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WESTERN CENTRAL ATLANTIC FISHERY COMMISSION (WECAFC)

SEVENTH SESSION OF THE SCIENTIFIC ADVISORY GROUP (SAG)

Panama City, Panama, 7-8 November 2015

Coordination and collaboration in fisheries research in the region

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Executive Summary

The task set was to provide the 7th Session of the Scientific Advisory Group (SAG) of the Western Central Atlantic Fishery Commission (WECAFC) with an overview of the research/activities undertaken by each of the WECAFC working groups over the period 2012 – 2015, and to report on any other research/activities with relevance to the working groups being conducted in the region during this period. In so doing information was also gathered on constraints faced by the working groups in conducting their work, and on key areas for future discussion.

Most working groups of WECAFC are joint working groups with other regional partner institutions, such as the Caribbean Regional Fisheries Mechanism (CRFM), the Organization of Fisheries and Aquaculture for Central America (OSPESCA), the Caribbean Fisheries Management Council (CFMC) and the French Research Institute for Exploration of the Sea (IFREMER). The full list of the ten Working Groups that were established or confirmed at the 14th and 15th session of the Commission respectively in 2012 and 2014 is given here:

1. OSPESCA/WECAFC/CRFM/CFMC Working Group on **Spiny Lobster**
2. WECAFC/OSPESCA/CRFM/CFMC Working Group on **Recreational Fisheries**
3. CFMC/OSPESCA/WECAFC/CRFM **Queen Conch** Working Group
4. IFREMER/WECAFC Working Group on Development of Sustainable Moored Fish Aggregating Devices (**FAD) Fishing** in the Lesser Antilles
5. CRFM/WECAFC **Flyingfish** in the Eastern Caribbean Working Group
6. WECAFC Working Group on the management of **Deep-sea Fisheries**
7. CFMC/WECAFC/OSPESCA/CRFM **Spawning Aggregations** Working Group
8. WECAFC/CRFM/IFREMER Working Group on **Shrimp and Groundfish** of the North-Brazil Guianas shelf

9. OSPESCA/WECAFC Working Group on **Sharks**
10. CRFM/WECAFC Working Group on **IUU Fishing**

The working groups comprise a variable number of subject experts and national representatives led by an elected convener. The conveners of each group were contacted by email to assist with this overview and were asked a number of standard questions, reflected by the headings used in this report. In some cases convenors recommended contacting others within the group for assistance. In all cases, additional subject experts were contacted, and a brief review of literature available on the web was conducted within the limits of the time available and presented in the report Appendices. Regional institutions were also contacted to give an overview of recent relevant research.

The response from conveners was generally average and reflected the constraints that the groups are generally comprised of volunteers with full-time jobs and little time to dedicate to the work of the group, outside specific focussed meetings. Despite this, many of the groups have made significant progress over the period 2012-2015, and their work has supported and/or has been supported by many other initiatives within the region.

1. OSPESCA/WECAFC/CRFM/CFMC

Working Group on Spiny Lobster

Current research/action by the working group (for period 2012-2015)

Overall, this working group has been relatively quiet since their first meeting in Panama City in October 2014. There is a draft report of this workshop in press which highlights some of the work presented at this meeting. This includes:

- An agreed CRFM–OSPESCA Joint Action Plan, created in 2012, which has placed Caribbean spiny lobster as a key area of cooperation.
- The MARPLESCA Plan (Manejo Regional de la Pesqueria de la Langosta Espinosa del Caribe) /Action Plan for Nicaragua's Caribbean Spiny Lobster Trap Fishery Improvement Project (FIP) developed as part of the pilot project "Subregional Management of the Caribbean Spiny Lobster *Panulirus argus*) fisheries – MASPLESCA – of the Caribbean Large Marine Ecosystem".
- The implementation of OSPESCA regulation OSP-02-09
- CRFM also adopted a regional declaration on the conservation and management of spiny lobster in 2015.

Associated research relevant to the working group

- There is a stock assessment research component on spiny lobster under the Caribbean Large Marine Ecosystem (CLME) project and its adopted Strategic Action Programme (SAP). It aims to develop a common stock assessment model in the second year of the project and carry out a stock assessment in the third year for the south-central stock

- The Regional Standard of Traceability for Caribbean spiny lobster (*Panulirus argus*) in the Caribbean – within the framework of the Central American Integration System (SICA–OSPESCA) and OIRSA was presented at the workshop in 2014.
- Under the ten-year CLME Strategic Action Programme (SAP), an ecosystem approach to the Caribbean spiny lobster fisheries is foreseen.
- A selection of published research papers reporting relevant work on spiny lobster is presented in Appendix 1

Issues perceived as constraints in conducting the work of the WG

Due to funding constraints, there has been very limited progress since the Workshop in Panama.

Key research priorities for discussion by the WG

- A review of recent literature given in Appendix 1 suggests the following key research priorities for the working group:
- Stock assessment of the spiny lobster fishery
- Fisher safety (SCUBA gear & depths) and participation in management
- Spread of lobster disease
- Network of MPAs for shared resource management
- Benefits and challenges of MSC certification
- Implementation of Spiny Lobster Declaration
- There is a need for a scientific baseline for further action at a regional, sub-regional and national level to determine the minimum size at capture.

2. WECAFC/OSPESCA/CRFM/CFMC

Working Group on Recreational Fisheries

- **Current research/action by the working group (for period 2012-2015)**

- An economic impact assessment manual has been written and tested to assess the impact of recreational fisheries in the Wider Caribbean Region. Three pilot sites were selected in 2013 for testing of this manual. Progress reports were submitted to WECAFC.

Associated research relevant to the working group:

- The MAGDALESA project
- CARIFICO project (CRFM/JICA project) aims at developing management of FAD fisheries.
- The CC4FISH - Climate Change Adaptation in the Eastern Caribbean Fisheries Sector Project of FAO, together with CRFM and other partners, will examine pelagic fishery assessment and management issues in the near future.
- CRFM conducted a study of recreational fisheries that was published in 2010 (CRFM Research Paper Collection, Volume 7)
- Recreational fisheries legislation in Caribbean states appears to be under-developed in most countries.

The Caribbean Billfish Project was initially developed from this working group and is coordinated by FAO/WECAFC in Barbados, in close cooperation with the IGFA. Some of this project's tasks include:

- A study on the status of billfish resources and the billfish fisheries in the Western Central Atlantic
- A Consortium on Billfish Management and Conservation meeting is being held 9-11 Nov, 2015. This will aim to:
  - Produce a draft billfish management and conservation plan for the Wider Caribbean Region (WCR).
  - Select two countries as pilot sites for the creation of business plans for the billfish fishery.
- A study on the legislative frameworks for fisheries, including recreational fisheries, is being conducted by the Caribbean Billfish Project.
- A selection of published research papers reporting relevant work on recreational fisheries is presented in Appendix 2.

Issues perceived as constraints in conducting the work of the WG

- Limited communication and transparent broad consultation.
- Interest among fisheries departments/divisions in the work of the WG is generally limited.
- Process used in last 2 years appears to be top-down.

Key research priorities for discussion by the WG

From general knowledge of the region's fisheries and a review of recent literature given in Appendix 2 suggests the following key research priorities for the working group:

- Data collection system for recreational fisheries (fishing effort, landings, economic, social)
- Development of recreational fisheries policies and regulations at the regional and national levels.

3. CFMC/OSPESCA/WECAFC/CRFM

Queen Conch Working Group

Current research/action by the working group (for period 2012-2015)

- With support from CRFM (summarized in 2012 reports):
  - Training in underwater visual surveys,
  - Analysis of scientific approaches to management of queen conch
  - Development of management options for regional-scale consideration.
- An Updated 3rd Draft regional Queen Conch Fisheries Management and Conservation Plan was developed in 2014 and is undergoing a review by experts and fisheries policy makers.
- Research was carried out and agreement was reached on regional Queen conch meat processing conversion factors under the Working Group with some Member States having developed national conversion factors (e.g. Jamaica, Antigua and Barbuda, the Bahamas,

Barbados, Belize). This will improve reporting and statistics on queen conch available at FAO and CITES.

