiatives to improve data reporting in Guyana so that it is more timely and accurate.

Monthly landings were available from all processors back to January 2002. Before this, monthly data were not consistently available, but annual landings were reported. Landings are reported as total tail weight in pounds by commercial size categories. Annual landings are available as gross weight to the start of the fishery. Discards are assumed to be zero.

3. POPULATION MODEL

3.1 Overview

The model used in this assessment was a statistical catch-at-age model (Quinn and Deriso 1999), implemented with the AD Model Builder software (Fournier *et al*. 2012). In essence, a statistical catch-at-age model simulates population dynamics in time including biological and fishing processes. Quantities to be estimated are systematically varied until characteristics of the simulated populations match available data on the real population. Statistical catch-at-age models share many attributes with ADAPT-style tuned and untuned VPAs.

The model is based on a standard forward-projection design, the same as that used in standard stock assessment software such as stock synthesis. The model used here is at an early stage of development, and in a much simpler form than Stock Synthesis III (NOAA Fisheries Stock Assessment Toolbox website: http://nft.nefsc.noaa.gov/), for example. It was necessary to develop a bespoke model to be able to use the available shrimp weight data. Age data are not available. This implementation also offers the opportunity to develop a model suitable for crustacean fisheries in the Caribbean and the data that has been collected in the region. The model can be adapted and maintained locally, incorporating improvements as they can be identified.

Where possible the observations and model are kept distinct. The model is adjusted to fit a sufficient data set. In some cases, exact fits can be obtained because there are enough parameters to allow the model to closely follow the data. This applies to the total catch. For other data, where observation errors are presumed to be significant, the model may not fit the observations closely, and some error is acceptable.

3.2 Monthly Catches

The basic population model time step is one month, which was considered appropriate for this species. Separate models are run for males and females. When monthly catch and size composition data are available, a simple approach can be used to model the population, clearly separating the model and data. For each sex, the numbers at the beginning of each age are calculated based on mortality parameters and standard negative exponential model:

$$N_{a+1\,t+1} = N_{at} e^{-M_t - F_t S_a}$$

where F_t = fishing mortality in month t and S_a = selectivity at age. Growth is estimated on the von Bertalanffy growth function (Equation 4) for the mean, and another parameter for the variation around the mean. Ages are measured in months, with maximum age of 12 months (0-11), after which there is a plus-

group in the default model. An alternative model was also considered where a higher proportion of shrimp die after 12 months, simulating higher mortality after spawning.

Selectivity was modelled as a logistic function based on length. Mid-point values for each weight bin were converted to carapace length for each sex using values obtained from the fitted morphometric model. The resulting selectivity model took the form:

$$S_w = \frac{1}{1+exp\left(-S_{tp}\left((aW)^{1/b}-S_{50\%}\right)\right)} \qquad 2)$$

Where S_w = selectivity for weight bin w, S_{tp} = steepness for the logistic, $S_{50\%}$ = carapace length at 0.50 selectivity, and a and b parameters convert weight to carapace length (Table 10). S_{tp} and $S_{50\%}$ were estimated in the stock assessment.

Table 10: Parameters derived from a morphometric linear model to convert weight to length (see Table 13). This conversion could be done so that each weight bin had a length associated with its mid-point weight.

	Female	Male
a	224.4852	73.14399
b	2.19276	1.798805

3.3 Population Model with Annual Catches

Only annual catches, rather than monthly catches, are available for years 1985-2001. These were divided into months based on the average observed distribution of catches among months for the period 2002-2006. Because only annual data were available, these catches could only be used to help set the initial condition for the full population model and specifically the initial level of depletion. Because the model could not fit an annual fishing mortality to the annual catch data (the Hessian matrix could not be inverted), these catch data were used in an approximation based on Pope (1972).

Observed annual catches were distributed among size categories and months based on a simple linear scheme. The annual catch was distributed among months based on the proportion of catches observed among months where monthly catches are available. The observed catch weight in each month (C_w) is approximately equal to the fishing mortality (F) multiplied by the biomass:

$$C_w \cong F \sum_x \sum_i^A \sum_j^W N_{xi} w_j p_{xij} s_{xj}$$

where the biomass is the population size (N_{xi}) by sex (x) and age (i) multiplied by the proportion of each age in each weight class (p_{xij}), the class weight (w_j) and selectivity (s_{xj}). Therefore, the fishing mortality can be estimated approximately as:

$$F \cong \frac{C_w}{\sum_x \sum_i^A \sum_j^W N_{xi} w_j p_{xij} s_{xj}} \qquad 3)$$

Similarly, the catch in numbers (C_{xna}) at age can be approximately given as:

$$C_{xna} \cong F \sum_j^W N_{xi} p_{xij} s_{xj}$$

and by substituting fishing mortality (F) with equation (3) gives:

$$C_{xna} \cong \frac{C_w N_{xi} \sum_j^W p_{xij} s_{xj}}{\sum_x \sum_i^A N_{xi} \sum_j^W w_j p_{xij} s_{xj}}$$

This estimate can be included as the cohort catch in the population model:

$$N_{x\,i+1} = N_{xi} e^{-M_i} - C_{xna} e^{-M_i/2}$$

In this case, the model is not fitted to the data, but the catch data does provide an estimate of initial conditions (i.e. the level of depletion).

3.4 Growth

Most age related data are available as tail weight. This includes both commercial size category data and scientific sampling (see section 2). The mean growth of seabob is assumed to follow the von Bertalanffy growth curve. However, the stock assessment will require conversion from length to weight in the growth model. The general form of the growth model will be:

$$W_t = W_\infty (1 - e^{-kt})^b \qquad 4)$$

Parameters W_∞, and k will be estimated within the stock assessment for each sex. b can be estimated only from a smaller morphometric data set.

