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Report of the

SECOND MEETING OF THE CFMC/WECAFC/OSPESCA/CRFM SPAWNING AGGREGATIONS WORKING GROUP (SAWG)

Miami, Florida, 27–29 March 2018



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PREPARATION OF THIS DOCUMENT

This is the report of the second meeting of the CFMC/WECAFC/OSPESCA/CRFM/NOAA Spawning Aggregations Working Group (SAWG) held in Miami, Florida, 27–29 March 2018.

The meeting was hosted by the Caribbean Fisheries Management Council (CFMC) and convened by Mr William Heyman from LGL Ecological Research Associates, Inc.

The workshop was made possible thanks to financial support from the National Oceanic and Atmospheric Administration (NOAA) of the United States of America and the logistical support provided by the CFMC and WECAFC Secretariat.

This final and approved document contains the summary of the presentations, discussions, conclusions and adopted recommendations and work plan. The document was compiled, edited and completed by Mr Heyman with support from workshop participants.

ABSTRACT

The Second meeting of the CFMC/WECAFC/OSPESCA/CRFM Spawning Aggregations Working Group (SAWG) was held in Miami, Florida on 27 and 29 March 2018. In preparation for the meeting, organizers conducted surveys of participants on the current status of FSAs (Appendix D) and management measures in place (Appendix E). The meeting brought together more than 35 fisheries experts, conservationists, marine biologists and fisheries officers from 15 WECAFC member states, national fisheries bodies, fisheries technical advisory institutions, non-governmental organizations, academic scientists, fishers, and other relevant stakeholders.

The experts at the meeting recognized the continued decline in stocks of many aggregating species, particularly groupers and snappers in the Western Central Atlantic. Participants re-affirmed and updated the recommendations of the Miami Declaration that Members of WECAFC made during the 1st SAWG meeting (2013). The SAWG developed a work plan and agreed to roles, responsibilities and timelines for key activities and actions. SAWG members have been extremely active in completing these activities between the time of the meeting and the publication of this report. Priority recommendations are included fully in Appendix A and summarized in priority order here:

1. Develop a Regional Fisheries Management Plan for Nassau grouper and other aggregating species. Present to WECAFC Secretariat in 2020. Members will develop National management plans congruent with the regional plan.
2. Determine the status of all snapper and grouper fish spawning aggregation (FSA) sites in the region and prioritize monitoring and conservation actions at sites based on local institutional capacity and resources, socio-economic value, and size and number of species.
3. Mobilize an active and strategic communications program to spread awareness and support FSA conservation and management actions in the WECAFC region.
4. Engage fishers more directly in FSA conservation and management and provide economic alternatives for FSA fishers.
5. Amplify and support international actions to protect FSAs (closed areas and seasons; gear restrictions, better enforcement).

6. Adopt a regional closed season for Nassau grouper, 1 December – 31 March; prohibit exports (whole, filet, roe) during the closed season.
7. Mobilize resources to support priorities above.

Key elements of the work plan (included in full in Appendix A) are summarized in priority order here:

1. Develop a Regional Fisheries Management Plan (FMP) for FSA-forming species.
2. Develop a strategic outreach and education plan to broadly elevate the urgent regional need to conserve FSAs. This includes presentation at national and international meetings (e.g. SPAW, STAC, COP, etc.).
3. Conduct national status and needs assessments of FSA sites in Member countries (including ecological, socio-economic, legal and institutional assessment criteria).
4. Summarize and synthesize regional status and trends from national reports and define national and regional research and management priorities and actions.
5. Develop and activate a regional cooperative monitoring system for FSAs (including adoption of standardized protocols and data management system).
6. Share technical capacity for FSA identification, characterization, monitoring and conservation.
7. Mobilize resources to support FSA conservation and management from bilateral and international agencies, private foundations, non-profit NGOs, national governments, fishing interests, etc.
8. Maintain SAWG network communications and collaborative efforts via regular communications, participation in regional meetings (e.g. GCFI); work jointly on funding proposals, social media networks, and hold next SAWG meeting in 2020.

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ABBREVIATIONS AND ACRONYMS

BFI	Big Fish Initiative
BNT	Bahamas National Trust
CaMPAM	Caribbean Marine Protected Area Management Network
CCR	closed circuit rebreather
CEP	Caribbean Environment Programme
CFMC	Caribbean Fishery Management Council
CLME	Caribbean Large Marine Ecosystem
CLME+	Caribbean and North Brazil Shelf Large Marine Ecosystems
COBI	Comunidad y Biodiversidad
COFI	Committee on Fisheries (WECAFC)
CONAPESCA	National Aquaculture and Fisheries Commission (Mexico)
CRFM	Caribbean Regional Fisheries Mechanism
CTD	conductivity temperature depth profiler
DGSA	Designated Grouper Spawning Area (Cayman Islands)
DMR	Department of Marine Resources (Bahamas)
EEZ	Exclusive Economic Zone
ESA	Endangered Species Act
FADAR	fish acoustic detection algorithm
FAO	Food and Agriculture Organization of the United Nations
FSA	fish spawning aggregation
FWC	Florida Fish and Wildlife Conservation Commission
FWRI	Fish and Wildlife Research Institute
GCFI	Gulf and Caribbean Fisheries Institute
GCOOS-RA	Gulf of Mexico Coastal Ocean Observing System Regional Association
GoM	Gulf of Mexico
GPS	geographic positioning system
LEK	local ecological knowledge
MPA	marine protected areas
NGO	non-government organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OSPESCA	Central American Fisheries and Aquaculture Organization of the Central American Isthmus
PAM	passive acoustic receiver

PR	Puerto Rico
RAD-seq	restriction-site-associated sequencing
RFB	Regional Fishery Body
RFMO	Regional Fisheries Management Organization
RH	Riley's Hump
S.I.	Statutory Instrument
SAG	Scientific Advisory Group
SAWG	Spawning Aggregations Working Group
SCRFA	Science and Conservation of Fish Aggregations
SERO	Southeast Regional Office
SGoM	Southern Gulf of Mexico
SICA	Central American Integration System
SOMEE	State of the Marine Environment and Ecosystems
SPAW	Specially Protected Areas and Wildlife Protocol
SWOT	strengths weaknesses opportunities threats (analysis)
TOR	terms of reference
UN	United Nations
USD	United States Dollar
USVI	US Virgin Islands
WECAFC	Western Central Atlantic Fishery Commission

OPENING OF THE MEETING

1. The second meeting of the CFMC/WECAFC/OSPESCA/CRFM Spawning Aggregations Working Group (SAWG) was held in Miami, Florida, 27–29 March 2018. Welcome remarks were delivered by the meeting convener, Mr William Heyman and Mr Lionel Reynal, Chairperson of WECAFC.

UPDATE TO THE TERMS OF REFERENCE AND ADOPTION OF THE AGENDA

2. Mr William Heyman, SAWG convener, offered an introductory presentation aimed at updating and clarifying the Terms of Reference for the Working Group. The primary goal of the meeting was to highlight the urgent need for the management of spawning aggregations in the WECAFC region and to define priority actions. By reviewing the recommendations from the 1st SAWG meeting, as outlined in the “Declaration of Miami” the SAWG recognized progress towards the recommendations had been made five years before. Nevertheless, the need for urgent action has increased. The SAWG committed to a common vision and goal to identify next steps for *implementation* of regional activities supporting research, management and conservation of spawning aggregations of Nassau grouper and other aggregating species. Final recommendations and the work plan were developed by consensus and are contained in this report as Appendix A.
3. The agenda was adopted without changes and is available in Appendix C.

ELECTION OF CHAIRPERSONS AND INTRODUCTION OF DELEGATE

4. The SAWG elected Mr Alfonso Aguilar-Perera as the Chair of the meeting, and Ms Celestine Moe as Rapporteur, to support the convener Mr William Heyman. Mr Alfonso Aguilar-Perera, Chair, introduced the SAWG and participants introduced themselves.
5. Representatives of the following States attended the meeting: The Bahamas, Barbados, Belize, Brazil, Cayman Islands, Hong Kong, Mexico, Puerto Rico, Turks and Caicos Islands, US Virgin Islands, and the United States of America. Representatives of the following organizations were present: Caribbean Fisheries Management Council (CFMC), Caribbean Regional Fisheries Mechanism (CRFM) Secretariat, Food and Agriculture Organisation (FAO), National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service Southeast Regional Office (NMFS SERO), Central American Fisheries and Aquaculture Organization of the Central American Isthmus (OSPESCA, and the Specially Protected Areas and Wildlife (SPAW) Protocol of the Cartagena Convention, United Nations Environment Program Regional Coordination Unit (UNEP/RCU) for the Caribbean Environment Programme (CEP).
6. A list of all participants and observers can be found in Appendix B.

INTRODUCTION AND HISTORY OF THE SPAWNING AGGREGATIONS WORKING GROUP

7. Mr Lionel Reynal who referred to the establishment process of the working group, its Terms of Reference (TORs) and the support provided by NOAA. Mr Reynal stated that The WECAFC was established in 1973 by Resolution 4/61 of the FAO Council under Article VI (1) of the FAO Constitution. The WECAFC is the oldest Regional Fishery Body (RFB) in the Caribbean region and has the broadest mandate and membership. The objective of the commission is to promote the effective conservation, management and development of the living marine resources of the area of competence of the Commission, in accordance with the FAO Code of Conduct for Responsible Fisheries and address common problems of fisheries management and development faced by members of the Commission. WECAFC is a so called “Regional Advisory Body” and does not have management authority.