- A Non-detriment finding (NDF) guideline format to facilitate trade in Queen Conch was developed and agreed by the experts in the region.
- With support from CITES, CFMC and FAO/WECAFC (2015):
  - The 'Report of the 2nd Meeting of the CFMC/OSPESCA/WECAFC/CRFM Working Group on Queen Conch' was provided as information to the 28th Meeting of the CITIES Animals Committee, Tel Aviv (Israel), 30 August-3 September 2015.
  - A National workshop of Industrial Fisheries for Queen Conch was organized in Honduras, La Ceiba, on 27-28 August 2015

Associated research relevant to the working group

- Caribbean ACP Fish II Projects, awarded through the CARIFORUM/ CRFM in 2013: includes many case studies and recommendations for harmonized management.
- The Belize Fisheries Department, in compliance with CITES recommendations, carried out a 'National Conch Stock Assessment' in 2012 to assess conch abundance and estimate Maximum Sustainable Yield (MSY) that was then used to guide the establishment of a Total Allowable Catch for the 2012 -2013 conch fishing season.
  - The results continue to indicate that the conch stock of Belize is healthy and robust.
  - This study recommends that the queen conch is placed under a limited entry fishery with designated landing sites in order to have better control of all harvesting activities
- NOAA Regulatory Amendment 2 was passed to improve the compatibility of Federal and U.S. Virgin Islands (USVI) territorial regulations for queen conch and thereby facilitate enforcement efforts while ensuring the long-term health of the queen conch resource. This will involve:
  - Revision of the commercial trip limit for queen conch in U.S. Caribbean federal waters to be compatible with the trip limit in USVI territorial waters.
  - Leaving the recreational bag limit unchanged because increasing the bag limit to make it compatible with the USVI would only slightly facilitate law enforcement efforts, but may negatively impact the continued health of the queen conch resource.
- A selection of published research papers reporting relevant work on queen conch is presented in Appendix 3.

Issues perceived as constraints in conducting the work of the WG

- Despite the achievements at the working group meetings and in-between, as supported by WECAFC and CFMC secretariats, the follow-up at national level by WG experts requires time, effort and funds that are often not available .

Key research priorities for discussion by the WG

A review of recent literature given in Appendix 3 (including journal articles and CRFM Special papers) suggests the following key research priorities for the working group:

- Consider revision of minimum size legislation across the region based on new research suggesting that active reproduction does not occur until the animals have attained a much larger shell lip thickness than currently used.
- Determine the relevant geographic range for shared management, as there seem to be various "sources" and "sinks".

- Implementation of regional management and conservation plan

4. IFREMER/WECAFC

Working Group on Development of Sustainable Moored Fish Aggregation Device (FAD) Fishing in the Lesser Antilles

Current research/action by the working group (for period 2012-2015)

- One of three planned volumes on best practices in FAD fishing has been written. It is hoped that the other two will be written in 2016.
- A sub-regional management plan for FAD fisheries was drafted and reviewed at the write shop in July 2015 in St. Vincent and the Grenadines.
- A project in support of the working group on FADs was to identify possible improvements that could be made with little further investment in areas including: product quality, safety and working conditions, and efficiency / selectivity of fishing gear.
- A component also worked on improving catch and effort data collection. Particular attention has been directed at marlin for which a conflict exists with recreational fishing; and blackfin tuna which is considered an important potential resource around FADs, but whose stock status is unknown.

Associated research relevant to the working group

- A CARIFICO Project 'Implementation of a Logbook System' was initiated in February 2015 to improve catch and effort data in FAD fisheries in participating countries (Antigua and Barbuda, St Kitts and Nevis, Dominica, St Lucia, St Vincent and the Grenadines, and Grenada).
- A selection of published research papers reporting relevant work on recreational fisheries is presented in Appendix 4.

Issues perceived as constraints in conducting the work of the WG

Participation in the WG was constrained by retirement of some key experts and limited funds available for the work of the WG.

Key research priorities for discussion by the WG

A review of the Working Group's Sub-regional Management Plan together with relevant current literature (Appendix 4) suggests the following key research priorities for the working group:

- Provide technical support to fishers to safely build and set up moored FADs
- Develop a harmonized system for moored FAD fishery data collection. It was noted that:
  - Special attention should be given to marlins
  - A logbook system should help in data collection

- Examine cost and earnings for moored FAD fisheries, including a comparison of the economic performance of different FAD fishing strategies (e.g. public versus private FADs) in several countries representing a diverse range of governance arrangements and socio-economic conditions.
- Examine the role of moored FAD fisheries in nutrition and food security and in poverty alleviation in selected countries representing a diverse range of governance and socio-economic conditions.
- Encourage further biological, ecological and ecosystem studies related to moored FADs such as studies on:
    - The impact of the moored FAD fishery on trophic interactions among target species (e.g. changes in species composition, diet, abundance).
    - The short, medium and long-term effects of the development of a moored FAD fishery on fishing pressure on nearshore / reef resources in selected countries representing a diverse range of governance and socio-economic conditions.
    - Assess fishing techniques / strategies to minimize juvenile catches and optimize catch selectivity on moored FADs.
    - The aggregating dynamics of target species around moored FADs.
    - The relative contribution of moored FADs to the overall fishing mortality of target species vs other fisheries.
    - Stock delineation of target species to identify member states which must be included in shared assessments and management.

5. CRFM/WECAFC

Flyingfish in the Eastern Caribbean Working Group

Current research/action by the working group (for period 2012-2015)

- The Sub-regional Fisheries Management Plan for Flyingfish in the Eastern Caribbean (Sub-regional Flyingfish FMP) was formally endorsed by the CRFM Ministerial Council in May 2014 and is now cleared for implementation by CRFM Member States.
    - A consultative process is ongoing in participating countries to facilitate stakeholder involvement in all stages of implementation of the plan.
- The Working Group is currently undertaking an evaluation survey to assess the status of implementation of the Sub-regional Flyingfish FMP in the six CRFM Member States of relevance: Barbados, Trinidad and Tobago, Dominica, St Lucia, St Vincent and the Grenadines, and Grenada.
    - A questionnaire was circulated to the six relevant CRFM Member States on 16 June 2015, with feedback required by 30 July 2015.
    - As at 22 September 2015 responses are still outstanding from two members despite the enormous importance of flyingfish to one of them.
    - A full report of the evaluation exercise over the period June 2014 to May 2015 will include details of national progress as well as regional level activities in support of flyingfish fisheries management, in accordance with the Sub-regional Flyingfish FMP. It

will also identify areas of success to be shared regionally and areas or critical gaps requiring priority attention for the management of the flyingfish fisheries in the eastern Caribbean. This report will be presented to the Caribbean Fisheries Forum, the Ministerial Council and WECAFC at the respective meetings in 2016.

- The research needs outlined in the Sub-regional Flyingfish FMP will be conducted under three regional projects. Two of these (CLME+ Project and the PPCR) were approved in 2015 for implementation and the third (CC4Fish) is awaiting approval (see below for more detail).
- A CARICOM 'Ministerial Sub-committee on Flyingfish Fisheries' has been established to provide policy direction and supervise the development of cooperative arrangements for improved governance and management of the flyingfish fishery to achieve optimum sustainable social and economic benefits for the people of the region.