The parameter b depends on the length-weight relationship, and may change dependent on the sex and location (Suriname vs Guyana) of the seabob. To simplify the assessment, this parameter can be estimated outside the main assessment and provided as a fixed number to the assessment model. This will slightly underestimate the uncertainty, but prevent unrealistic parameter estimates and should improve the stability of the fit.

The parameter can be estimated using a log-linear model from the morphometric data collected in 2007/8 (CRFM 2009). The model has the general form:

$$w_i = e^{bc_i + a} \qquad 5)$$

where the independent variable c_i is the log carapace length, the dependent variable w_i is the unpeeled tail weight and the linear predictor contains parameters a and b which can be estimated as part of a generalized linear model.

The first issue is whether it is necessary to estimate separate b parameters for the sexes and countries. A simple analysis of variance chi-squared test was used to check whether these additional factors were necessary (Table 11) and the findings suggested that an interaction term is required only for sex. This indicates that the shape of a seabob is affected by its sex.

Table 11: The basic model is: tailwt ~ lcl + sex + country + sex:country. These are the full terms for parameter *a* in equation 5. The models add all interaction terms for lcl (log carapace length). Comparison is made between models (Pr(>Chi)) assuming that the change in deviance approximately follows the X^2 distribution, which can be used to guide the minimum model. The only interaction term which would seem to be justified in this case is the lcl:sex parameter. Importantly, there is no significant with country where data were collected.

	Residual degrees of freedom	Residual Deviance	Degrees of freedom	Deviance	Pr(>Chi)
Basic model	862	77.205			
Basic model + lcl:country	861	77.203	1	0.00256	0.8647
Basic model + lcl:sex	860	75.833	1	1.36946	0.000082
Basic model + lcl:sex + lcl:country	859	75.810	1	0.02368	0.6046
Basic model + lcl:sex + lcl:country + lcl:sex:country	858	75.805	1	0.00491	0.8136

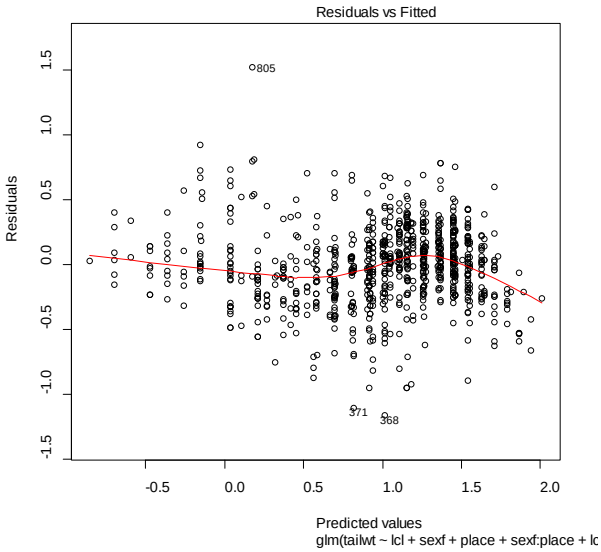

Residuals vs Fitted
Residuals
Predicted values
glm(tailwt ~ lcl + sexf + place + sexf:place + lc
805
371
368
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-0.5
0.0
0.5
1.0
1.5
2.0

Table 12: Analysis of variance comparing models where sex "U" (unknown) is allocated to the female (U=F) or male (U=M) category, or kept separate (U=U). The change in deviance represents the loss from combining unknown with females of males respectively. There was a clear significant change if unknown was allocated to males, but the change was not significant for females.

	Residual degrees of freedom	Residual Deviance	Degrees of freedom	Deviance	Pr(>Chi)
U=F	862	76.330			
U=U	860	75.833	2	0.4963	0.05974
U=M	862	77.118			
U=U	860	75.833	2	1.2844	0.00068

Table 13: Parameter estimates for the basic model with sex interaction term and "unknown" allocated to "female". The resulting maximum likelihood estimates for the *b* parameter for males and females are also given.

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-4.292430	0.263996	-16.259	< 2e-16
Lcl	1.798805	0.092706	19.403	< 2e-16
Sex.F	-1.121380	0.285088	-3.933	9.05E-05
Country.Suriname	0.008994	0.026108	0.345	0.730551
Sex.F : Country.Suriname	-0.113920	0.030129	-3.781	0.000167
lcl:Sex.F	0.393955	0.099369	3.965	7.96E-05
b Parameter (Equation 4)				
Male	1.798805			
Female	2.192760			

A conversion from age in months to weight class bin was provided by constructing an age-length matrix from the model, including growth variation. There were 29 weight bins from 0.0g to 6.0g, each of 0.2g width. Weights were rescaled to length, which provided a better model fit. The probability that a seabob was in a particular weight bin given its age is:

$$Pr(w|a) = N\left(u_w{}^{1/b}; W_a{}^{1/b}, \sigma\right) - N\left(l_w{}^{1/b}; W_a{}^{1/b}, \sigma\right) \qquad 6)$$

Where w =weight bin, a =age in months, $N()$ = cumulative normal, u_w and l_w are the upper and lower bounds for the weight bin, W_a is the expected weight of seabob age a (equation 4), b = length-weight parameter (equation 5 estimated in Table) and σ = growth standard deviation. The cumulative normal was set to 1.0 or 0.0 at the weight boundaries (u_w =6.0 and l_w=0.0 respectively). Separate growth was allowed for each sex. The resulting probability matrix (Figure 16) was used to convert age to weight class by multiplying the numbers-at-age vector by this growth matrix.