8. Its area of competence is the FAO Area 31 and the north part of Area 41. WECAFC's mandate area includes 51 percent of high seas and 86 percent of its area is deep sea (>400 meters). Membership is open to coastal States whose territories are situated wholly or partly within the area of the Commission or States whose vessels engage in fishing in the area of competence of the Commission. The current membership includes the following (33 countries + EU): Antigua and Barbuda, The Bahamas, Barbados, Belize, Brazil, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, European Union, France, Grenada, Guatemala, Guinea, Guyana, Haiti, Honduras, Jamaica, Japan, Mexico, Netherlands, Nicaragua, Panama, Republic of Korea, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Spain, Suriname, Trinidad and Tobago, United Kingdom, United States of America, and the Bolivarian Republic of Venezuela.
9. WECAFC is structured around four organs that are:
 - The Commission, which is the governing body and meets every two years. All members are part of it. Partner organizations are invited in capacity of observers.
 - The Scientific Advisory Group (SAG), which consists of seven scientists. It provides scientific advice to the commission and the (ad hoc) working groups.
 - The current 11 working groups generate advice and recommendations on fish stocks and fisheries in support of fisheries management decision making processes, based on the best scientific information available. One of these working groups is the joint working group on spawning aggregations.
 - The secretariat is provided by FAO from its sub regional office for the Caribbean. WECAFC is a member of the network of regional fisheries body secretariats, which meets every two years back to back with the Committee on Fisheries (COFI).
10. The first step taken towards establishment of this working group was at the Regional Workshop on Nassau grouper held during 20–21 October 2008 in Cartagena (Colombia). This meeting was attended by 17 countries, organized by the Caribbean Fishery Management Council (CFMC) and WECAFC and financed by NOAA and the NMFS (USA). The main objective was to prepare a regional summary of the status of Nassau grouper fishery and a compilation of country reports. At the end of this meeting, the main recommendations to WECAFC were:
 - i. Establishment of a WECAFC/CFMC Ad hoc Working Group on Nassau grouper (NGW). The tasks proposed for an inter-sessional work plan were to: collect historical documentation, diagnostics and literature reviews, review and compile existing monitoring protocols, foster cooperation among countries, share scientific information, recognize spawning aggregations as seed banks, harmonize management, and mobilize resources.
 - ii. The SAWG recognized:
 - a. Management is most effective at national levels.
 - b. Closed seasons are one of the most effective ways to protect fish spawning aggregations (FSAs), when the species is more vulnerable to fishing.
 - iii. Countries that do not have a closed season from December to February should establish one. Full-moon period should be considered when determining the closed season because of its importance for spawning.
11. The 13th session of WECAFC was held in Cartagena (Colombia) 21–24 October 2008 and endorsed the Recommendations of the Regional Workshop. The session stressed that the main purpose of the group would be to foster regional cooperation in the management, and conservation and restoration of Nassau grouper stocks in the WECAFC region; and to include coordination and harmonization of efforts for the management and conservation of the Nassau grouper.
12. The 14th session of WECAFC was held in Panama City (Panama), 6–9 February 2012, and Members agreed to continue the Nassau grouper Working Group as CFMC/WECAFC/OSPESCA/CRFM Working Group on Spawning Aggregations. In the terms of reference, it was specified that the working group will carry out the following tasks:

- i. Compile and analyze data on spawning aggregations in the member countries and monitor any changes.
 - ii. Seek partnerships with other institutions that could provide assistance in the monitoring, evaluation, and recommendations for management for protection and conservation of spawning aggregations.
 - iii. Provide advice on the management and implementation of regional strategies and regulations to protect spawning aggregations.
 - iv. Report to the appropriate institutions at each session.
13. The 1st meeting of the CFMC/WECAFC/OSPESCA/CRFM Working Group on Spawning Aggregations was held in Miami (USA), 29–31 October 2013. The meeting issued a “Declaration of Miami”, which included a recommendation to the fifteenth session of WECAFC on the establishment of a regional closed season for Nassau grouper fisheries in the WECAFC area to protect spawning aggregations of this species. Following the advice from the Working Group a regional closed season for Nassau grouper was adopted by WECAFC at its 15th session in 2014 in Trinidad and Tobago, through Recommendation WECAFC/15/2014/1 “On the establishment of a regional closed season for fisheries in the WECAFC area to protect spawning aggregations of groupers and snappers”.
14. Moreover, the working group advised in 2014–2015 NOAA on the inclusion of Nassau grouper on the list of threatened and endangered species under the US Endangered Species Act, to reduce trade pressure on Nassau Grouper.

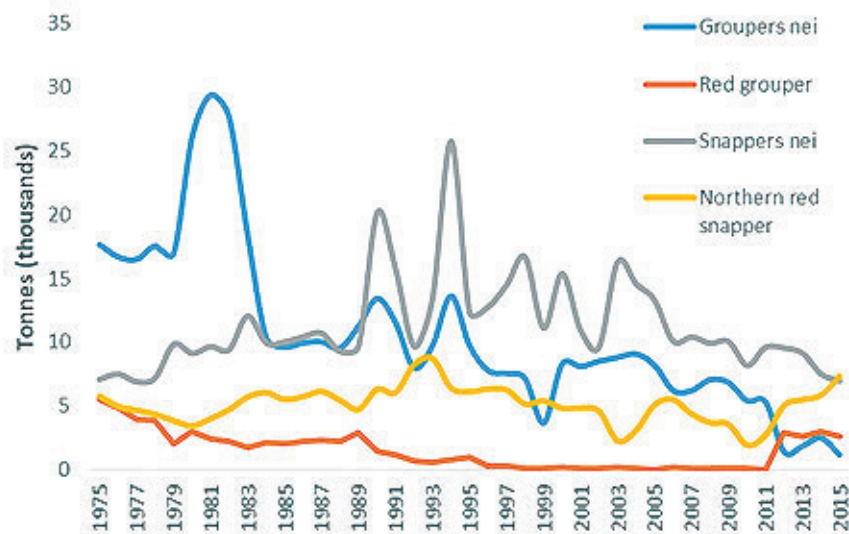


Figure 1. Landings of selected snappers and groupers in the WECAFC region 1975–2015 (WECAFC 2017)

15. The 16th session of WECAFC held in Guadeloupe (French West Indies), 20–24 June 2016 endorsed new terms of reference of the working group, which included the following: Support the development of a regional plan for the management and conservation of fish species that aggregate to spawn (targeting groupers and snappers), in accordance with the best available scientific evidence to be presented to the 17th session of WECAFC for review, consideration and regional adoption.
16. Total landings of groupers reported in area 31 were 16 400 tonnes in 2010 and 18 425 tonnes in 2015. This is equivalent to 1.3 percent and 2 percent of total capture fisheries production in the region in these years. Mexico (66 percent), USA (22 percent), Venezuela (5 percent) and Dominican Republic (3 percent) are, according to official statistics, largest producers. USA is the largest importer. It should be noted that these production figures likely include fishes harvested outside

of the territorial waters of these countries. Illegal, un-reported, and un-regulated (IUU) fishing for Nassau grouper and other species commonly occurs in waters of the Turks and Caicos Islands, the Bahamas, Cuba, Belize and other countries.

17. The catch of Groupers (family Epinephelidae), reported in recent years mainly by the Dominican Republic and Venezuela, continued to show a decreasing trend up to 2015; however, this decrease may be partially explained by changes in taxonomic resolution from reports by the United States of America. Snappers (family Lutjanidae), reported from Venezuela, Mexico, Dominican Republic, and Antigua and Barbuda, showed a decreasing trend mainly from Venezuelan landings in recent years (see figure above).
18. According to the SCRFA (Science and Conservation of Fish Aggregations) out of a total of 978 spawning aggregations identified globally, 413 occur in the waters of WECAFC Member countries. The figure below shows the distribution of countries that have identified spawning aggregations. In the south of the region and in the Lesser Antilles, research is needed to out to identify the spawning aggregations that are likely to produce juveniles.



Figure 2. Fish Spawning Aggregation identified in the wider Caribbean (data from SCRFA, 2018)

SPAWNING AGGREGATION STATUS AND MANAGEMENT UPDATE IN CRFM MEMBER STATES

19. Ms Maren Headley, CRFM Secretariat, made a presentation on the spawning aggregation status and management update in CRFM member states. She noted that CRFM is an inter-governmental organization with its mission being: “To promote and facilitate the responsible utilization of the region’s fisheries and other aquatic resources for the economic and social benefits of the current and future population of the region.” The CRFM consist of three bodies – the Ministerial Council; the Caribbean Fisheries Forum; and the CRFM Secretariat. Its members are Anguilla, Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago and the Turks and Caicos Islands.
20. Landings of spawning aggregation species were obtained from the FAO Fishstat database (FAO, 2018). These species were chosen based on the SAWG Spawning Site spreadsheet and included snappers, groupers, mackerels, permits, and jacks. Total landings of spawning aggregation species by countries in the WECAFC area over the time period (1975–2015) ranged from 51 685 tonnes in 1975 to 48 965 tonnes in 2015. Landings have fluctuated over the years, and a landing peak of 73 106 tonnes occurred in 1994. Over the 40-year period, landings from CRFM Member States

accounted for between 2 to 9 percent of the total landings in the WECAFC area. CRFM Member States landings were from Anguilla, Antigua and Barbuda, The Bahamas, Dominica, Grenada, Guyana, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, and Trinidad and Tobago.