Associated research relevant to the working group

- The Caribbean Large Marine Ecosystem PLUS Project (CLME+) has a 'Flyingfish Sub-project' being implemented by the CRFM. Under this the following activities are planned:
  - Research on bio-economic and governance aspects including a review and evaluation of monitoring indicators and reference points with all stakeholders to increase transparency and overall good governance practices.
  - An economic and social evaluation of current flyingfish fisheries.
- The Climate Change Adaptation in the Eastern Caribbean Fisheries Sector project (CC4FISH) will be undertaking:
  - Risk assessment modelling for pelagic fisheries under climate change and variability.
  - A sub-project on the impacts of *Sargassum* entitled 'Modeled growth and transport of pelagic *Sargassum* invasions into the Eastern Caribbean and implications for pelagic fisheries' will be focusing on impacts affecting large pelagic and flyingfish fisheries in particular.
  - This project is currently awaiting final approval and funding from the Global Environment Fund (GEF) through the FAO.
- The IDB Pilot Programme on Climate Resilience (PPCR) is undertaking the following:
  - Examination of the impacts of climate change on the distribution and abundance of key species (including flyingfish).
  - The consequent impacts on fisheries of any changes in seasonality and distribution.
  - Provision of management advice for decision-making in climate change adaptation and disaster risk management.
- A selection of published research papers reporting relevant work on recreational fisheries is presented in Appendix 5.

Issues perceived as constraints in conducting the work of the WG

- Apparent reluctance of key members to implement and champion the Flyingfish FMP.
- Institutional and language constraints of including Martinique in the initiatives.

Key research priorities for discussion by the WG

A review of the Sub-regional Flyingfish FMP and other research literature (Appendix 5) suggests the following key research priorities for the working group:

- Examination of the constraints and opportunities for meaningful implementation of the Sub-regional FMP
- Development of a harmonized catch and effort database for flyingfish fisheries to be shared by relevant members.
- Determination of the location of critical flyingfish spawning areas

- Impacts of *Sargassum* influx on the flyingfish resource and the fishery

6. WECAFC

Working Group on the management of deep-sea fisheries

Current research/action by the working group (for period 2012-2015)

- A FAO/WECAFC Technical Workshop on 'Bottom Fisheries in the High Seas Areas of the Western Central Atlantic' was held in October 2014 in Barbados.
- Since this workshop, the working group has sharing information with partner organizations, WECAFC members and the United Nations. Moreover, the convener organized a conference in October 2015 in which various WG members participated.

Associated research relevant to the working group

- Research is being conducted on potential for new deep-sea fisheries in the Colombian Caribbean Sea (Appendix 6).
- The Latin American Congress of Ocean's Sciences (COLACMAR) will hold a conference from 18-22 October, 2015 in Santa Marta with a section about Deep-sea fisheries and vulnerable ecosystems.
- A selection of published research papers reporting relevant work on recreational fisheries is presented in Appendix 6.

Issues perceived as constraints in conducting the work of the WG

- Limited funding available for WG meetings.

Key research priorities for discussion by the WG

Discussions with the WG convener together with a review of the relevant literature (Appendix 6) including the suggestions and recommendations of the technical workshop on 'Bottom Fisheries in the High Seas Areas of the Western Central Atlantic' that was held in Barbados, suggests the following key research priorities for the working group:

- Implement 'International Guidelines for the Management of Deep-sea Fisheries in the High Seas' throughout WECAFC member states.
- Submit a research proposal to the Nansen Programme for support to examine the potential for deep-sea fisheries in the WECAFC region.
- Disseminate existing identification guides for species caught by deep-sea fisheries in the region.

7. CFMC/WECAFC/OSPESCA/CRFM

Spawning Aggregations Working Group

Current research/action by the working group (for period 2012-2015)

- The CFMC/WECAFC/OSPESCA/CRFM Working Group on Spawning Aggregations had its first meeting in Miami, USA in Oct 2013. This was reported in:
  - FAO Western Central Atlantic Fishery Commission (2014). Report of the first meeting of the CFMC/WECAFC/OSPESCA/CRFM Working Group on Spawning Aggregations, Miami, United States of America, 29–31 October 2013. FAO Fisheries and Aquaculture Report. No. 1059. Bridgetown, Barbados, FAO. 29 pp
- The main outcomes of the meeting were:
  - Concern regarding the on-going decline in stocks of many aggregating species (especially groupers and snappers) in the Wider Caribbean Region
  - Recognition and concern regarding reduced numbers of spawning aggregations and the small size of remaining aggregations.
  - Agreement that the status of Nassau grouper, goliath grouper and several other species stocks in the Wider Caribbean Region should be considered as "overexploited" or in some cases as "depleted".
  - Recognition of the high ecological and biological value of reef fishes that aggregate to spawn for the ecosystem and aquatic biodiversity in the region.
  - Recognition of the importance of these reef fish, if properly managed, in contributing to regional food security and livelihood objectives.
  - A compilation of information on spawning aggregation management and conservation measures in place, and their current effectiveness.
  - The adoption of a "Declaration of Miami" in which the WG members committed to individually and collectively take measures and actions to further improve the management and conservation of fish aggregations and aggregating species in the Wider Caribbean Region. Specifically the Declaration included:
    - Endorsement of recommendations to the 6th WECAFC Scientific Advisory Group and 15th session of WECAFC on the establishment of a regional suit of harmonized closed seasons for specific species (starting with Nassau Grouper and adding others as appropriate) in the WECAFC area to protect spawning of overexploited aggregating species.
    - Recommendation that the WECACFC countries collect and share species-specific national and international trade data for Nassau Grouper and other fish species that aggregate to spawn.
    - Recommendation that WECAFC members propose the listing of species that aggregate to spawn (in particular Nassau grouper and goliath grouper) under Annex III of the SPAW Protocol
    - Recommendation that WECAFC, CFMC, CRFM and OSPESCA support the development of a 'Regional Plan for the Management and Conservation of Fish Species that Aggregate to Spawn' for presentation to the 16th session of WECAFC in 2016 for review, consideration and regional adoption
    - Recommendation that member countries assess the timing, location and status, of all known transient multi-species spawning aggregations, and produce a prioritized list of sites for monitoring, conservation and management.

  - Recommendation that assessments be conducted along with local fishers who presently fish these aggregations.
- The 15th session of WECAFC recommended establishment of a regional closed season for fisheries in the WECAFC area to protect spawning aggregations of groupers and snappers.

Associated research relevant to the working group

There is a vast amount of research being conducted on Spawning Aggregations including but not limited to work in the Florida Keys, Belize, USVI, Cayman Islands, Mexico and Puerto Rico.

  - The majority of the studies in the USVI are using acoustic telemetry to understand timing and movement patterns around aggregation sites and area requirements for determining boundaries for MPAs.
- The work of the international marine science and conservation NGO 'Science and Conservation of Fish Aggregations' (SCRFA) is very relevant to the WG (see http://www.scrfa.org/). Recently they have:
  - Released a new film in September 2015 highlighting the link between fish spawning aggregations, ecosystem health and food and livelihood security (see: https://www.youtube.com/watch?v=bpLMCyx9cic)
  - Published a global report on status of spawning aggregations,
- The Belize National Spawning Aggregation Working Group (BNSAWG), initiated in 2001 as an effective collaboration among NGOs, Belize Fisheries Department and Fisher Organizations, continues to work actively in improving the conservation and sustainable management of the country's important SPAG sites
  - They publish annual reports of work achieved which are available on their website, along with many other relevant documents on successes and lessons learned by the group, and status reports of the SPAG sites in Belize (see http://www.spagbelize.org/en-us/home.aspx).
  - SPAG sites are managed as no-take areas (no fishing of any kind), patrols are strengthened, particularly during the closed seasons, and illegal harvesting of Nassau groupers does not occur.