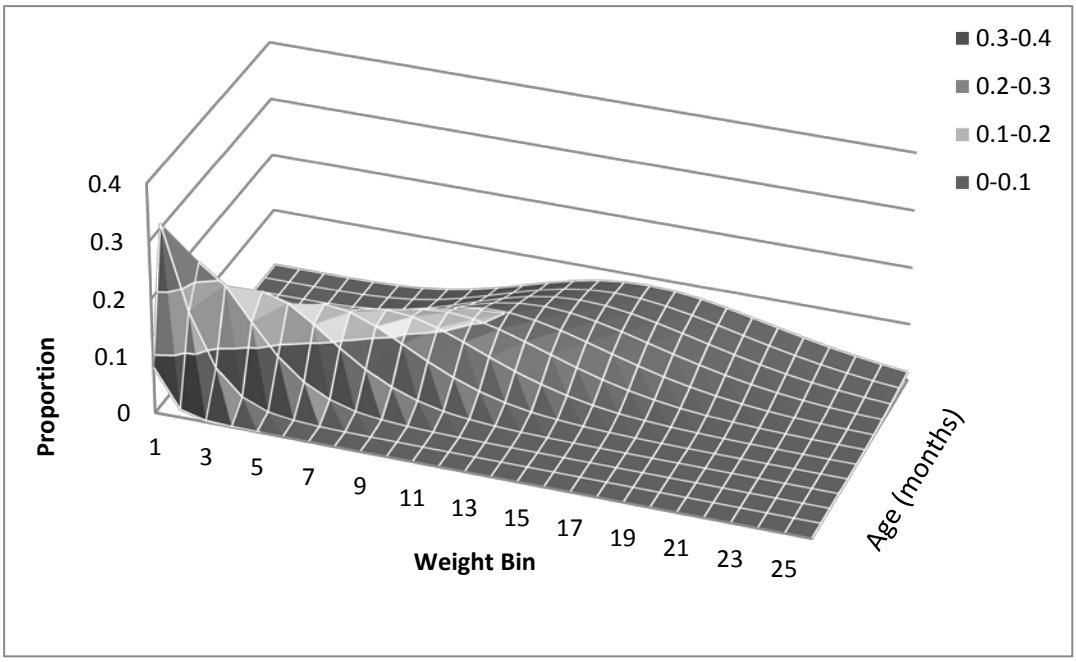


Figure 16: Female age-weight probabilities for bins 1-25 (from 0-28 bins) produced from the growth curve (Equation 4) and a normal distribution on length (Equation 6).

3.5 Recruitment

The stock recruitment model used was the Beverton-Holt, with the "steepness" parameterization:

$$R = \frac{4hR_0S}{R_0S_R(1-h)+S(5h-1)} \qquad 7)$$

Where R =Expected recruitment, S =spawning stock biomass from the previous month or earlier depending on the length of the larval stage, R_0 = expected recruitment when the stock is unexploited, S_0 =spawning biomass per recruit when the stock is unexploited and h =steepness parameter ($0.2< h <1.0$). The recruitment was modeled as a log normal, with equation 7 the log-normal mean, and individual deviations fitted as parameters from 2002-2013. Before 2002, when only annual catches are available, no deviations from equation 7 are fitted.

3.6 Likelihood

3.6.1 Overview

The log-likelihood was calculated for each data component based on the multinomial or normal log-likelihoods as follows:

- The negative log-likelihood for the size composition by size and sex in the random samples is calculated from the predicted catch proportions in numbers by size and sex and the observed numbers in the sample by size and sex. The scaled multinomial negative log-likelihood for a particular month is given as:

$$LL = \sum_{ij} Ln\left(\left(N\,e_{ij}/C+\varepsilon\right)\Big/\left(o_{ij}+\varepsilon\right)\right) * o_{ij}$$

Where N = total sample size (number of shrimp measured) within a month, C = predicted total catch in numbers within a month, e_{ij} = predicted catch in numbers of sex i, weight class j, o_{ij} = observed numbers

in the samples of sex *i*, weight class *j*, and ε = small number constant to avoid zeroes leading to numerical errors during minimization.

- The likelihood for the total catch and catch and effort data were based on the normal. Assuming a Poisson probability function for the catch, the scale parameter was assumed to be the square root of the predicted catch, so the negative log-likelihood would be:

$$LL = \sum_k \frac{(o_k - e_k - \varepsilon)^2}{e_k + \varepsilon} + \mathrm{Ln}(e_k) \qquad 8)$$

Where o_k = observed catch, e_k = predicted catch for a particular month *k* and ε = small number to avoid numerical errors. The predicted total catch weight is predicted from the model fishing mortality and selectivity, with catches summed over all sizes and sex. The predicted catch weight for a given level of effort is estimated from the population numbers in each weight class:

$$e_k = qf \sum_{ij} s_i w_i P_{ij} \qquad 9)$$

Where q = catchability parameter, f = observed effort, s_i = selectivity for weight bin *i*, w_i = mid-weight point, and P_{ij} = predicted population numbers in weight bin *i* and sex *j*.

- The catches and catch and effort within commercial size categories are based on integrating over possible catch allocations among categories. This was necessary because commercial categories overlap and are incomplete. The details are given in section 3.6.2 below.

- The average count per pound was assumed to follow a Poisson and therefore the log-likelihood Equation 8 was used. In this case, the predicted count was the predicted catch number divided by the seabob weight summed over the weight bins in each category ID (see Table 14) converted from grams to pounds. Most categories also had a standard deviation for the observed counts taken in each month which was used as a weight. A minimum standard deviation of 10.28 was applied based on the mean standard deviation where sample sizes exceeded ten observations.