21. In Antigua and Barbuda, there is a closed season from 1 January to 31 March annually for Nassau grouper (*Epinephelus striatus*), red hind (*E. guttatus*) and coney (*Cephalopholis fulva*). The closed season for Nassau grouper is 1 December to 28 February in The Bahamas, and 1 December to 31 March in Belize. In Grenada, a closed season for Nassau grouper, red hind and coney can be gazetted by the Minister from 1 January to 31 March, if considered necessary. Closed areas for spawning aggregations exist in The Bahamas and Belize. The Bahamas has a minimum size for groupers.
22. Currently, the status of snappers and groupers in CRFM countries is unknown. The review of the state of fisheries in Area 31 indicate that the Nassau grouper in The Bahamas is over-exploited, and snappers and groupers in Mexico, USA, and Venezuela are fully/over-exploited (FAO, 2017).
23. In order to improve regional research and resource assessment, the CRFM has developed a research agenda. The research agenda lists reef and slope species, fisheries and ecosystems as one of the 26 high priority regional activities, and identifies the need for a regional stock assessment and trade analysis of the Nassau grouper (CRFM, 2015). The research agenda also emphasizes the need for improved understanding of climate change impacts on commercially important marine species. This will be especially important for spawning aggregating species, since their reproduction and distribution could be impacted by changes in water temperature.
24. Regarding the way forward, the CRFM intends to collaborate at both the regional and sub-regional levels to ensure management and conservation of these species. Through the joint working group, CRFM will participate in the following activities: drafting of a regional management plan; and development of a protocol for identification, monitoring, control and surveillance of spawning aggregation sites. Regarding the Nassau grouper which currently comes under the SPAW protocol, finalization of the Memorandum of Understanding between The UN Environment Programme and the CRFM will contribute to improved management of this species. This will be achieved under the Areas of Cooperation, which allows identification and evaluation of marine species for listing on the SPAW Protocol and preparation and implementation of fisheries management and recovery plans for commercially important species.

SPAWNING AGGREGATION STATUS AND MANAGEMENT UPDATE IN OSPECA MEMBER STATES

25. Mr James Azueta presented and delivered an update on The Central American Fisheries and Aquaculture Organization (OSPESCA for its Spanish acronym) which promotes fisheries and aquaculture development in the framework of the Central American Integration Process by formulating, approving and implementing policies, regulations, strategies, programs and regional projects. This important work is conducted under the framework of the Central American Fisheries and Aquaculture Integration Policy which entered into force on 1 July 2005 and updated and readopted on 1 July 2015. OSPESCA has a Council of Ministers and an Executive Committee that give policy direction, the Technical Committee (fisheries directors) that supervise operations and various working groups that provide recommendations for decision making.
26. Fishing of spawning aggregations can be unsustainable (e.g. in Belize, the Emily Nassau grouper site produced over 200 tonnes annually). About 45 percent of Nassau grouper aggregations have been extirpated worldwide. Spawning aggregations occur in the six Central American Integration System (SICA) member states that connect to FAO Area 31 and both local and international

researchers are working on spawning aggregation. Spawning aggregation sites in all countries are not fully identified as there is the need for species identification at the sites (transient or resident), the need for characterization of the sites once identified and monitoring for specific species (prioritization).

27. Belize is the most advanced country in managing spawning aggregations. Some countries have national spawning aggregations monitoring groups, closed seasons, minimum and maximum sizes and closed areas for certain species. Belize uses all of these approaches. However, there is much more work to be done to address overfishing on spawning aggregations throughout the region and leveraged funding for studying and managing these sites is urgently needed. Countries can assist each other with human capacity building, share and compare information and focus on species that are threatened and can recover through management interventions. OSPESCA is willing to coordinate spawning aggregation monitoring efforts for its member countries, participate in the formulation of a regional management plan and assist with the possible identification of funds.
28. Ms Yvonne Sadovy presented a summary of the global importance of spawning aggregations and reviewed the recommendations from the 1st meeting of the SAWG. As part of the introduction Ms Sadovy illustrated several examples of dramatic declines in aggregating species from various data sources (peer reviewed publications, technical reports), locations (Cuba, Florida), and species including Nassau grouper (*E. striatus*) and black grouper (*Mycteroperca bonaci*). Ms Sadovy used data from the Science and Conservation of Reef Fish Aggregations (SCRFA) database of over 900 FSA sites to illustrate that in cases where the status of aggregations is known, a large portion (35 percent) of the grouper and snapper FSAs are in decline, although the status of nearly half of the reported aggregations sites is unknown. These data pointed to a need for a pro-active and precautionary approach.
29. Ms Sadovy reviewed and reiterated the primary conclusions and recommendations from the 1st SAWG meeting, encapsulated in the Miami Declaration that can be summarized as the urgent need to improve the management and conservation of fish aggregations and aggregating species in the Wider Caribbean Region. Key recommendations included proposed listing of Nassau and goliath groupers under Appendix III of the SPAW protocol, creating a regional management plan for Nassau grouper and other aggregating species. SAWG also recommended a regional assessment of the timing, location and status of FSAs in the region and a priority setting exercise for their monitoring and conservation based in part on the institutional capacity for management at each site. Further, national level and site level assessments should involve local fishers that fish the sites, as a way to promote and include them in research that ultimately leads to effective monitoring and protection.

OVERVIEW OF FISHERIES RULES AND REGULATIONS IN SELECTED WECAFC MEMBER STATES

The Bahamas

30. Ms Krista Sherman gave an overview of Fisheries regulations in The Bahamas with a focus on Nassau grouper. The history of management of Nassau grouper and the management of their FSAs is summarized in [Sherman *et al.*, 2016](#). Further summary of the fisheries rules, regulations and enforcement actions is available in [Sherman *et al.*, 2018](#). In summary, the minimum legal weight limit for Nassau grouper in The Bahamas is 3 lb. Fish must be landed with skin intact. There is a closed season from 1 December to 28 February. All fishing is restricted (for all species) within designated no-take MPAs. Unfortunately, the minimum size limit and duration of the closed season are inadequate measures. A new conservation and management plan for Nassau grouper has been developed and contains recommended amendments to national fishery regulations.

Cayman Islands

31. Mr Bradley Johnson of the Cayman Islands Department of Environment explained that Designated Grouper Spawning Areas (DGSAs) which legally halted all grouper harvest from within them, were created in 2003. Additional protections were added in 2007 which limited the use of spear guns and fish pots within one mile of any DGSA. Cayman Islands enacted the National Conservation Law in 2013 adding additional measures for Nassau grouper including: Closed season (1 December – 20 April), catch limits of 5/boat or 5/person (whichever is less), a slot size limit allowing retention of fishes only between 16” and 24” inclusive, and possession clause.
32. Mr Johnson explained the challenges of implementation to include lack of enforcement capacity, boundaries of DGSAs being too small, and aggregations of other species remain unprotected. To address these challenges, Cayman Islands closed all fishing in DGSAs during the closed season.

Cuba

33. Regarding FSA management in Cuba, Mr Ken Lindeman presented on behalf of Mr Rodolfo Claro and described existing regulations and the history of their development. As some of this information is readily available in Claro *et al.*'s 2009 article in *Fisheries Research*, only limited details are provided herein. Different than many countries, all Cuban fisheries are owned and operated by the state such that fishers are employees of the Cuban Government. Cuba enacted gear restrictions to exclude trawling with long bottom trawls (>1 000 m). This regulation decreased juveniles in catches and total bycatch. Cuba also banned the use of channel nets that cross some pre-spawner migration routes. The ban likely reduced the catch of lane (*Lutjanus. synagris*), mutton (*Lutjanus analis*) and grey snapper (*L. griseus*).
34. Occasionally, Cuba has enacted closed seasons for specific sites and species (mainly lane, mutton, and gray snappers, and mullet). License provisions are in place to restrict effort on all subsistence, commercial, and recreational fishing, but fishing effort remains high. Size limits are established for most commercially important species but are generally too small to be of much value.
35. Cuba has a large protected area program with several important multi-species FSAs inside MPAs, including national parks. Actual rules to protect spawning aggregations within these MPAs are variable. Primary attributes of eight of these FSA sites were recently reviewed in terms of potential management effectiveness and regional connectivity in Claro *et al.*, (2018).

Turks and Caicos

36. Mr Claydon outlined that any and all species of fish that aggregate to spawn are protected during their aggregations by a 2015 amendment to the Fisheries Protection Regulations. However, in reality this is limited to Nassau grouper, and an amendment has been approved but not yet incorporated into law that will exempt mutton snapper spawning aggregations from Regulation. There is a minimum size for Nassau grouper of 21 inches, and a maximum of 35 inches (although an amendment for commercial fishers only was approved to eliminate the maximum size and reduce the minimum to 17 inches). Snapper and bonefish minimum sizes are 7 inches and 20 inches, respectively. There is also a closed season for Nassau grouper running from 1 December to 28 February (inclusive). During this time, it is illegal to buy, sell, or possess Nassau grouper.
37. Protected areas in the Turks and Caicos Islands are comprised of 35 no-take marine areas. However, these cover a small percentage of the shelf edge, and only incorporate one known spawning aggregations site in the Northwest Point Marine National Park.