The 2014-2015 work plan includes the following activities

  - To manage, monitor and patrol spawning aggregation sites for the next five years, including monitoring the impact of use on the sites
  - To involve the stakeholders in monitoring, research, and patrolling of spawning aggregation sites
  - To create, house, and maintain a spawning aggregation database
  - To analyze the data and provide recommendations for the conservation, protection and sustainable use of the sites
  - To disseminate information for the education of all stakeholders
  - To utilize the information to advocate for and build support for the management, conservation, protection and sustainable use of the spawning aggregation sites
  - To support other initiatives that contribute to this general goal
  - To promote alternatives for the traditional users of spawning aggregation sites.
- A selection of published research papers reporting relevant work on fish spawning aggregations is presented in Appendix 7.

Issues perceived as constraints in conducting the work of the WG

- No funding was secured for the 2014-2015 biennium. The Convener is seeking to hold a WG meeting in 2016 or 2017.

Key research priorities for discussion by the WG

Discussions with SCFRA together with a review of the recommendations from the last meeting and other relevant literature (Appendix 7) and active researchers in the region suggests the following key research priorities for the working group:

- Update and publish the spawning aggregations monitoring manual for WECAFC members.
- Focus on the need for regional action that harmonizes management including:
  - Develop a regional plan for the management and conservation of fish species that aggregate.
  - Implement the agreed recommendation of a regional closed season for fisheries in the WECAFC area in order to protect spawning aggregations of groupers and snappers.
  - Identify areas for the seasonal closure of commercial and recreational fishing on Nassau grouper for the period 1 December -31 March.
  - Establish base line conditions at Fish Spawning Aggregation (FSA) sites to know if populations are increasing or declining and determining the appropriate management (seasonal, market or area closures) to best protect and rebuild overfished spawning populations.

8. WECAFC/CRFM/IFREMER

Working Group on Shrimp and Groundfish in the Northern Brazil-Guianas Shelf

Current research/action by the working group (for period 2012-2015)

- First meeting of the working group took place in conjunction with the 'Shrimp and Groundfish Investment Workshop' in September 2015 in Barbados. Outcomes of this meeting included:
  - Updating and endorsing TORs and Recommendations of the former WECAFC *ad hoc* working group on Shrimp & Groundfish as appropriate for the newly formed WG.
  - The preparation of a general investment plan for the sector, to improve efficiency and profits in a sustainable fishery, which should be followed by pre-feasibility studies in each of the countries in 2016.
  - A bio-economic assessment was carried out by the Working Group and reviewed in 2015.
  - An analysis of management controls and measures used in shrimp and groundfish fisheries was carried out in preparation of the WG meeting.
  - Endorsing draft Recommendation for WECAFC 16 to:
    - Increase collaboration in stock assessments of fish and shrimp resources among countries.
    - Build capacity to carry out the necessary analyses in support of fisheries management decision making.
    - Develop a regional plan of action to combat illegal, unreported and unregulated (IUU) fishing

- Develop a sub-regional shrimp and groundfish fishery management plan for the Northern Brazil-Guianas Shelf countries.
- Assist countries in conducting the necessary feasibility studies for the preparation of fully-fledged, location-specific fisheries investment proposals.

Associated research relevant to the working group

- The CLME project Strategic Action Programme (SAP), which was endorsed by the countries of the region as well as by regional bodies and organizations clearly identifies the key strategies and actions to be pursued for a sustainable exploitation and management of the groundfish and shrimp fisheries of the North Brazil-Guianas Continental Shelf and the entire CLME region.
- Under CLME+ there is a Shrimp and Groundfish Sub-project that aims to update shrimp and groundfish status reports on catch and effort, biological and socio-economic information to be disseminated through FIRMS resources and fisheries inventories for 4 participating countries.
- A selection of published research papers reporting relevant work on shrimp and groundfish is presented in Appendix 8.

Issues perceived as constraints in conducting the work of the WG

- The frequent changes in national experts participating in the WG and relevant CLME meetings on the same subject cause that steps taken in terms of delivery of advice for management are slow. Involvement of private sector stakeholders has increased, but in fact the contribution by the private sector stakeholders to the work of the WG is limited.

Key research priorities for discussion by the WG

A review of the recommendations from the first meeting and other relevant literature (Appendix 8) suggests the following key research priorities for the working group:

- Conducting biological/ecological stock assessments to define the current status of stocks in the region.
- Improving data collection and information on catch and by-catch (including discarded by-catch), especially of vulnerable/endangered species.
- Examining current use of by-catch reduction technology/devices by the fleets, and the impact of such devices on economic viability of the fishery.
- Examination of livelihoods dependence and value chain analysis.
- Development of financially and ecologically sound business plans for investment in the fishery, including the potential for greater access to niche markets (e.g. Marine Stewardship Council certification).

9. WECAFC/CRFM/OSPESCA/CFMC

Working Group on Sharks

Current research/action by the working group (for period 2012-2015)

A virtual meeting was held with those members of the working group that could attend in October 2015 to discuss current work of the members and future actions. The following was reported:

- Antigua and Barbuda have developed a National Plan of Action (NPOA) for the conservation and management sharks which is currently awaiting cabinet approval.
- Barbados is in the early stages of developing a NPOA for sharks, with a preliminary field assessment of elasmobranch resources currently underway.
- Trinidad and Tobago are developing a NPOA for sharks and have so far conducted surveys describing the shark fisheries and by-catch in Trinidad.

Associated research relevant to the working group

- The Smithsonian Institute and the Pew's Global Shark Conservation Campaign are collaborating on a project to characterize and quantify shark species being sold in local markets across the Wider Caribbean using genetic barcoding techniques.
- The Inter-American-Tropical-Tuna-Commission (IATTC) (specifically Salvador Siu) is working on shark fisheries in Central America.
- The Cape Eleuthera Institute in The Bahamas has a very active Shark Conservation and Research Group that is working on a number of relevant research projects (see http://www.ceibahamas.org/research/sharks/)
- The Global FinPrint project (https://globalfinprint.org/) is using Baited Remote Underwater Video (BRUV) units to determine relative abundance and diversity of elasmobranchs in reef areas across the globe. A prototype was tested at the end of October in Barbados as a first step in assessment of elasmobranchs there.
- Effective from 1st January 2012, OSPESCA's Regional Regulation OSP-05-11 prohibits the practice of shark finning within SICA member countries.
- An email survey was conducted in 2015 by CRFM & WECAFC across member countries asking about the status of their shark fisheries and shark research. A few responded as given below:
    - Suriname lands some sharks, but is mostly concerned with the use of by-catch reduction devices that prevent capture of elasmobranchs in their seabob fishery, in keeping with their MSC certification.
    - Several countries report that sharks are landed but not targeted, and that they are considered low priority for management due to limited resources that are directed towards species of greater commercial significance. They are generally caught as by-catch (e.g. St Lucia) especially in the snapper fishery (e.g. Anguilla).
    - Many of the islands do not disaggregate shark landings in their catch database, although ICCAT contracting parties (e.g. Trinidad & Tobago) make an effort to do so.
    - PEW Shark Conservation Campaign is conducting collaborative research in Trinidad and Grenada
    - The catching and selling of sharks in the Bahamas has been prohibited since 2011
- A selection of published research papers reporting relevant work on sharks is presented in Appendix 9.

Issues perceived as constraints in conducting the work of the WG

- Due to non-availability of funding the WG has not met since establishment.

Key research priorities for discussion by the WG

Discussion with regional experts and a review of the relevant literature (Appendix 9) suggests the following key research priorities for the working group:

- Conduct assessments of the shark fishery and resources in each of the member countries.
- Develop Shark-NPOAs in all countries with significant shark landings.

- Develop a Regional POA for the conservation and management of sharks.