- The negative log-likelihood log-recruitment deviations was the standard sum-of-squares (normal) differences between the parameter and the expected recruitment (Equation 7), with an additional scale parameter (σ_R) which could be fitted or fixed.

- A auto-regressive penalty was added for the recruitment deviations:

$$LL = \sum_t (R_t - R_{t-1})^2$$

This has the effect of penalizing large fluctuations in the recruitment deviations on the basis that good or bad recruitment months will tend to occur next to each other. The importance of this penalty depends upon the weight it is given. For the current model, no additional weight was applied and its contribution to the overall likelihood was small.

3.6.2 Log-Likelihood for Commercial Size Composition

For each size composition, it is possible to estimate the number of seabob within it. This is the sum of seabob over the size category from smallest to largest. For example, the 90-110 count per pound size category would contain sizes varying from 5.04 (1000/(2.20462*90)) down to 4.12 (1000/(2.20462*110)) grams weight. The expected number of seabob in each size category can be obtained from the population model based on the fishing mortality for each size category, population abundance in each category and the fishing selectivity.

All commercial categories can be defined as a subset of a larger category which contains it. In the simplest case, the category contains all the catch, so no larger category is required. Therefore in this case, the "larger" category and the category are the same and the log-likelihood is simply based on the expected landings directly from the model. In this simple case, the likelihood for numbers in a particular size category would be Poisson:

$$L = \frac{\mu_a^{x_a}}{x_a!} e^{-\mu_a} \qquad 10)$$

where x_a=numbers observed in the category A and μ_a=expected numbers in category A. The expected numbers can be calculated by simply summing over all sizes from the model within the category. Suitable alternatives to the Poisson can be used to account for over-dispersion and/or to simplify the calculations. Taking advantage of the situation where x_a and μ_a are very large, as in this case, the normal likelihood or log-normal could be used.

Unfortunately, this likelihood cannot be applied in this simple form unless the data are manipulated to allocate all catches to non-overlapping well-defined categories. This should be avoided if possible, since the model would not be fitted to raw data and such manipulations can introduce unknown bias in the result. Instead, it was considered preferable to develop a likelihood which captures what size information there is in the data rather than impose such information by manipulating the data.

In all cases, a significant proportion of the catch will be undifferentiated by size. Any catch allocated to a particular size range can therefore always be defined within the context of a larger size category which is complete. The known catch in the smaller category represents a minimum catch within this range, where other catches within the larger category might also be in the smaller one. The likelihood becomes the sum of likelihoods across possible allocations of catch between the two categories.

To illustrate the basic calculation, we consider categories A and B covering separate size categories (Figure 17) for each of which the statistical model can estimate the expected catch in a particular month. The category B may envelop A (B_l and B_u) or extend it only (B_l or B_u), but it should always be possible to calculate the expected catch for both A and B.

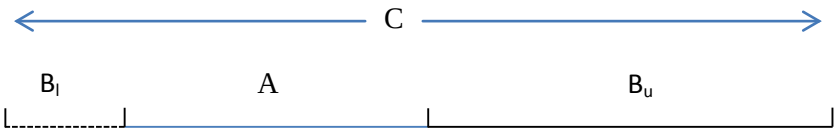


Figure 17: Illustration of size categories, where size category A is enveloped in size category B. Landings can be reported as in A or in B, but also a significant proportion of catches may not have been graded (category C) and could belong to either A or B.

The data however is only available partially for A and B, and otherwise the total catch is made up in C, where C landings have been ungraded among A and B. We need to sum the likelihood over possible allocations of landings in C between A and B, so the likelihood for the joint Poisson likelihood becomes:

$$L = \sum_{x_a=X_a}^{X_c+X_a} \frac{\mu_a^{x_a}}{x_a!} \frac{\mu_b^{(X_c+X_a+X_b-x_a)}}{(X_c+X_a+X_b-x_a)!} e^{-\mu_a-\mu_b} \qquad 11)$$

where X_a, X_b and X_c are the observed landings in A, B and C (unallocated A+B), and μ_a and μ_b are the expected catches in A and B which are estimated from the model.

This can be simplified to some extent by reformulating to create a Poisson term for the total catch in A+B and a sum of binomial terms for the proportion in category A:

$$\mathrm{L} = e^{-\mu_a-\mu_b}\frac{(\mu_a+\mu_b)^{(X_c+X_a+X_b)}}{(X_c+X_a+X_b)!}\sum_{x_a=X_a}^{X_c+X_a}\frac{(X_c+X_a+X_b)!}{x_a!\,(X_c+X_a+X_b-x_a)!}\left(\frac{\mu_a}{(\mu_a+\mu_b)}\right)^{x_a}\left(\frac{\mu_b}{(\mu_a+\mu_b)}\right)^{X_c+X_a+X_b-x_a} \quad 12)$$

Similarly, the likelihood for several categories within a larger category can be described using a multinomial.

For large catches it is not possible to sum over possible catches and Equation 12 can only be simplified by closely approximating the binomial with a normal probability. The binomial term then becomes:

$$\mathrm{B}\left(p=\frac{\mu_a}{(\mu_a+\mu_b)}, n=(X_c+X_a+X_b)\right)\approx N\left(\frac{(X_c+X_a+X_b)\mu_a}{(\mu_a+\mu_b)}, \sqrt{\frac{(X_c+X_a+X_b)\mu_a\mu_b}{(\mu_a+\mu_b)^2}}\right) \quad 13)$$

Similarly, the total catch likelihood can be approximated with a normal density:

$$\mathrm{L}\approx N\left((X_c+X_a+X_b);(\mu_a+\mu_b),\sqrt{(\mu_a+\mu_b)}\right)\int_{x_a=X_a}^{(X_c+X_a)} N\left(\frac{(X_c+X_a+X_b)\mu_a}{(\mu_a+\mu_b)}, \sqrt{\frac{(X_c+X_a+X_b)\mu_a\mu_b}{(\mu_a+\mu_b)^2}}\right)dx_a \quad 14)$$

The cumulative normal can be well approximated numerically (West, 2004), so the likelihood can be calculated reasonably easily for each datum.