38. Data collection of domestic landings of finfishes is limited, it is however assumed that most fish landed and consumed in-country are sold to processing plants, or directly to hotels and restaurants rather than traded or bartered on island. Mr Claydon reported that there is no requirement for most fishers to report catch. Pelagic fishing vessels and trap vessels should report catch and bycatch, but this is not enforced and there is no mechanism in place for this reporting. Processing plants must report the products they buy from fishers.
39. The number of small diving boats remained relatively constant as revealed by Mr Claydon, interestingly the complement of divers increased with this upward trend being prevalent when foreign assistant divers work on the vessels. This is unlike the decline in large trap boats due to their destruction by hurricanes since 2008. Mr Claydon advised that prior to 2015 when the closed season for Nassau grouper came into effect, fishing on aggregations was predominantly by divers using spear guns and Hawaiian slings on Nassau grouper aggregations. However, hook and line and traps are the preferred method for fishing mutton snapper aggregations. The majority of fishers catch fish with spears so there is limited to no bycatch with this method.
40. Mr Claydon stated that at current levels of enforcement, the regulations are largely inadequate to deal with or prevent increased fishing pressure for any species, both outside and within aggregations. Presently, only Nassau grouper is protected (predominantly by the closed season), and yellowfin mojarra (*Gerres cinereus*) by the fact that an aggregation site is mostly within an MPA. However, the largest threat is from large fishing vessels from the Dominican Republic working illegally in the Turks and Caicos Islands. The closed season for Nassau grouper could be extended to cover the full range of months the species is believed to spawn (i.e. include March as well), but also extended so as to have a closed season for all grouper species that encompasses their spawning months.

Belize

41. Mr Mauro Gongora, Fisheries Officer with the Belize Department of Fisheries explained the derivation of fisheries legislation in Belize, starting with the Fisheries Act of 1977, revised in 2000 and 2003. The Minister of Fisheries enacted protection for 11 new marine reserves in 2003 (S.I. 162 of 2003) to protect spawning aggregations for Nassau grouper and other aggregating species. The act was replaced with (S.I. 49 of 2009) Nassau grouper regulations which created a total possession ban from 1 December to 31 March (with the exception of fishing from two sites), and a slot size possession limit of between 20 and 30 inches. Further, every Nassau grouper must be landed whole in Belize. These regulations were amended in 2010 to stop all take of Nassau grouper from spawning aggregation sites.
42. Fishing pressure on spawning aggregations has dropped in the last five years such that only about 24 vessels and 80 persons directly target spawning aggregations. Export trade is restricted to those with export permits.
43. Challenges facing Belize's management of spawning aggregations include the need to address poaching through increased enforcement of existing regulations, increased field monitoring and research, sub regional and regional management approaches and public awareness campaigns.

Brazil

44. Ms Athila Bertoncini detailed the history of fishing rules and regulations in Brazil, highlighting laws in place and strategies to improve policies. The government of Brazil has established committees and appointed ministers to oversee fisheries. Several legal instruments regulate fisheries in Brazil overseeing the protection of fisheries and stimulate fisheries, fisheries closures for spawning seasons and environmental protections. The combined involvement of the Ministry of Environment and the Ministry of Fisheries and Aquaculture have established controlled access over fisheries: by

regulating who has access to fisheries and permit issues, registering vessels and issuing permits are for specific resources/areas. Additionally, there have been fisheries closures, gear restrictions, area closures and size restrictions on 36 species.

45. However, as of 2008, there is no nationally scaled monitoring program in place. The weakening of the fisheries policies in the last decade has led to a lack of continuity. Ms Bertocini expressed a need for recovery plans of several species of Epinephelidae, increased gear restrictions, an increase of marine protected area coverage from 1.5 percent to 25 percent and national action plans directed at the recovery of biogenic and rocky reefs, mangroves, sharks and rays.

Mexico

46. Mr Alfonso Aguilar-Perera presented on the findings for Mexico, currently, scientific evidence of the presence of fish spawning aggregations (FSAs) in the Southern Gulf of Mexico (SGoM) and Mexican Caribbean is available mainly for those of groupers (Epinephelidae). Through fisher interviews, 60 FSAs sites in coral reefs have been identified (about 10 inches SGoM and 50 inches Mexican Caribbean) of which only five sites in the SGoM and five sites in the Mexican Caribbean remain scientifically verified for groupers. The most common and important species in these latter sites is the Nassau grouper (*Epinephelus striatus*), followed in importance by the black grouper (*Mycteroperca bonaci*). In the SGoM, black grouper is important in terms of abundance, since Nassau grouper aggregations were wiped out from the Arrecife Alacranes according to fishers' information. In this latter area, the red hind (*E. guttatus*) aggregations still form during December and January. In the SGoM, the most commercially important grouper is the red grouper (*E. morio*) but no scientific evidence is available about forming spawning aggregations; however, it is IUCN Red Listed as Threatened.
47. In terms of fishery management, specific regulations for FSAs in Mexico are nonexistent. For red grouper, CONAPESCA (National Aquaculture and Fisheries Commission) established a one-month ban (15 February – 15 March) on harvest of all groupers in 2005 and then changed to two-months (1 February – 31 March) in 2017. This ban is supposed to cover the red grouper reproductive period but evidently is not considering the reproductive period of the remaining grouper species. In order to make the red grouper ban legally issued, CONAPESCA must officially publish it each year as an agreement in the Diario Oficial de la Federación (Official Diary of Federation), and sometimes there are date amendments.
48. Other legal instruments considering the grouper fishery in the SGoM and Mexican Caribbean are the *Norma Oficial Mexicana* 065-SAG/PESC-2014 (Mexican Official Norm) and the red grouper management program. These two instruments briefly address the other grouper species in the region with the latter including some information about grouper spawning aggregations. However, these instruments are only references and have no direct regulation on the fishery until CONAPESCA issues agreements of understanding in a given time. While most of the grouper aggregation sites in both SGoM and Mexican Caribbean are located within natural protected areas, fishers remove groupers all the time except during the Red grouper ban. In this regard, the effectiveness of NPAs to protect grouper aggregations is not as effective as expected or achieved in other countries.
49. In 2013, a new fishery management instrument emerged in Mexico by local fisher initiatives promoted by the NGO Comunidad y Biodiversidad. This instrument called Zona de Refugio Pesquero (Fishery Shelter) allows for the establishment of no-take zone within established natural protected areas, to protect reproductive organisms including both fishes and invertebrates (lobster and conch). Also in 2013, CONAPESCA used this new regulation to designate four new no-take zones (Fish Refuges) protecting four FSAs within Quintana Roo in the Mexican Caribbean.

United States

50. Ms Stephanie Bolden of the National Marine Fisheries Service, Southeast Regional Office, NOAA presented on the Fisheries Rules and Regulations for the southeast US: South Atlantic, Gulf of Mexico, US Virgin Islands, Puerto Rico, and the Caribbean EEZ. A list of species by area that benefit from protective measures was presented: Nassau grouper, red hind, goliath grouper, mutton snapper, and yellowtail snapper are protected in all five areas.
51. A summary of closed periods for each grouper and snapper species was presented highlighting that both Nassau and Goliath grouper were prohibited year-round; however recreational fishers in the Gulf of Mexico had closed periods for grouper but commercial fishers did not, the South Atlantic had a closed period (1 January – 30 April) for some groupers that exceeded other areas; whilst both the South Atlantic and Gulf of Mexico used minimum length regulations to protect groupers and snappers instead of closed periods. Closed periods were more prevalent in the Caribbean for the protection of groupers and snappers, in contrast with the yellowtail snapper which were protected by minimum length instead of closed periods in all areas.
52. Licenses are required for both fishers and vessels in all areas; however, only commercial catch is reported. Closed areas to protect aggregation areas are common. Maps illustrate these closed areas, which are generally small and isolated.

NEW RESEARCH TECHNIQUES FOR THE STUDY AND MANAGEMENT OF SPAWNING AGGREGATIONS

53. Ms Schärer's presentation showcased techniques commonly used to study and monitor fish spawning aggregations (FSAs) including underwater visual surveys to document species, abundance and condition of the fish aggregated to spawn. This method improved significantly with new technology applied to scientific and technical diving as well as focusing the surveys at the time fish are aggregated to make monitoring more efficient. The use of closed-circuit rebreathers (CCR) has been instrumental in extending the time that researchers can spend at the seafloor, especially for those FSA sites deeper than 100 ft. The extended time at depth has allowed researchers to conduct the surgery to implant acoustic tags *in situ* reducing the potential harm of study animals due to barotrauma when bringing fish to the vessel.
54. With CCR researchers have also been able to hear and record the low-frequency sounds produced by fish during their reproductive behaviors since no bubbles are released by divers. The availability of underwater laser pointers as parallel guides along with video cameras allowed researchers to document the lengths of fish that are aggregated to spawn *in situ* within a short time span, this way creating size frequency distributions without any need to handle, harass or harm fish. This method also allows for the documentation of color phases in fish that are ready to spawn as an indirect confirmation of spawning and condition (distended or spent) that allows to determine the timing of the FSA. The use of GPS hand held units attached to a dive buoy towed by divers allows the identification of the relative location of each fish in the FSA with a standardized, repeatable method in areas where the underwater currents are strong and stationary methods are unfeasible. Underwater synchronous video and audio recorders (Cyclops, Loggerhead Instruments) have allowed the detection, description and interpretation of the behaviors and associated sounds produced by groupers at depth in the absence of divers during the aggregation. This methodology has proven essential to develop the use of passive acoustic methods to study the reproductive behaviors for species of grouper that produce sounds.
55. Passive acoustic monitoring (PAM) without video in combination with underwater surveys, acoustic tagging and active hydro acoustic techniques has demonstrated that the presence and reproductive activity of fish aggregated to spawn for at least six species (*E. guttatus*, *E. itajara*,

E. morio, *E. striatus*, *M. bonaci*, *M. venenosa*) just by their sound production is unequivocal. The presence of these species can be detected remotely over the long-term by underwater recorders (DSG, Loggerhead Instruments) in very high resolution (every 5 minutes), over long-term periods of continuous recordings. This technique has been used to compare the temporality of multiple species simultaneously at various FSA sites, to compare the temporality of reproductive behaviors of a species at multiple sites simultaneously, to locate the FSA sites for species that aggregate to spawn and to evaluate the timing of management measures applied to protect FSA sites or species during their reproductive period.