10. CRFM/ WECAFC/OSPESCA/CFMC

Working Group on IUU Fishing

Current research/action by the working group (for period 2012-2015)

- Unknown, since establishment of the WG in March 2014, but some associated actions were conducted by institutional members of the group below.
- The convener of the WG, CRFM, has drafted together with WECAFC, a project for NOAA funding to support the 1st meeting of the WG in 2016.

Associated research/action relevant to the working group

- FAO/WECAFC held a 'Workshop on Implementing the 2009 FAO Agreement on Port State Measures to Combat Illegal, Unreported and Unregulated (IUU) Fishing' in Port of Spain, Trinidad and Tobago, 24-28 March 2014.
- The 2014 15th session of WECAFC adopted the following relevant resolutions;
  - WECACF/15/2014/9 on implementation of the Port State Measures Agreement and the FAO Voluntary Guidelines on Flag State Performance in the region.
  - WECAFC/15/2014/6 on region-wide support to the implementation of the CRFM Castries, St Lucia, (2010) Declaration on Illegal, Unreported and Unregulated Fishing.
- St Kitts and Nevis is now party to the 1995 United Nations Fish Stocks Agreement (UNFSA), focusing on high seas fishing for straddling and highly migratory fish stocks, and the 2009 Port State Measures Agreement (PSMA) on combating IUU fishing. As a result, they became the first country in the region to introduce port inspection measures of international best-practice standards.
- NOAA, USA is very active in research and efforts to tackle IUU fishing.
  - The National Ocean Council Committee on IUU fishing and Seafood Fraud (NOC Committee) has developed a 'Draft list of principles for determining species at risk of IUU fishing and seafood fraud'. This will serve as the basis for the first phase of a risk-based seafood traceability program (see http://www.nmfs.noaa.gov/ia/iuu/taskforce.html)
  - In 2014 NOAA announced its commitment to establishing an integrated seafood traceability program as part of a broader, coordinated effort to tackle IUU fishing. Trade Monitoring Programs for seafood and fisheries products will be going electronic. NOAA Fisheries is working with U.S. Customs & Border Protection on the International Trade Data System (ITDS), a single U.S. government system for electronic submission of trade data that will make it easier for industry and seafood suppliers to ensure only legally caught seafood enters the U.S. market (see details of this and other initiatives at http://www.nmfs.noaa.gov/ia/iuu/iuu_stories.html).
  - NOAA's 2015 biennial report to Congress on IUU fishing identified six nations: Colombia, Ecuador, Mexico, Nigeria, Nicaragua, and Portugal as engaging in the practice (see http://www.nmfs.noaa.gov/mediacenter/2015/02/09_02_iuureport.html)
- The high-level international 'Our Ocean' conference held in October 2015 in Chile saw the announcement of 'Sea Scout' a new global initiative that seeks to unite governments and other stakeholders worldwide in the fight against IUU fishing by focusing global assets and

partnerships on identifying, interdicting, and prosecuting IUU fishing organizations and networks around the world.

- ICCAT is active in initiatives to further combat IUU fishing activities, and to strengthen its monitoring, control, and surveillance regime. They have adopted the following recommendations:
    - The trans-shipment of Atlantic HMS (Recommendation 12-06);
    - International port inspection for vessels landing Atlantic HMS in foreign ports or making port calls in foreign ports (Recommendation 12-07);
    - Use of unique vessel identifiers (Recommendation 13-13).
- CRFM and partners is hosting a regional validation workshop in October 2015 in Grenada as part of an initiative to provide technical support to produce new prosecution and enforcement manuals for CARIFORUM States to enhance the effectiveness of fisheries monitoring, control and surveillance, in order to combat IUU fishing.
- A selection of published research papers reporting relevant work on IUU fishing is presented in Appendix 10.

Issues perceived as constraints in conducting the work of the WG

- None highlighted, but funding constraints limited development of the WG.

Key research priorities for discussion by the WG

A review of the relevant literature (Appendix 10) suggests the following key research priorities for the working group:

- Develop a legal basis and capacity for the implementation of effective port state measures at the national level.
- Facilitate the discussion of wider regional plans to combat IUU and the sharing of 'best practice' in the design and implementation of Port State Measures (PSM).
- Provide technical assistance to strengthen institutional capacity so as to ensure the effective implementation of PSM in the member states.
- Examine the current impacts of IUU fishing on transboundary fish stocks and fisheries in the region.

Appendices – Annotated Bibliographies

Appendix 1 – Spiny Lobster

Catch quotas

- Babcock, Elizabeth A., Robin Coleman, and Janet Gibson (2012). Toward Catch Quotas for Spiny Lobster (*Panulirus argus*) at Glover's Reef Marine Reserve. Available at: http://www.wcsgloversreef.org/wpcontent/uploads/2013/04/Babcock_Catch_Quotas_Lobster_2012.pdf

Management efforts

Gittens, Lester (2014). The Bahamian spiny lobster fishery: Current status and the ongoing journey. *10th International Conference and Workshop on Lobster Biology and Management*, Cancun, Mexico.

> The Bahamas recently embarked on a multiyear fisheries improvement project among the government, private sector, local and international NGOs, and fisher organizations with further motivation for change driven by an interest in Marine Stewardship Council (MSC) certification of the fishery. As a result, management effort has grown and there is a peer reviewed stock assessment of the fishery, an attempt to quantify illegal unreported and unregulated fishing, a study on the prevalence of the PaV1 viral disease, better stakeholder involvement through a formally established national spiny lobster working group, and studies aimed at unravelling some of the unknowns surrounding the effect of casitas on lobster fisheries. However, the journey is not complete, as The Bahamas aims to soon enter an MSC full assessment with the larger goal of ensuring sustainability.

Fisher safety and satisfaction

Box, S. (2014). Solving the lobster diving paradox: Closing the Honduran dive fishery without collapsing the rural economy. *10th International Conference and Workshop on Lobster Biology and Management*, Cancun, Mexico.

> For four decades the Miskito of eastern Honduras have worked in the scuba diving fishery to harvest spiny lobster. The work is dangerous, with an average of 120 dive accidents (20 fatal) each season requiring treatment in a decompression chamber. In 2012 a census of communities in the Honduran Moskitia found 1,180 paralyzed men (an alarming 18% of the male working age population in the region). There is general consensus that this damaging fishery needs to end, but the challenge is that closing the dive fishery would remove an estimated $7.2 million from the rural economy, in an area where dive fishing is the main source of employment. Local groups in the Moskitia have been developing a viable solution: to replace the dive fishery with a skin diving fishery using lobster shades positioned around a string of 49 offshore cays, in a 14,500 km^2 area that the Miskito groups are asking to be designated for the exclusive use of artisanal fishers. Ongoing research to support the Miskito plans have integrated remote sensing, in-water surveys, genetic studies and market chain analysis to help underpin the development of this new lobster fishery. The aim is to convert a socially and ecologically damaging fishery into one that's locally managed and sustainable.

Monnereau, Iris, and Richard Pollnac (2012). Which fishers are satisfied in the Caribbean? A comparative analysis of job satisfaction among Caribbean lobster fishers. *Social indicators research* 109: 95-118.

Monnereau, Iris, and Patrick McConney (2015). Governability of Small-Scale Lobster Fisheries in the Wider Caribbean. In *Interactive Governance for Small-Scale Fisheries*, pp. 223-241. Springer International Publishing.