The binomial part of the likelihood is only informative on landings below those expected in category A. As the expected landings fall below the observed landings in category A, the log-likelihood declines. Clearly, as higher landings have been observed than those estimated, the estimated landings become less likely. Conversely, since any ungraded landings in C could be allocated to A, there is no information on higher estimated landings in A as all are equally possible. Therefore, the log-likelihood asymptotically approaches 1.0 as the expected catch increases. As the expected landings exceed the total landings observed (A+C), then the likelihood begins to decline again (Figure 18). In this case, the estimated landings in A exceed the possible observed landings in A (A+C), and the estimate becomes less likely. The result is a flat-topped likelihood, where the flat top covers the likely range of the landings within the category. Because the likelihood will include a term for the total catch as well, the likelihood should have a mode for the full model, but additional information is likely to be required to be able to estimate parameters defining stock size composition.

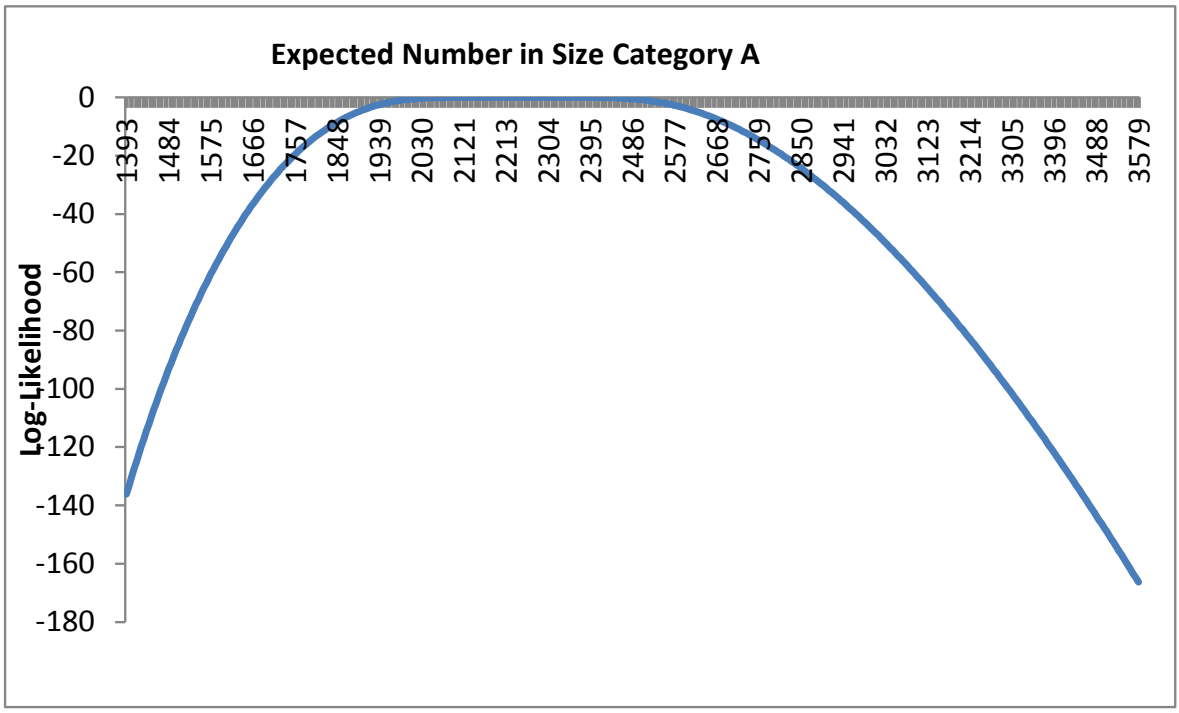


Figure 18: Example conditional log-likelihood of expected number in a category (parameter μ_a) where the observed catch in categories A and C are 2000 and 500, so 500 may or may not belong to category A.

In reality several commercial size categories may overlap (Table 14) and therefore the likelihood (Equation 14), which assumes categories are independent, with the exception of the overlap between categories A and C, is not strictly correct. Calculating the likelihood correctly over several overlapping categories would strictly require summing over all combinations of allocating non-graded catch among overlapping categories, which would become more complicated. However, because the likelihood is flat when the observed landings within a specific category is less than the expected landings, how ungraded landings are distributed is uninformative and the assumption of some independence should provide a good approximation to the likelihood as long as the total landings are also fitted.

To capture the dependency between categories, landings can be combined within categories forming hierarchical relationships. For example, category 7 has landings within categories 5 and 2 added to it, but all other categories would be excluded (Table 14). This leads to a complete set of likelihood calculations based on the category landings in each month (Table 15).

The smallest and largest category in each month would include the smallest and largest shrimp. Not all months contain all categories. So, for example, Category 1 is often not present. In these months Category 3 would be assumed to cover all larger shrimp (i.e. combines with Category 1 sizes). For smaller shrimp, the categories show less discrimination, so a category 11 is present in every month.