56. The use of PAM on an automated wave glider in collaboration with the Harbor Branch Oceanographic Institute (Florida Atlantic University) was successfully tested for the first time in the Caribbean with significant results, locating additional FSA sites that are essential for the adequate monitoring of species that aggregate to spawn. The research and development of a fish acoustic detection algorithm (FADAR) has been instrumental in the application of PAM to the monitoring of FSAs and to use the wave glider to detect reproductive activity of these groupers *in-situ*. This research has also raised a series of questions related to the importance of the soundscape for fish that are aggregated to spawn since the acoustic communications between the individuals may be affected by anthropogenic noise such as vessels or increased maritime traffic. The PAM has become a useful tool for the study, monitoring and location of grouper FSA.

PREDICTION AND CONSERVATION OF SPAWNING AGGREGATIONS IN THE WECAFC REGION

57. Mr Kobara introduced a project of NOAA RESTORE Act Science Program: Cooperative monitoring program for spawning aggregations in the “Gulf of Mexico: an assessment of existing information, data gaps and research priorities.” Mr Kobara led the development of the project web site with Co-PIs Messrs Heyman and Erisman. The Gulf of Mexico Coastal Ocean Observing System Regional Association (GCOOS-RA) serves as the data platform. It is available at <https://geo.gcoos.org/restore>. This website contains all of the products from the project and provides a comprehensive review of FSA locations, timing, biology, monitoring and management in the US Gulf of Mexico.
58. Messrs Kobara and Heyman collected and summarized the location of FSA sites in the Caribbean Large Marine Ecosystem (CLME) management unit, Gulf of Mexico and Southeast Atlantic area. Summaries of the biogeography of the FSA locations in the wider Caribbean were published in 2013, documenting that many of these locations have a similar geomorphology. Many multi-species spawning aggregation sites occurred along convex curving shelf edges in this region. Since then, experiments using satellite imagery and bathymetric data have been used to predict FSA sites based on sinuosity of the shelf edge have been undertaken using Geographic Information System (GIS) technology.
59. To test the ability to predict FSA sites, fisher derived sites from satellite were compared to predicted sites in the Mexican Caribbean, using a reef geomorphology product generated by University of South Florida’s Millennium Coral Reef Mapping project was used to calculate a sinuosity index for the shelf edge in Quintana Roo, Mexico. Comunidad y Biodiversidad (COBI), a Mexican NGO, was aware of 39 potential spawning aggregation sites in Quintana Roo, Mexico based on fishermen interviews. Satellite predictions matched 100 percent with the locations of five FSAs sites where COBI had data generated by fishers, and has field verified the locations with mapping and monitoring.
60. The remote-sensing-based prediction method revealed several sites that were not recorded from fisher’s knowledge previously and represented an opportunity for further testing of the prediction methods, along with the local NGO, COBI. Importantly, while sites can be predicted, and

potentially protected prior to fishing, the locations of predicted sites will never be released to groups or organizations outside those, like COBI, that are well-trusted partners with the interest and capacity to characterize and manage new sites.

RESEARCH UPDATES BY COUNTRY

The Bahamas

61. Ms Krista Sherman gave an overview of research in The Bahamas showing the prioritized research objectives for Nassau grouper including the identification of multi-species fish spawning aggregations (FSAs) during a Nassau grouper strategic meeting that was organized by the Bahamas National Trust (BNT). A comprehensive project was developed inclusive of FSA monitoring, outreach and education, and advocacy to improve conservation and sustainable fisheries management for Nassau grouper. To address national research priorities, investigations of FSAs using acoustic telemetry, population genetics and stakeholder assessments have been undertaken through collaborations between scientists affiliated with the University of Exeter, Shedd Aquarium, BNT and Perry Institute for Marine Science with approval from the Department of Marine Resources (DMR).
62. Approximately 40 FSAs have been reported by local fishers in The Bahamas, but most remain unverified. Of the sites that have been surveyed, only two have been confirmed to support >1 000 Nassau grouper. Underwater visual surveys indicate variability in Nassau grouper abundance, with peak abundances occurring within a few days of the full moon. However, these estimates are likely to be conservative based on fish movement patterns. One of the long-term monitoring sites is also a confirmed multi-species FSA. Additionally, bathymetric mapping and larval dispersal tracking have also been used to characterize FSAs and explore potential patterns of larval connectivity. Although illegal fishing activity at FSAs is not as high as it was in 2010, illegal fishing during the closed season persists.
63. Acoustic telemetry work has been used in Andros and the Exuma Sound to understand movement patterns and migratory corridors between reefs and FSAs. To date, this research has revealed the likely collapse of an historic Nassau grouper FSA (High Cay, Andros) and suggested the existence of another FSA located at the northern end of the island. Current telemetry research (via a Vemco Positioning System with overlapping detections) is being used to examine fine-scale movement patterns within an active FSA over successive spawning seasons. Preliminary analysis supports diver observations of Nassau grouper behavior. Population genetics research based on microsatellite markers has shown that Nassau grouper are weakly differentiated, exhibit similar patterns of diversity (with low allelic richness) and have experienced both recent and historic bottlenecks. Restriction-site-associated sequencing (RAD-seq) analysis has also been conducted to investigate fine-scale genomic variation and examine patterns of connectivity.
64. A SWOT analysis and questionnaires have been used to assess stakeholder perspectives regarding the Bahamian Nassau grouper fishery and its management. Results from this work have been incorporated into the national management plan for the species. A brief overview of the structure of the plan was presented during the SAWG meeting. The Nassau grouper management plan for The Bahamas was created based on available scientific (biological and social) data and outlines recommended changes to existing fishery regulations (e.g. closed season and size limit) and proposes the addition of new regulations along with recommendations for strategic surveillance and enforcement. Next steps for research include publishing the RAD-seq, telemetry and stakeholder findings, validating reported FSAs, increasing capacity for ongoing FSA monitoring, addressing other research priorities and implementing the management plan with support from a range of stakeholders.

Belize

65. Mr Nicanor Requena representing the Environmental Defense Fund in Belize discussed the history of research and monitoring of spawning aggregations in Belize. Requena described the goal and work of the Belize Spawning Aggregations Working Group - an ad hoc consortium of local and international NGOs, the Belize Fisheries Department, Fishing Cooperatives, and the University of Belize. Their goal is to develop strategies to maintain aggregation sites for the protection, conservation and sustainable use of the fishery, through monitoring of the aggregation sites, public awareness and training. The working group members monitor seven FSA sites as regularly as possible with a focus on Nassau grouper. The working group priorities include data storage and analysis, public awareness and aggregation monitoring training. Belize uses standard monitoring techniques following the 2004 protocol but is testing the use of additional techniques for monitoring, e.g. laser calipers for size estimation, as guided by working group member, WCS. Continued monitoring, data analysis, and awareness building are seen as priorities.

Brazil

66. Mr Vinicius Giglio provided highlights research updates stating most research describing aggregation sites and seasons relies on using fishers' LEK and fisheries data. Approximately twenty spawning aggregation sites have been described and two goliath grouper aggregations are monitored with telemetry. High poaching pressures mainly from recreational spear fishers has resulted in a drastic decline of goliath groupers.

67. Species including largemouth sawfish (*Pristis pristis*), goliath grouper (*E. itajara*), Brazilian guitarfish (*Pseudobatos horkelii*) and wreckfish (*Polyprion americanus*) are poached by industrial and artisanal fishermen, captured in gillnets and bottom trawls and then sold in an unrecognizable form or listed as an alternative species.

Cayman Islands

68. Research and monitoring of spawning aggregations in the Cayman Islands began in 1986. Mr Bradley Johnson examined how accurately current drifters approximate egg/larval distribution after spawning and introduced an improved model of the Sea Surface Acrobat, equipped with a CTD, wings for depth control and a microscope for improved sampling.

69. Future research in surrounding spawning sites in the Cayman Islands includes improved understanding of eggs and larval transport, improved understanding of fertilization rates, hatch timing and survival rates, in addition to continued assessments.

Turks and Caicos

70. Ms Marta Calosso and Mr John Claydon examined fishers' knowledge of spawning aggregations and fishery landings data to inform management of Nassau grouper through semi-structured interviews of full time and part time retired fishers with knowledge of aggregations and understand their perspective on historical changes. At least 60 percent of those interviewed were aware of spawning aggregation formations, seasons and sites. Evidence of aggregation fishing was corroborated by grouper-dominated catches, presence of large fish with ripe gonads, estimated fishing effort and landings and confirmation from fishers.

71. Ms Calosso and Mr Claydon also assessed the impacts of a closed season on Nassau grouper spawning aggregations. Closing the season in December 2015 led to unexpected consequences: other groupers were fished more heavily, Nassau grouper was mislabeled, unknown grouper species were imported for resale, pressure on conch and lobster increased and trap fishers did not deploy traps.
72. Finally, Mr Claydon introduced the results of a study factoring natural disasters into small-scale fisheries management demonstrating that hurricane frequency could have implications for ontogenetic shifts in habitat use. Further, the timing of these events could impact environmental, economic, and infrastructure of fisheries, tourism, and recovery of developing species.