Pathogenic *Panulirus argus* virus 1 (PaV1)

Moss, Jessica, Mark J. Butler, Donald C. Behringer, Jeffrey D. Shields (2012). Genetic diversity of the Caribbean spiny lobster virus, *Panulirus argus* virus 1 (PaV1), and the discovery of PaV1 in lobster postlarvae *Aquatic Biology* 14: 223–232

Behringer, Donald C., Mark J. Butler and Jeffrey D. Shields (2010). A Review of the Lethal Spiny Lobster Virus PaV1 – Ten Years After Its Discovery. *Proceedings of the Gulf and Caribbean Fisheries Institute* 62: 370-375

The *Panulirus argus* virus 1 (PaV1) was first discovered in Caribbean spiny lobsters from the Florida Keys, USA and has since been confirmed in lobsters in other parts of the Caribbean. The disease is now considered a threat to fisheries throughout the pan-Caribbean range of *P. argus*. The virus is lethal; infected lobsters die over one to several months with more rapid mortality for small juveniles. Genetic analysis of the virus indicates that lobsters can be infected with multiple viral strains. The discovery of PaV1 in *P. argus* postlarvae (pueruli), suggests that the virus may disperse through the Caribbean within the long-lived (5 to 7 mo) planktonic phyllosoma larvae.

Larval connectivity

Cruz, Raúl, Carlos EP Teixeira, María OB Menezes, João VM Santana, Toivi M. Neto, Juliana C. Gaeta, Pedro P. De Freitas, Katia CA Silva, and Israel HA Cintra (2015). "Large-scale oceanic circulation and larval recruitment of the spiny lobster *Panulirus argus* (Latreille, 1804)." *Crustaceana* 88: 298-323.

Butler, Mark, Andrew Kough and Claire Paris (2014). Caribbean spiny lobster larval connectivity: the "Holy Grail" for management of an iconic species. *10th International Conference and Workshop on Lobster Biology and Management*, Cancun, Mexico.

Predicting the oceanic dispersal of the planktonic larvae that connect disjunct marine populations is difficult, especially for species such as spiny lobster whose long-lived larvae do not recognize geopolitical boundaries. Yet, understanding the connectivity of lobster metapopulations among often far-flung regions is crucial to the sustainable management of lobster fisheries. Multi-scale biophysical modelling coupled with empirical estimates of larval behaviour and gamete production were used to predict and empirically verify the spatio-temporal patterns of larval connectivity throughout the Caribbean from Venezuela to Florida. Various spatial arrangements of marine protected area networks (i.e., random, stratified random, self-recruitment, long-distance dispersal, maximum export) and their influence on the recruitment of lobsters in the Caribbean was also explored. Our findings reveal the long sought sources, sinks, and dispersal corridors of *P. argus* in the Caribbean – information that represents the "holy grail" for the proper international management of this iconic Caribbean species

Monitoring and Assessment

Headley, M. and Seijo, J.C., (2015). A review of the methodologies used for monitoring and evaluation of the spiny lobster stocks in the WECAFC countries and the development of a common methodology. FAO Publication - in prep.

Ley-Cooper, Kim, Simon De Lestang, Bruce F. Phillips, and Enrique Lozano-Álvarez (2013). "Estimates of exploitation rates of the spiny lobster fishery for *Panulirus argus* from tagging within the Bahía Espíritu Santo 'Sian Ka'an' Biosphere Reserve, Mexican Caribbean." *Marine Biology Research* 9: 88-96.

MPAs

Ley-Cooper, K., S. De Lestang, B. F. Phillips, and E. Lozano-Álvarez (2014). An unfished area enhances a spiny lobster, *Panulirus argus*, fishery: implications for management and

conservation within a Biosphere Reserve in the Mexican Caribbean. *Fisheries Management and Ecology* 21: 264-274.

The Sian Ka'an Biosphere Reserve has since received MSC certification for the spiny lobster fishery.

Maxwell, Kerry E., Thomas R. Matthews, Rodney D. Bertelsen, and Charles D. Derby (2013). Age and size structure of Caribbean spiny lobster, *Panulirus argus*, in a no-take marine reserve in the Florida Keys, USA. *Fisheries Research* 144: 84-90.

Appendix 2 - Recreational Fisheries

Reviews

Alió, J. J. (2013) Recreational Fishery Component of the Caribbean Large Marine Ecosystem, Large Pelagic Fisheries Case Study: Southern Caribbean Area (Venezuela with Notes from Colombia) *CRFM Research Paper Collection,* 7: 1-26.

In spite of the long history of recreational fishing as an activity, rules to regulate it are of relative recent origin (the first regulation in 1944 and then 2008 in Venezuela and 1991 in Colombia). Since 1988, an ICCAT financed project on sport fishing of billfishes has recorded the results of most sport fishing events and evaluated the tendencies of the historic abundance (CPUE) of the different species. Billfish are incidentally captured by industrial tuna long liners and directly targeted by artisan fishers off the central coast and in northern Margarita Island. There is seldom overlap in the areas of operation of sport fishers and the industrial fleet, but complete overlap between sport and artisan fishers in the central coast which is a source of an unresolved conflict. Few research activities have been performed in Colombia on sport fishing. There has been a recent complaint against the granting of permits to foreign industrial tuna long liners because billfish by-catch cannot be avoided and this will further reduce the low densities of these resources. Along with the economic importance of sport fishing to local economies, the data provided from these activities in the Southern Caribbean Sea area have proven to be of enormous importance for the assessment of the billfish resources in the general Atlantic Ocean Information on distribution of fishing effort.

Mohammed, E. (2013) Recreational fisheries of the Eastern Caribbean. *CRFM Research Paper Collection,* 7: 27-95.

Many countries in the Caribbean are known for their sport fishing which is a major component of marine-based tourism activities and targets mainly billfishes, yellowfin tuna, wahoo, king mackerel and the common dolphinfish. However, recreational fisheries have received limited management attention in most Caribbean countries due to the absence of relevant governance mechanisms and the paucity of data and information to facilitate effective management. The paper provides a description of the key elements of recreational fisheries in selected eastern Caribbean countries, with emphasis on the biological, ecological, economic and sociological aspects relevant to fisheries management. Preliminary estimates of catches, landings, number and species of fish tagged and released, fishing effort, revenue and cost of fishing among other key factors are derived for selected components of the fisheries. Current legislation and management measures implemented in the region are reviewed and ecological and technological interdependencies with commercial fisheries are discussed. Based on the findings recommendations for future research and management of recreational fisheries, consistent with the ecosystem approach to fisheries management are proposed.

Carter, A. L., Mackesey, B., Chaibongsai, P., Cox, A., Peel, E. (2013) Caribbean pelagic recreational fishing, economic growth, poverty alleviation, and food security. *CRFM Research Paper Collection,* 7: 96-169.

This report aims to better characterize and quantify the economic importance of recreational fishing for highly migratory pelagic species in the Northern Caribbean (Puerto Rico & USVI) and offers insight to fisheries managers tackling significant challenges in the development of effective

regional management strategies. Despite regulatory challenges, recreational highly migratory species fisheries provide essential employment opportunities, vital food security, and significant prospects for economic development in the Caribbean and justify further socioeconomic study. While commercial fishing industries have a long history of participation in the regulatory process, recreational stakeholders have only recently began to garner the attention of Caribbean governments.

Movements and stock structure - dolphinfish

Baird, Spencer F. (2015). Genetic structure and dispersal capabilities of dolphinfish (*Coryphaena hippurus*) in the western central Atlantic. *Fishery Bulletin* 113: 419-429.

Merten, Wessley, Richard Appeldoorn, and Donald Hammond (2014). Movements of dolphinfish (*Coryphaena hippurus*) along the US east coast as determined through mark and recapture data. *Fisheries Research* 151: 114-121.

Merten, Wessley, Richard Appeldoorn, and Donald Hammond (2014). Spatial differentiation of dolphinfish (*Coryphaena hippurus*) movements relative to the Bahamian archipelago. *Bulletin of Marine Science* 90: 849-864.

Dolphin Research Programme (2015) April newsletter - available at: http://dolphintagging.homestead.com/News.html

Reports using satellite tags to track dolphinfish movements in northern Caribbean / USA. Northern stock migration route proposed by Oxenford and Hunte (1986) is strongly supported both in timing and space by these results.