Table 14: Commercial size categories based on "counts per pound" to be used in the stock assessment model. Categories are numbered from 1 to 11 for identification purposes only. So, for example category one includes all larger shrimp in the 90 and below count, whereas category 4 includes counts 100-130 per pound. Category 2 would include all catches which have not been allocated to a size category, such discarded ungraded catch. Actual commercial category allocation to category ID is given in Table 3.

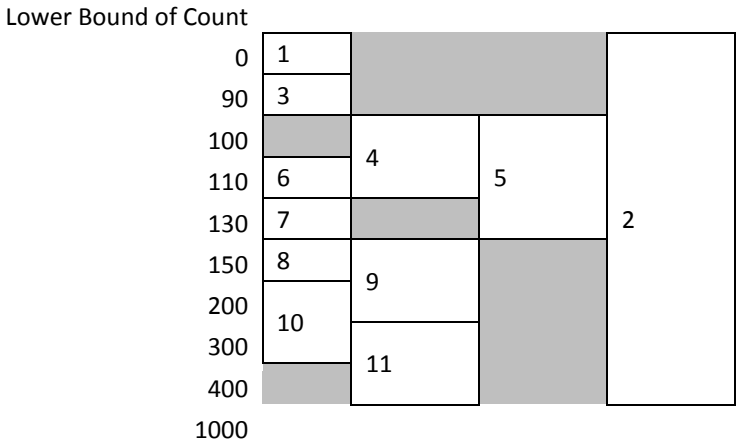


Table 15: Likelihood calculations (CID) for category combinations based on allocation to category A, B and C in Equation 14 and Figure 17. Category A consists of all complete categories with well-defined boundaries, C any potentially overlapping categories and B all categories which would be excluded. The number of likelihood calculations is the same as the number of categories (11), preserving the degrees of freedom.

CID	A	B	C	Category A Count Range	Calculated
1	1-11			0-1000	For all months
2	1	3-11	2	0-90	Where 1 exists
3	3	1,4-11	2	90-100	Where 3 exists Including <90 if no larger category
4	4,6	1,7-11	2,5	100-130	Where 4 exists Including <100 if no larger category
5	6	1,3,7-11	2,4,5	110-130	Where 6 exists Including <110 if no larger category
6	4,5,6,7	1,3,8-11	2	110-150	Where 5 exists Including <110 if no larger category
7	7	1,3-4,6,8-11	2,5	130-150	Where 7 exists
8	8	1,3-7,10-11	2,9	150-200	Where 8 exists
9	8,9	1,3-7,11	2,10	150-300	Where 9 exists
10	10	1,3-8	2,9,11	200-400	Where 10 exists
11	11	1,3-9	2,10	300-1000	Where 11 exists

Table 16: Example landings in kilograms tail weight by size category in 2004.

	1	2	3	4	5	6	7	8	9	10	11
1	584	220601	6592	2756	6814	22194	44992	178989	0	544252	131274
2	0	74136	929	3290	8096	0	0	0	0	141195	18424
3	313	296615	5238	3886	9135	20865	32194	122156	0	401671	146774
4	118	293066	12072	8090	16568	43915	62272	199271	0	452643	198056
5	1385	225885	7500	0	0	23477	32994	114893	0	321880	183980
6	576	231786	3438	0	0	34619	46379	159091	0	330705	139831
7	2092	367871	14156	7193	10227	25689	54256	201972	35814	503004	141161
8	1473	186498	4163	1842	6592	7252	13222	115028	22772	252127	179220
9	324	55278	994	129	390	3465	2775	30041	0	58044	36880
10	0	7623	9	270	596	0	0	0	0	8804	6524
11	907	173842	2843	6157	7737	10645	13423	52010	0	247989	133886
12	3641	186048	6086	0	0	16600	21997	77631	0	225774	145369

4. RESULTS

4.1 Model Configuration

The base case was determined from reviewing various configurations for the model (Table 4). This model was used to determine stock status and as the basis for carrying out MCMC simulations to estimate uncertainty.

The resulting base model estimates fishing mortality, recruitment deviations and other parameters on growth and productivity (Table 18). Stock status and fishing mortality are reported in section 1.1. There is little evidence of a strong seasonal pattern in recruitment (Figure 19).

Table 17: Deliberations of the working group to decide upon the base case and lower and upper credible bounds for the model structure.

Structure/ assumption	Base Case	Justification	Scenarios
Sex ratio	The sex ratio will be set at 50:50, and will not be fitted.	There is no known reason why the sex ratio of recruits will be other than 50:50. When fitted, the estimated proportion of females was 0.43. Improvements to the fit were not large, so this parameter was fixed at 0.5.	Estimated proportion female in the recruits
Recruitment Variation	σ_R=0.5	Results were insensitive to reasonable values for the recruitment variation parameter (σ_R). The parameter could not be fitted without a strong penalty function. 0.5 was chosen as a reasonable fixed value, although variation in estimated recruitment deviations suggested a higher figure. Higher values for this parameter (σ_R=>1.0) could not be fitted.	σ_R=0.2, 0.5, 0.8
Recruitment Seasonality	No explicitly seasonality was added to the recruitment model.	Although there may be seasonality in recruitment, it is uncertain what shape function should be used or how many recruitments there are each year. The recruitment deviations should show up any seasonal pattern which can be investigated at a later date.	None