Cuba

73. Research on spawning aggregations in Cuba began decades before any other area of the region by extraction of information from standard biological, life history, and fisheries related studies of commercially important snapper and groupers species led in large part by Mr Rodolfo Claro. Indeed, the quality, regularity and quantity of fisheries dependent data collection, and high-quality analysis in Cuba continues to stand as a model for the region. This long-term data set has permitted analyses of FSA forming species that are not possible elsewhere. Claro continues to collaborate with scientists from the US and other regions, most recently focusing on connectivity and larval transport. The Claro and Lindeman (2003) paper is the first study in the region that illustrated multi-species spawning aggregations of groupers and snappers at 21 sites around the Cuban Archipelago.
74. Intensive fishing on FSA forming species have led to significant population declines and harvests. Recorded landings of Nassau grouper commenced in 1955 and had peak production in the mid-1960s of over 1 600 tonnes per year. Landings then declined over time, with some fluctuations to the mid-1990s as national landings fell below 100 tonnes and continued to dwindle (Figure 3). The enormous seasonal spike in landings, which occurred during the known peak spawning season for Nassau grouper and that was based on the directed fishery at spawning aggregations and their migration routes, was clearly evident in landings data from the early 1960s. The seasonal spike has gradually dampened as spawning aggregations have been fished to near extirpation and the stocks continue to be depleted. Again, as reported above, reported landings may not reflect IUU fishing which is known to occur.

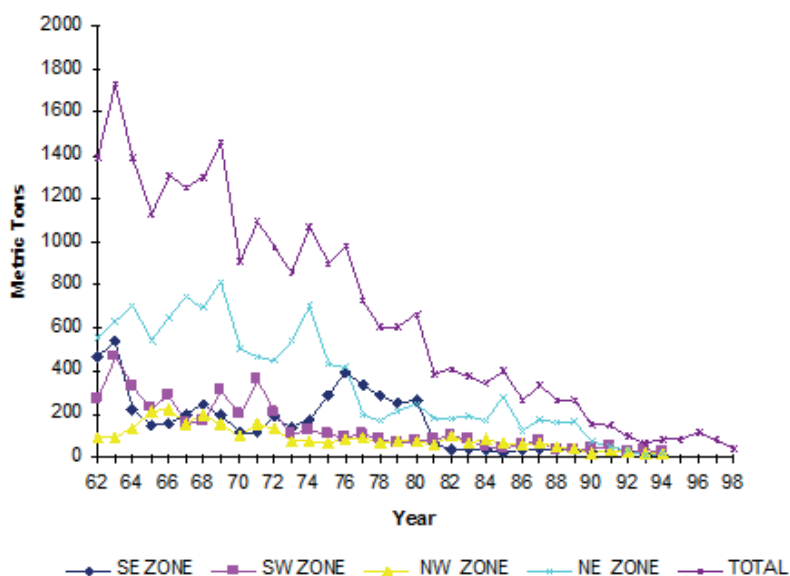


Figure 3. Landings by geographic zone of Nassau grouper, *Epinephelus striatus*, in Cuba, 1962–1998. (Source: Claro et al., 2001)

Other aggregating species have experienced similar, though not as dramatic, declines in Cuba over the same time period. Claro *et al.*, 2009 attribute differential rates and magnitudes of landings declines between species with the relative vulnerabilities of species to aggregation fishing.

75. Modelling studies of larval transport and connectivity modelling between Cuban spawning aggregations and other areas have dominated recent literature regarding spawning aggregations, in part due to the relative difficulty and expense of field work, compared to studies that can be done remotely, using biophysical models to create simulations of larval transport.

United States

76. Mr Alejandro Acosta presented a pilot study on the use of echo-sounder buoys as sampling platforms for FSAs since monitoring multi-species aggregations can be difficult with direct observations, when they are being utilized by stakeholders or are difficult to reach. To effectively assess the biomass, distribution, behavior and ecological importance of spawning aggregations, techniques are required which are non-invasive, incite as little behavioral change as possible, can repetitively acquire high-resolution data for entire spawning seasons and are comparatively easy and cost effective to deploy. Conventional sampling techniques such as direct observation (visual census, diver operated video, stereo cameras, baited remote underwater video systems), or passive observation, (conventional and acoustic tagging, acoustic recordings, or fishery related sampling), often provide only a snapshot-in-time of the aggregation. Acoustic tagging can record movement details and habitat utilization of the aggregation site but it does not provide an overall picture of the size of the aggregation or the possible multi-species nature of it. The previously mentioned more traditional approaches suffer from sampling bias induced by the method itself. No sampling method is exempt from bias; however, the integration of a suite of techniques pertinent to the biological and behavioral characteristics of the species can provide complementary data sets that allow a better understanding of their biases.

77. To improve the knowledge of many key processes occurring within an aggregation site, it is necessary to expand the current spatial-temporal coverage and rates of data acquisition. The tuna fishery has been using geo-locating buoys equipped with echo-sounders near their fish aggregating devices (FADs) to provide remote information on the aggregated biomass using the FADS. Although these buoys are currently only used for tuna fishing, they can also be used for scientific purposes. This proposal aims to investigate the potential use of the echo-sounder buoy as a sampling device to monitor temporal and spatial biomass of fish spawning aggregations present at Riley's Hump (RH), Tortugas South Ecological Reserve, and in the Dry Tortugas region of the Florida reef tract. These buoys also allow the integration of other technologies to validate the species composition such as: automated remote underwater video systems, acoustic receivers for recording fish tagged with acoustic transmitters and hydrophones to record sound production.

78. The combination of echo-buoys, cameras, and hydrophones in the attempt to capture and characterize fish dynamics and behavior in a multi-species fish spawning aggregation site will assist the research to develop a sampling technique dedicated to the evaluation of the fish spawning aggregation at RH. Through a collaborative scheme between FWC, Mr Nelson Ehrhardt from University of Miami, Mr Laurent Cherubin from Florida Atlantic University, and the buoys manufacturer, this pilot project is aimed to: (1) provide a practical methodology for continuously monitoring reef fish assemblages in a multi species aggregation site, (2) assemble all relevant acoustic and sound data for spawning fishes at RH, and (3) develop a transferrable, cost-efficient, science-based approach to examine and monitor multi-species aggregation sites. This work will provide managers with critical information to assist with marine resource management and allow the boundaries of the marine reserves within the Florida Keys to be more critically evaluated.

79. To achieve the project goal three distinct underwater survey methods will be conducted to record and characterize the biomass and sound produced by reef fishes utilizing RH multi-species spawning aggregation site. The main benefits of this research are: (1) to provide a practical methodology for continuously monitoring reef fish assemblages in a multi species spawning aggregation site, (2) to assemble all relevant sound data for fishes at RH, and (3) develop a transferrable, cost-efficient, science-based approach to examine and monitor multi species aggregation sites. This technique will provide managers with critical information to assist with marine resource management and allow the boundaries of the marine reserves within the Florida Keys to be more critically evaluated. Additional funding will be necessary to: a) purchase, develop and deploy an array of acoustic echosounder buoys and sound recorders around the identified snapper and grouper aggregations of RH, and b) charter a commercial boat for the deployment of the instruments and other equipment.

US - Caribbean (Puerto Rico and USVI)

80. Recent research of FSAs in the US Caribbean included two projects focusing on Nassau grouper (*E. striatus*) and one on red hind (*E. guttatus*). These projects also contained data for other species of grouper that form multi-species aggregations. One project was funded by the CFMC and is titled “Nassau grouper spawning aggregation research: Bajo de Sico, PR and Grammanik Bank, USVI” during 2013 and 2014. Specifically, this study used underwater visual surveys with closed circuit rebreathers, passive acoustic monitoring and acoustic tagging of Nassau grouper at the only two known FSA sites in the US Caribbean. Results demonstrated the presence of approximately 100 individuals at Bajo de Sico, Puerto Rico and 200 at the Grammanik Bank, USVI. An important revelation of this study was that Nassau grouper were detected in the FSA sites after the seasonal protections expired at each one of the marine protected areas where they are located (in April at Bajo de Sico and May at the Grammanik Bank). A follow up study of these two FSA sites along with others at Mona Island titled, “Sustainability and recovery of groupers in Puerto Rico and the US Virgin Islands” conducted during 2016 and 2017 also documented that multiple species of grouper aggregated to spawn from January through April in Puerto Rico and through May in the USVI. Tagging revealed that at least one Nassau grouper that aggregated to spawn at the Grammanik Bank travelled to El Seco off the southeast coast of Vieques in Puerto Rico, highlighting the need for shared management efforts in this region by both local jurisdictions.
81. Preliminary results of surveys have detected an increase in the maximum number of Nassau grouper at the Grammanik Bank and a decrease at Bajo de Sico over the monitoring period. These results also revealed that 64 percent of tagged Nassau groupers reside throughout the year in home ranges located on the shallowest (< 70 m) areas of the Bajo de Sico seamount, equivalent to an area of approximately 2.2 km², within the 31 km² marine conservation district MPA. Finally, the Nassau grouper genome will be constructed with fin clips collected as part of this project and DNA RAD genetic skimming will be performed on samples from both FSA sites.
82. The research project titled “Management of red hind (*Epinephelus guttatus*) spawning aggregations in the US Caribbean Islands: What is the most effective option for stock enhancement?” led by the University of the Virgin Islands applied underwater visual survey techniques, passive acoustic monitoring and wave gliders to detect new FSA sites and collection of red hind samples of hard parts and gonads for the determination of life history characteristics. The preliminary results suggest that the red hind in western Puerto Rico and USVI aggregated to spawn in similar lunar cycles, which may occur after the seasonal closure off the west coast in EEZ and in Puerto Rico jurisdiction waters, which ends on 28 February. The preliminary results of otoliths collected from all three FSA sites evidenced that red hind from the Red Hind Bank, St Thomas are older (mean age 11 years; max age 22 years) and larger (mean TL 39.0 cm; max TL 45.2 cm) than either Lang Bank, St. Croix (mean age 7 years; maximum age 12 years and mean TL 33.8 cm; max TL 43.9 cm) or Buoy 4, western Puerto Rico (mean age 5 years.; maximum age 9 years and mean TL 33.4 cm; maximum TL 43.0 cm).