Climate change impacts – billfishes and tuna

Muhling, Barbara A., Yanyun Liu, Sang-Ki Lee, John T. Lamkin, Estrella Malca, Joel Llopiz, G. Walter Ingram Jr et al. (2015). Past, ongoing and future research on climate change impacts on tuna and billfishes in the Western Atlantic. *Collect. Vol. Sci. Pap. ICCAT* 71, no. 4 (2015): 1716-1727.

Biology – blue marlin

Arocha, Freddy, Luis Marcano, and José Silva. "Sex Ratio at Size of Blue Marlin (*Makaira nigricans*) from the Venezuelan Fishery off the Caribbean Sea and Adjacent Waters." *Collect. Vol. Sci. Pap. ICCAT* 68, no. 4 (2012): 1387-1396.

Appendix 3 - Queen Conch

CRFM (2013).Support to improve and harmonize the scientific approaches required to inform sustainable management of queen conch (*Strombus gigas*) by CARIFORUM States: Regional review of the queen conch. CRFM Technical and Advisory Document. No. 2013/11

Aldana D. H.A. Oxenford, C. Bissada, M. Enriquez, T. Brulé, G.A. Delgado, I. Martínez, and L. Frenkiel (2014). Reproductive patterns of queen conch, *Strombus gigas* (Mollusca gastropoda) across the wider Caribbean. *Bulletin of Marine Science* 90: 813-831.

Outlines distinctly different reproductive strategies of queen conch from different geographical locations and the implications for regionally harmonized closed seasons to protect spawning stock.

FAO (2012). Report of the first meeting of the CFMC/OSPESCA/WECAFC/CRFM Working Group on Queen Conch. Fisheries and Aquaculture Report 1029: 99-102.

Appeldoorn RS and N. Baker (2013). A literature review of the queen conch, *Strombus gigas*. Department of Marine Sciences, University of Puerto Rico. Unpublished. 80p.

Banks, Michael A., Jonathan D. Minch, and Allan W. Stoner (2014). Preliminary report on population genetic structuring among queen conch (*Strombus gigas*) from The Bahamas. Technical Report to the Community Conch. Available from: http://www.communityconch.org/our-research

Identifying genetically distinct populations is a critical link for guiding sustainable management of heavily exploited fishery species. Early genetic studies with queen conch (*Strombus gigas*) indicated a high degree of gene flow among populations dispersed over the species' geographic distribution, with definitive separation observed only between populations in Bermuda and those in the Caribbean basin (Mitton et al. 1989). Two relatively recent developments indicate that a closer look at population connectivity is warranted. First, we know now that pelagic larvae are often retained within close proximity to the parental stocks by mesoscale and fine-scale ocean circulation in the Caribbean region allowing for localized self-recruitment patterns (Kool et al. 2010). Second, new, more sensitive genetic tools have been developed revealing previously undetected genetic structure within populations of Caribbean species (see Christie et al. 2010) that is relevant to fisheries management. Knowledge of genetic connectivity among stocks is critical in determining the appropriate geographic units for fisheries management including quotas, the design of marine protected areas, and international relations related to sources of recruitment for fishery stocks in a complex geopolitical environment such as the Caribbean Sea.

CRFM (2013). Report of workshop to deliver training in the conduct of queen conch field surveys. CRFM Technical and Advisory Document, No. 2013/16.

Stoner, Allan W., Martha H. Davis, and Catherine J. Booker (2012). Abundance and population structure of queen conch inside and outside a marine protected area: repeat surveys show significant declines. *Marine Ecology Progress Series* 460: 101-114.

Stoner, Allan W., Karl W. Mueller, Nancy J. Brown-Peterson, Martha H. Davis, and Catherine J. Booker (2012). Maturation and age in queen conch (*Strombus gigas*): Urgent need for changes in harvest criteria. *Fisheries Research* 131: 76-84.

Research indicated that queen conch gonad maturity lagged substantially behind first formation of the shell lip. Minimum LT for reproductive maturity was 12 mm for females and 9 mm for males, and 50% maturity for the population was achieved at 26 mm LT for females and 24 mm LT for males, higher than previous estimates. A review of fishing regulations indicates that immature queen conch are being harvested legally in most Caribbean nations, providing at least a partial explanation for widespread depletion. While relationships between shell lip thickness, age, and maturity vary geographically, sustainable management of queen conch will require a minimum shell lip thickness for harvest no less than 15 mm, along with other urgently needed management measures.

Stoner, Allan W., Martha H. Davis, and Catherine J. Booker (2012). Negative consequences of Allee effect are compounded by fishing pressure: comparison of queen conch reproduction in fishing grounds and a marine protected area." *Bulletin of Marine Science* 88: 89-104.

Surveys for queen conch *Strombus gigas* made in 2011 at two locations in the Exuma Cays, The Bahamas, were compared with surveys conducted during the early 1990s at Warderick Wells (WW) near the center of the Exuma Cays Land and Sea Park (ECLSP) and at a fished site near Lee Stocking Island (LSI). There was no change in adult conch density and abundance in the shallow bank environment at LSI where numbers were already low in 1991, but numbers declined 91% in the deeper shelf waters. At WW, the adult population declined 69% on the bank and 6% on the island shelf. Unlike observations made in the 1990s, queen conch reproductive behavior near LSI is now rare. Average age of adult conch (indicated by shell thickness) at LSI decreased significantly during the 20 yr period between surveys, while average age increased at WW and juvenile abundance decreased. These results show that the LSI population is being overfished and the WW population is senescing because of low recruitment. In 2011, the ECLSP continued to be

an important source of larvae for downstream populations because of abundant spawners in the shelf environment. However, it is clear that the reserve is not self-sustaining for queen conch, and sustainable fishing in the Exuma Cays will depend upon a network of MPAs along with other management measures to reduce fishing mortality.

Appendix 4 – Moored FADs

CRFM (2013). Report of the CRFM-JICA CARIFICO/WECAFC - IFREMER MAGDELESA Workshop on FAD Fishery Management, 09 - 11 December 2013, St Vincent and the Grenadines. CRFM Technical & Advisory Document, No. 2013/9. 42p.

Alvard M, Carlson D, McGaffey E (2015) Using a partial sum method and GPS tracking data to identify area restricted search by artisanal fishers at moored fish aggregating devices in the Commonwealth of Dominica. PLoS ONE 10(2): e0115552. doi:10.1371/journal.pone.0115552

Management

Guyader, Olivier, Manuel Bellanger, Lionel Reynal, Sébastien Demanèche, and Patrick Berthou (2013). Fishing strategies, economic performance and management of moored fishing aggregating devices in Guadeloupe. *Aquatic Living Resources* 26: 97-105.

Proudfoot, Maddison, and Susan Singh-Renton (2012). Exploring the use of an ecological risk assessment tool for management of the large pelagic fishery in the Eastern Caribbean. *CRFM Research Paper Collection* 6: 75pp.

Reynal, L., O. Guyader, C. Pau, H. Mathieu, and C. Dromer (2015). Different means contributing to anchored FAD's fishing selectivity in the Lesser Antilles. *Collect. Vol. Sci. Pap. ICCAT* 71: 2297-2301.

Horner, Michele (2011). An overview of the history of fish aggregating devices (FADS) in Dominica. Research paper, Texas A&M University, 7pp.

Taquet, Marc (2013). Fish aggregating devices (FADs): good or bad fishing tools? A question of scale and knowledge. *Aquatic Living Resources* 26: 25-35.

Appendix 5 - Flyingfish

Ecosystem approach to management

Campbell, Brooke, and Susan Singh-Renton (2012). Towards an Ecosystem Approach for flyingfish fisheries in the Eastern Caribbean: An evaluation of Multi-Criteria Analysis as a tool for improving information in multi-objective decision-making. *CRFM Research Paper Collection* 6: 39-74.