Structure/ assumption	Base Case	Justification	Scenarios
M	M=0.183	Estimates from longevity reported in scientific literature depend on growth estimates. In general, they imply low natural mortality which is not consistent with the catch data (i.e. poor fit if M<0.1 $month^{-1}$). Estimates in the model are too high to be credible (M>0.6 $month^{-1}$). Available direct estimates of natural mortality suggest 0.1-0.2 $month^{-1}$. Estimates from Soomai *et al*. (2012) were used.	M=0.1, 0.2, 0.3, estimated
K, t0	Females: K=0.216; t0=0 Males: K=0.246; t0=0	K cannot be fitted. The estimate from the fit (K>0.6 $month^{-1}$) is too large to be biologically realistic. Indications suggest males grow faster than females. All published estimates found are less than 0.3 $month^{-1}$. Higher estimates fitted the data better. Ribeiro De Campos, *et al*. (2011) were used as the higher estimates available.	K=0.08, 0.15, 0.2, 0.3, 0.22/0.25
SSB survival after 12 months	No extra mortality after 12 months.	It was considered possible that survival after 12 months or after spawning could be low. There is no evidence in the data for this, however, so a standard plus-group for 12 month olds is applied.	None
SSB delay before spawning	Use 2 month delay, as opposed to 1 month	There is a very small improvement in log-likelihood for 2 months as opposed to 1 or 3, so for the current model it makes very little difference. 4-8 week larval stage would seem reasonable for this species.	Delays of 1, 2, 3, 4
Domed selectivity	A logistic curve was used.	The "domed shaped" selectivity will make the perception of the stock much more positive. There is no evidence that a domed-shaped selectivity is appropriate, although it does fit the data better. The logistic should be more precautionary.	Estimated domed parameter
$S_{50\%}$ Sex selectivity	The same selectivity curve was used for both male and female.	There was no significant difference in selectivity between males and females when selectivity was based on length.	Estimated separate $S_{50\%}$ by sex
S_{tp} selectivity steepness	This was fixed to the boundary value (25).	The estimate consistently moved to the boundary, indicating essentially "knife edge" selectivity. Fixing the parameter would avoid additional problems with the MCMC	Estimated
SR Steepness (h)	h=0.8	Estimated steepness very low (h=0.314), but gave the worst case for stock status. There is no evidence of a stock recruit relationship (possible obscured by seasonality). It was concluded that steepness cannot be estimated and the default h=0.8 was considered relatively precautionary for this stock.	h=0.9, 0.8, 0.7, 0.6, Estimated

Table 18: Parameter estimates from base case model for all fitted parameters apart from the monthly fishing mortality and recruitment deviations.

Parameter	Estimate	Standard Deviation	Reference
W_∞ Females	3.87	3.55E-03	Females: Equation 4
W_∞ Males	2.41	1.67E-03	Males: Equation 4
Growth σ	0.24	2.17E-04	Equation 6
Ln(q)	-16.14	3.43E-03	Log Catchability: Equation 9
S50%	12.34	1.37E-03	Equation 8
Ln(R0)	21.14	3.04E-03	Equation 7

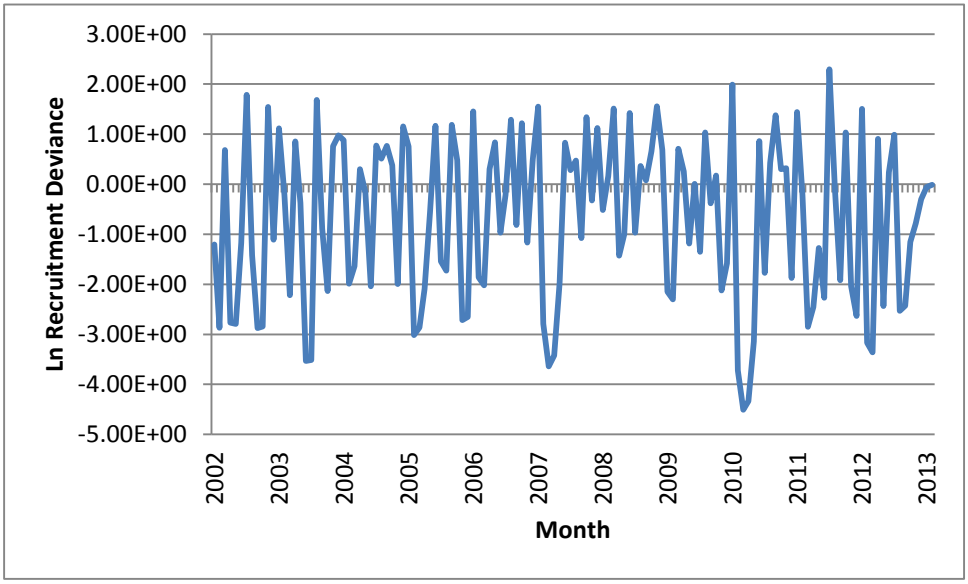


Figure 19: Logarithm of the recruitment deviations from the stock recruitment relationship (Table 18) fitted in the model base case.

4.2 Diagnostics

Diagnostics were primarily based on plotting standardised residuals. Observed-predicted, predicted-residual, time-residual and, where appropriate, weight bin-residual plots were examined. With some notable exceptions, the model fitted the data well and there were no unacceptable violations of model assumptions. It is not considered likely that there will be any change in the stock status estimate when the problems identified (outlined below) have been addressed.

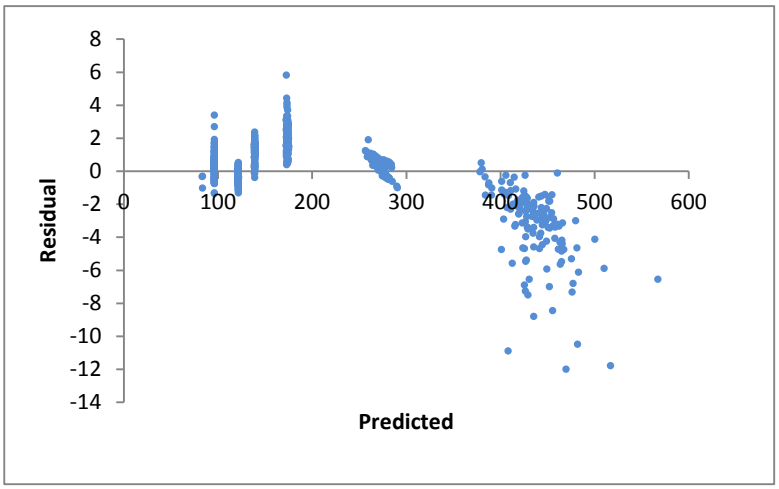


Figure 20: Standardised residuals plotted against predicted values for the average count data.