83. An additional study is currently being performed to evaluate the effectiveness of the marine reserve around Mona and Monito for reef fish populations. A secondary goal of this project is to determine if the marine reserve has caused any difference in red hind or other species that aggregate to spawn at FSA sites located on Mona Island. This offshore marine reserve has been studied by researchers of the University of Puerto Rico since 2005. The project titled “Assessing the efficacy of the Mona Island, Puerto Rico no-take MPA, with emphasis on the recovery of fish communities and grouper spawning aggregations”, has preliminary results on the reef fish assemblages, but FSA survey results are still ongoing.

REGIONAL INITIATIVES

84. Mr William Heyman presented a regional vision of research and conservation action summarized in what is being called, the Big Fish Initiative (BFI). The BFI is designed to develop a network of people and institutions that together cooperatively monitor and conserve a network of “sentinel sites” multi-species spawning aggregations throughout the Western Central Atlantic. The BFI is Mr Heyman’s answer to the recommendations of the Declaration of Miami made during the first meeting of the SAWG in 2013. Recognizing the massive needs for cooperative regional efforts for research, monitoring, conservation, management, and communications, Heyman has teamed with Ms Ana Salceda, Beluga Smiles to create the Big Fish Initiative. BFI is developing pilot programs along with partners in the Mesoamerican Reef, the Gulf of Mexico, Cuba, Puerto Rico and the Virgin Islands and The Bahamas. Big Fish is developing a network of partners and institutions that will together monitor and conserve a network of “sentinel sites” at multi-species FSAs and thus contribute to regional fisheries and biodiversity productivity and conservation. Using a strategic communications strategy, including a film for broad public viewing (PBS Nature), BFI will broadly raise the awareness of the urgent need for FSA conservation and management. Big Fish aims to help restore snapper and grouper populations throughout the WECAFC region, through the working lens of cooperation around FSA management.

OUTREACH AND EDUCATIONAL CAMPAIGNS

85. Ms Ana Salceda’s presentation focused on the role of communication in promoting the protection of multispecies FSAs among fishers, fishery managers, every day citizens/seafood consumers, and policy makers in the Wider Caribbean. The presentation included a brief overview of existing communication efforts revealing that to date much of the communication about FSAs in the Wider Caribbean has been localized: individual sites communicating to specific, local audiences. Additionally, there are numerous quality stand-alone communication programs and products that could get lost in a cluttered communication landscape. Ms Salceda pointed out the need to unify messaging, curate and consolidate existing products, scale up successful efforts (e.g. fisher-to-fisher materials), and develop targeted distribution strategies that promotes FSA conservation and management.
86. Ms Salceda’s presentation offered some background on The Big Fish Initiative (BFI), a new project that seeks to fill the communication gaps previously identified and to foster cooperation among members of the WECAFC SAWG to support ongoing work on FSAs and FSA protection. With an animated map of the Wider Caribbean, Ms Salceda showed what the BFI looks like today: six countries involved (The United States, Mexico, Belize, Guatemala, Honduras, and Cuba). She described the project’s partners (including fishers,) and the core of the initiative: a network of 11 FSAs, dubbed sentinel sites. In addition to the criteria to pick these sites, it was pointed out that the Cayman Crown is included given its potential for hosting FSAs, recognizing that confirmation is still needed.

87. The BFI's communication effort is a robust region-wide public engagement strategy to build support for the initiative and FSA research, monitoring and protection. It is designed to promote the value of FSAs to local and regional audiences; build a constituency among stakeholders such as fishers, fisheries managers, policy makers and consumers; attract citizen scientists recruits (largely drawn from fishermen); publicize viable economic alternatives and incentives for fishers through programs like fisher-to-fisher exchanges; and broadcast the story of FSAs and the work in the Wider Caribbean to international audiences.
88. Other goals of BFI include uniting geographically disperse participants around a shared vision and a common story in order to promote teambuilding, strengthen collaboration, foster a common mission, and advance a shared sense of stewardship. All in all, "stakeholders are serving their communities by working together across international boundaries to protect FSAs, fisheries and the marine systems they depend on. In doing so, they are protecting, jobs, food security, and cultural heritage for generations to come.
89. To see how the communication strategy might work, Ms Salceda showed a BFI satellite project called, Big Fish in the Mesoamerican Reef (BFMAR). Smaller in scale, the BFMAR is currently in laboratory for testing the regional communication strategy, products and messaging. Ms Salceda's presentation closed with an analysis of the challenges and opportunities to design and apply the communication strategy for the entire region.
90. Ms Georgina Bustamante, CaMPAM coordinator, representing the SPAW Secretariat, presented information on the background and context of the SPAW contribution to the SAWG. SPAW proposed the following actions: 1) bringing the recommendations of this SAWG to the attention of the SPAW Protocol Contracting parties and the WCAFC Commission, 2) contributing to the development of national management plans for aggregating species, and 3) and promoting an ecosystem-based approach to the management of Nassau grouper and other aggregating species. In addition, the SPAW Secretariat is considering development of an Ambassador Program to support local fishers' involvement and support for sustainable fisheries management throughout the region. Finally, SPAW Secretariat is considering collaboration with relevant partners to develop a regional analysis of MPAs that protect spawning sites and to publicize findings and promote the implementation of emerging recommendations.

NEW TOOLS FOR REGIONAL MANAGEMENT

91. Ms Chelsey Young presented on new tools for regional management and conservation of Nassau grouper as it is a focus species for the United States, because it is listed under the US Endangered Species Act (ESA) as Threatened and in Annex III of the Specially Protected Areas and Wildlife Protocol (SPAW Protocol). As such, the United States is mandated to conserve and recover the species. The ESA was passed in 1973 with the main purpose of providing a conservation program for threatened and endangered species and the ecosystems on which those species depend. Due to significant declines in Nassau grouper spawning aggregation sites throughout its range, both in number and size, combined with ongoing threats of overfishing and inadequate regulations and enforcement to protect the species, NOAA Fisheries determined that the Nassau grouper warranted listing as Threatened and listed it as such in 2016.
92. Once a species is listed under the ESA, a number of regulatory and non-regulatory tools become available to promote the conservation and recovery of the species, including the development of recovery plans. Recovery plans are guidance documents that provide a "roadmap to recovery" by identifying site-specific actions that are necessary to help recover a species to the point that it no longer needs the protections of the ESA. For transboundary species such as Nassau grouper that occur across a wide range and largely within waters outside of US jurisdiction, recovery plans

encourage international cooperation and regular communication with appropriate agencies in other nations. Additionally, if a recovery team is formed, foreign nations can serve as members on those teams or participate as observers in the meetings. Given the strong need for regional coordination to recover this species across its range, the United States is committed to working cooperatively with its international partners to develop regional management strategies for the conservation and recovery of Nassau grouper.

FINAL RECOMMENDATIONS AND WORK PLAN

93. The SAWG deliberated and came to consensus on recommendations and a joint work plan (Appendix A).

CLOSURE OF THE MEETING

94. Mr Vinicius Giglio and several other participants expressed gratitude for being able to participate in the 2018 SAWG meeting. Ms Georgina Bustamante and several other participants reaffirmed their strong support for the SAWG 2018 recommendations and work plan. Mr Chris Koenig expressed that the meeting was well run and highly productive. Mr Miguel Rolon thanked everyone for their participation. Ms Ana Salceda pledged to move forward on FSA communications via the Big Fish Initiative. Fisher, Don DeMaria expressed his support for continued and expanded fisher involvement in the SAWG. Convener, Mr William Heyman expressed his gratitude for the hard work and contributions of all participants and re-affirmed commitment to the SAWG. Mr Alfonso Aguilar-Perera, SAWG meeting chair, officially closed the meeting.

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APPENDIX A – SAWG RECOMMENDATIONS AND WORKPLAN

SAWG Recommendations

Members of the WECAFC, belonging to the Spawning Aggregation Working Group (SAWG), reviewed and reaffirmed support for the Declaration of Miami (2013) and adopted the following recommendations during the 2018 meeting:

1. Members of WECAFC identify and determine the status of all known and exploited Fish Spawning Aggregation (FSA) sites of groupers and snappers and inform the WECAFC Scientific Advisory Group (SAG) of any changes in these areas.
2. WECAFC Secretariat and Members invest resources to engage fishers more directly in FSA conservation and management including SAWG meeting participation.
3. Members of WECAFC call for international action to protect FSAs, including strengthening enforcement of closed seasons, closed areas, and sales bans during the closed season.
4. Members of WECAFC agree upon and adopt a regional seasonal closure for all commercial and recreational fishing of Nassau grouper (*Epinephelus striatus*) in all known aggregation sites and during all known aggregation periods *at least* for the period 1 December – 31 March.
5. Members of WECAFC not permit any export of Nassau grouper or its products (e.g. roe, fillets) for the duration of the regional seasonal closure.
6. WECAFC support an assessment to ascertain the economic value of spawning aggregations and socio-economic impacts of the proposed management measures to inform future management decision-making.
7. WECAFC, CFMC and others, support the development of a regional Fisheries Management Plan (for national adoption throughout the region) for species forming FSAs (targeting groupers and snappers) to be presented to the WECAFC Secretariat in 2020.
8. Members develop and adopt national fisheries management and conservation plans for grouper and snapper species that aggregate to spawn.
9. The WECAFC Secretariat will support a regional outreach and communication strategy on conservation and management of FSAs.
10. The WECAFC Secretariat, together with the Members of WECAFC, will seek to mobilize resources to assist the Members in the implementation of research, monitoring, enforcement, and management for FSAs.
11. Members of WECAFC take note that boundaries of the identified spawning areas, spawning seasons and conditions to fish therein, as referred to in previous paragraphs, may change on the basis of the SAWG and SAG advice coming from additional knowledge and due to natural variation over time; hence buffer areas and timing need to be considered for management planning.
12. Members of WECAFC prioritize FSAs areas for monitoring, conservation, and management based on status and institutional capacity for management in each country member.