Multi-Criteria Analysis (MCA), together with its data needs, was evaluated as a tool for use in multi-objective, ecosystem-oriented, management decision-making for the Eastern Caribbean flyingfish fishery.

Fanning, L. Paul, and Hazel A. Oxenford (2011). Ecosystem issues pertaining to the flyingfish fisheries of the eastern Caribbean, p. 227-240 in: Fanning, Mahon and McConney (eds) *Towards marine ecosystem-based management in the Wider Caribbean*. Amsterdam University Press, Amsterdam.

The Lesser Antilles Pelagic Ecosystem (LAPE) project of the FAO included a consideration of flyingfish and its importance in the ecosystem and to other fisheries. Flyingfishes are an important component of the oceanic pelagic food web, especially for dolphinfish, a fact that should be considered under an ecosystem approach to fishing if expansion of the flyingfish fishery is occurring or planned. Likewise other pelagic fisheries are reliant on flyingfish for bait, which highlights the urgent need to begin monitoring catches that are used for bait, not just foodfish landings, and include them in assessments.

CRFM (2014). Sub-Regional Fisheries Management Plan for Flyingfish in the Eastern Caribbean. CRFM Special Publication No. 2, 42 p. + annexes. Available at: http://www.crfm.net/images/documents/2014%20Sub-regional%20FMP%20for%20Flyingfish%20(final%20version%2025.09.14)%20(1).pdf .

Appendix 6 - Deep-Sea Fisheries

Potential new deep-sea fisheries

Paramo, Jorge, Matthias Wolff, and Ulrich Saint-Paul. "Deep-sea fish assemblages in the Colombian Caribbean Sea." *Fisheries Research* 125 (2012): 87-98.

Paramo, Jorge, and Ulrich Saint-Paul. "Spatial structure of the Caribbean lobster (Metanephrops binghami) in the Colombian Caribbean Sea." *Helgoland Marine Research* 66, no. 1 (2012): 25-31.

Takei, Yoshinobu (2013). *Filling regulatory gaps in high seas fisheries: discrete high seas fish stocks, deep-sea fisheries and vulnerable marine ecosystems*. Martinus Nijhoff Publishers.

Mahon, Robin, Lucia Fanning, and Patrick McConney (2014). Assessing and facilitating emerging regional ocean governance arrangements in the Wider Caribbean Region. *Ocean Yearbook Online* 28: 631-671.

Paramo, Jorge, and Ulrich Saint-Paul (2012). Deep-sea shrimps *Aristaeomorpha foliacea* and *Pleoticus robustus* (Crustacea: Penaeoidea) in the Colombian Caribbean Sea as a new potential fishing resource. *Journal of the Marine Biological Association of the United Kingdom* 92: 811-818.

Appendix 7 - Spawning Aggregations

Overview

Sadovy de Mitcheson, Y., and P.l. Colin (eds.) (2012). *Reef Fish Spawning Aggregations: Biology, Research and Management*, Springer Netherlands Springer Netherlands. 621pp.

13 Chapters of relevance to the working group.

Hughes, Roger N., David Hughes, and I. Philip Smith (2013). Biogeography of transient reef-fish spawning aggregations in the Caribbean: a synthesis for future research and management." *Oceanography and Marine Biology: An Annual Review* 51 (2013): 281-326.

One of the major threats to spawning aggregations is overfishing, accompanied by a general absence and/or poor application of fishery management. The proposal of mariculture, through hatchery-rearing, increases production of a few species and contributes to satisfying high market demand, but many such operations

depend heavily on wild-caught juveniles with resultant growth and recruitment overfishing. Better management of fishing and other conservation efforts are urgently needed, and we provide examples of possible actions and constraints.

Other relevant literature at SCRFA: http://www.scrfa.org/studying-aggregations/publications.html

Status

Sadovy de Mitcheson, Yvonne, Matthew T. Craig, Athila A. Bertoncini, Kent E. Carpenter, William WL Cheung, John H. Choat, Andrew S. Cornish et al.(2013). Fishing groupers towards extinction: a global assessment of threats and extinction risks in a billion dollar fishery. *Fish and Fisheries* 14: 119-136.

Russell, M.W., Sadovy de Mitcheson, Y., Erisman, B.E., Hamilton, R.J., Luckhurst, B.E., Nemeth, R.S. (2014). Status Report – World's Fish Aggregations 2014. Science and Conservation of Fish Aggregations (SCRFA), California, USA and International Coral Reef Initiative (ICRI).

Amargos et al (2012). The importance of the use of traditional ecological knowledge to assess Goliath grouper distribution and status throughout Cuba. *Proceedings of the Gulf and Caribbean Fisheries Institute* 65:126-127.

> Used traditional ecological knowledge to assess goliath grouper distribution and status in nine of Cuba's 15 provinces. Goliath grouper are targeted primarily by spearfishers and commercial hook and line fishers operating close to identified spawning corridors and spawning aggregation sites. Interviewees related that abundance and size of goliath grouper has decreased in the last few decades with overfishing of large adults in spawning aggregation sites as a cause of population decline. Tourism focusing on goliath grouper encounters takes place in the Jardines de la Reina archipelago. Expansion of questionnaire-based data collection to other provinces in Cuba is proposed to provide a country-wide baseline for the species and to underpin the development of a national management plan for goliath grouper.

Erisman, B.E., et al. (2013). Sad farewell to C. Lavett-Smith's iconic Nassau spawning aggregation site. *Proceedings of the Gulf and Caribbean Fisheries Institute* 66: 421-422.

> Reports on the disappearance of the largest known Nassau grouper spawning site at Little Cat Cay, Bimini, Bahamas. Anecdotal reports from fishers indicated that the site was fished out by seasonal fishing there in the 1980s.

Management

Sadovy de Mitcheson, Y. (2012). Endangered and unlucky: region-wide action needed for recovery of the Nassau grouper, *Epinephelus striatus.* *Proceedings of the Gulf and Caribbean Fisheries Institute* 65: 295-300.

> The threatened Nassau grouper, with a few important and notable exceptions, continues to decline throughout its geographic range. Unaddressed and emerging threats are set to worsen the situation. Without regional action that harmonizes management across the region, we risk the loss of this iconic species and the benefits it brings. Failure to find the means and political will to save the Nassau grouper, sets the scene for sequential loss of other valuable and vulnerable species with serious consequences for food security and seafood independence for many communities in the region and ongoing threat to marine biodiversity.

Erisman, B.E., et al. (2015). Fish spawning aggregations: where well-placed management actions can yield big benefits for fisheries and conservation. *Fish and Fisheries* DOI: 10.1111/faf.12132

> Provides evidence-based arguments supporting an urgent need to recognize fish spawning sites (FSAs) as a focal point for fisheries management and conservation on a global scale, with particular emphasis placed on the protection of multispecies FSAs. This approach will bring

disproportionately large benefits to fisheries and biodiversity conservation. Numerous case-studies confirm that protected aggregations do recover to benefit fisheries through increases in fish biomass, catch rates and larval recruitment at fished sites. The small size and spatio-temporal predictability of FSAs allow monitoring, assessment and enforcement to be scaled down while benefits of protection scale up to entire populations. Fishers intuitively understand the linkages between protecting FSAs and healthy fisheries and thus tend to support their protection.

Behaviours

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Appendix 8 - Shrimp and Groundfish

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Appendix 9 - Sharks

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Appendix 10 - IUU Fishing

Vulnerability

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It is well recognized that not all fisheries catches are reported or recorded properly by either government or non-government agencies. In the last year of available data, 2010, official and total estimated catches were 1.5 mt and 2.2 mt respectively. This study does not single out a responsible party, but a call to the many sectors of society who contribute to a lack of control, to help overcome these conditions, and increase and sustain the benefits from Mexico's marine fisheries.