There were small departures between the observed and expected average counts for the commercial size categories, particularly for the smallest category (Figure 20). In general, the lowest count categories indicated that the predicted count was higher than the observed. Conversely, for the higher count categories the predicted count was lower. This might suggest that the size categories need to be adjusted. However, while this adjustment should be explored, it should also be verified that the higher counts than expected in the smallest size categories are not just due to the increased presence of broken tails. It should also be noted that adjusting the size categories is not a trivial exercise, since it involves altering the data preparation as well. If the smallest commercial size category includes a high proportion of pieces in the count, this category should be removed from this data component.

The other major issue with the model was identified for the random size sampling standard residual plot against weight bin (Figure 21). A clear pattern emerged suggesting that the selectivity model used is flawed. In both males and females, there were fewer shrimp than expected in the catches in the bin range 4-10 (0.8-2.0g peeled tail weight). In addition, males lack a peak of smallest individuals very evident in females and overall the male residual plot appears shifted to the left (Figure 21). One obvious reason for this is that selectivity may also depend on age, which might help explain the difference between males and females since they exhibit different growth. It may also be due to misunderstood life history patterns, since the basic biology of the species is not well understood. It is also possible bias may occur through misallocation between males and females particularly in the youngest categories. Although this last explanation seems unlikely to explain the observed patterns, it does need to be verified. Completion of the Suriname assessment, with its different fishery characteristics, would help understand how these different factors might be affecting size composition.

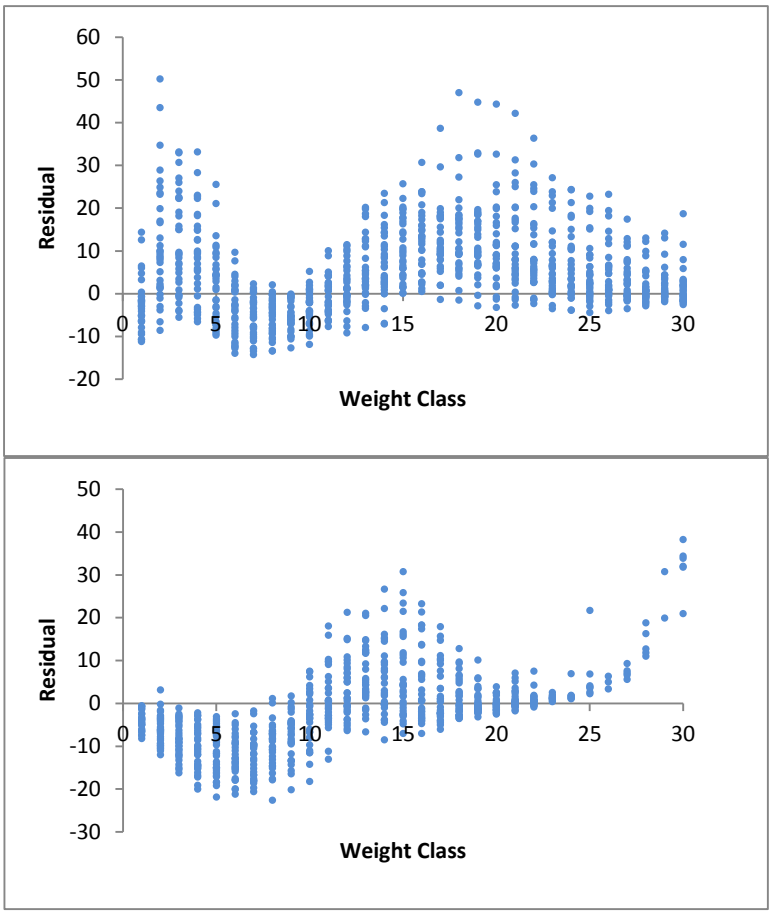


Figure 21: Female (top) and male (bottom) plot of residuals by weight class.

5. CONCLUSION

The model may be improved, but such improvements are not likely to lead to a dramatic change in the perception of stock status. It appears most likely improvements in the model would come from adjusting the selectivity model and improving the interpretation of the size categories.

Notwithstanding these improvements, the assessment model can be used for scientific advice at this stage of development, conditional on further model development and evaluation. It provides a useful assessment of the history of the fishery, an improved understanding of the impact of the fishery on the population, and a sound basis for developing a harvest control rule.

5.1 Further Work

The following tasks were identified as requiring attention in 2013/14:

- Complete the Suriname stock assessment for comparison.
- Examine average counts of the smallest shrimp to see what proportion are pieces as opposed to whole shrimp.
- Adjust commercial category definitions in the assessment model to improve residual patterns.
- Explore alternative selectivities and life history patterns that might explain the size composition in the landings better.

- Explore increasing the recruitment random walk penalty to examine any recruitment patterns that may emerge.
- The commercial category likelihood is not strictly correct in that it does not take account of allocation of category C landings to categories other than A. So the likelihood only accounts for partial, pair-wise dependency. Further development of the likelihood to account for more category combinations should be considered.

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