13. Members of WECAFC conduct FSA assessments, along with local fishers who are presently fishing those aggregations, in part to gather their support and in part to offer economic alternatives to fishers who exploit FSAs.
14. WECAFC Secretariat takes action to assist the country members in the Wider Caribbean Region to implement the above-listed recommendations.
15. The SAWG will create a listserv on the Gulf and Caribbean Fisheries Institute (GCFI) network will host meetings at the annual GCFI Conference.
16. The SAWG meeting participants will share updates regularly on the GCFI listserv, via annual meetings of the SAWG at the GCFI conference, and bi-annually to inform the WECAFC Secretariat of the progress on and measures taken to adhere to the above ***SAWG Work Plan 2018-2020***.

ACTIVITY	TIMEFRAME	RESPONSIBLE
1. Convene the 2 nd meeting of the SAWG in Miami	27–29 March 2018	WECAFC + CFMC as coordinator; meeting supported by NOAA <i>Completed</i>
2. Finalization, publication and dissemination of the report from March Meeting	November 2018	WECAFC + CFMC as coordinator; (Moe, Heyman, Young, Bolden, Rolon) <i>Second draft submitted to WECAFC</i>
3. Develop draft Regional Fisheries Management Plan (FMP) for Nassau grouper and other FSA-forming species	January 2019	CFMC (Sadovy, Azueta, Prada and Lindeman, and SAWG Members) <i>First draft in review</i>
4. Finalization of the Regional FMP for aggregating species	2020	CFMC (Sadovy, Azueta, Prada and Lindeman, and SAWG Members)
5. Support contributions for the State of the Marine Environment and Ecosystems SOMEE, CLME+ Report	March 2019	Heyman, <i>funding dependent</i>
6. Draft regional cooperative monitoring protocol, database and data management systems to characterize and monitor FSAs	December 2019 (funding dependent)	Heyman and WG Members, <i>funding dependent</i>
7. Final cooperative monitoring program and database.	December 2020	Heyman and WG Members, <i>funding dependent</i>
8. Conduct a regional and national status and needs assessment of FSA sites in the WECAFC region	2019–2020	CFMC and NOAA (W. Heyman, C. Young, S. Bolden, J. Azueta, R. Claro and others as appropriate; <i>funding dependent</i>)
9. Presentation of recommendations generated by the 2 nd Meeting for review / discussion and adoption by CRFM, OSPESCA and WECAFC	March–May 2019	Interim Coordination Mechanism for Sustainable Fisheries (supported by CLME+)
10. Presentation to the meeting of the WECAFC Scientific Advisory Group (SAG) to review the recommendations	November 2019	WECAFC secretary

ACTIVITY	TIMEFRAME	RESPONSIBLE
11. Develop communications strategy and tools for FSA conservation and management including two short videos about the urgency to protect FSAs	2019–2020	CFMC (support to A. Salceda, Beluga Smile and SAWG communications subcommittee) <i>draft submitted for review</i>
12. Mobilize resources from bilateral and international agencies to assist Members of WECAFC	2018–2020	WECAFC, CFMC, NOAA, SAWG members, and others
13. Organization and planning of the 3rd Meeting of the SAWG	2019	WECAFC + CFMC
14. Share technical capacity to identify FSAs in regions where FSAs have not been documented or characterized (e.g. Eastern Caribbean)	2019–2020	WECAFC; L. Reynal; <i>funding dependent</i>
15. Maintain the SAWG network intersessional communications by regularly posting FSA news and events to the GCFI, CAMPAM, and other lists	June 2018	FWRI (Acosta) <i>completed</i>

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OSPESCA/CRFM WORKING GROUP ON FISH SPAWNING AGGREGATIONS
Miami, Florida, USA, 27-29 March 2018



Attendees: Front row left to right: Alejandro Acosta, Ana Salceda, Ruth Gomez, Nicanor Requena, Araceli Acevedo, Yvonne Sadovy, Diana Martino; Standing left to right: John Claydon, Alfonso Aguilar-Perera, Lionel Reynal, Carlos Farchette, Michelle Schärer, Stephania Bolden, Chelsey Young, Jim Loscasio, Georgina Bustamante, Bradley Johnson, Will Heyman, Shinichi Kobara, Maren Headley, Vinicius Giglio, Tyler Loughgran, Celestine Moe, Chris Malanowski, Don DeMaria, Mauro Gongora, Krista Sherman, Orian Tzadik, Miguel Rolon, Chris Koenig, James Azueta, Maria de los Angeles Irizarry. Missing: Gladys Martinez, Áthila Bertoncini, Ken Lindeman, and Laurent Cherubin.

Photo courtesy: Ana Salceda, BelugaSmile Productions, LLC,

APPENDIX C – WORKSHOP AGENDA

27 March 2018	
<i>Morning session</i>	
09:00	Registration of participants
09:15	Opening of the session Welcome words by: <ul style="list-style-type: none"> • Will Heyman, Convener • Lionel Reynal, WECAFC Chair
09:30	Vote of thanks
09:45	Introduction of delegates
10:00	Introduction of the Working Group and update to the TOR – Convener: Will Heyman
10:15	Election of the Chairpersons and rapporteurs
10:20	Adoption of the agenda and arrangements for the Working Group
10:30	<i>Break</i>
10:45	Biogeography and socioeconomics of fish spawning aggregations in WECAFC region: Nassau grouper as the canary in the mine (Will Heyman, convener)
11:15	Status update of WECAFC work on Spawning Aggregations (Lionel Reynal, WECAFC Chair)
11:25	Spawning aggregations status and management update in CRFM member states (Maren Headley)
11:35	Spawning aggregations status and management update in OSPESCA member states (James Azueta)
11:45	Global importance of spawning aggregations and review of recommendations from the 1 st Meeting of the Spawning Aggregations Working Group (Yvonne Sadovy)
12:00	<i>Lunch break</i>
<i>Afternoon session</i>	
13:30	Overview of fisheries rules and regulations for species that aggregate to spawn in selected WECAFC member states (10 minutes each, including time for discussion and validation of survey information) <ul style="list-style-type: none"> • The Bahamas (Lester Gittens) • Cayman Islands (Bradley Johnson) • Cuba (Ken Lindeman for Rodolfo Claro) • Turks and Caicos (John Claydon)
15:30	<i>Break</i>
16:00	Continue overview of fisheries rules and regulations <ul style="list-style-type: none"> • Belize (Mauro Gongora) • Brazil (Vinicius Giglio or Áthila Bertoncini) • Mexico (Alfonso Aguilar) • United States (Caribbean, GoM South Atlantic; Stephania Bolden)
17:00	Facilitated discussion regarding Day 1 presentations (summary and integration with pre-meeting questionnaire) and progress made since 1 st Meeting of the Spawning Aggregations Working Group Meeting. Facilitator: Yvonne Sadovy
18:00	End of the first day of the meeting
28 March 2018	
<i>Morning session</i>	
09:00	New research techniques and tools for the study and management of spawning aggregations (Michelle Schärer and others)
09:20	Prediction, verification, and conservation of FSAs in the WECAFC Region (Shin Kobara)

09:40	<p>Research updates by country 10 minutes each</p> <ul style="list-style-type: none"> • Mexico (Alfonso Aguilar or Araceli Acevido) • The Bahamas (Krista Sherman) • Turks and Caicos (John Claydon) • Cayman Islands (Bradley Johnson) • Cuba (Ken Lindeman for Rodolfo Claro) • Belize (Nicanor Requena) • Brazil (Vinicius Giglio or Áthila Bertoncini) • United States (Caribbean, GoM and South Atlantic Alejandro Acosta, Chris Koenig, Ken Lindeman, Michelle Schärer)
11:30	Big Fish: A vision of cooperative monitoring and management of spawning aggregations in the WECAFC region (Will Heyman)
12:00	<i>Lunch break</i>
Afternoon session	
13:30	Update on outreach and education campaigns (Ana Salceda)
13:45	Plenary discussion – review and identify priorities and recommendations for research, monitoring and education to support regional management of FSAs in the WECAFC region Facilitator: Will Heyman
14:15	New tools for regional management and conservation of Nassau grouper – ESA, SPAW (NOAA – Chelsey Young/CEP Georgina Bustamante)
14:35	Implementation and enforcement challenges of current management recommendations (including IUU fishing issues, successes and lessons learned; facilitated discussion led by Chair)
15:30	<i>Break</i>
16:00	Plenary discussion on enhancing implementation of current management recommendations and identifying new/revised recommendations for establishing a regional approach to conserving spawning aggregations and Nassau grouper
17:00	Identify preferred regional management measures to conserve spawning aggregations and Nassau grouper and propose management recommendations to WECAFC SAG 9 in 2018
18:00	End of the second day of the meeting
29 March 2018	
Morning session	
09:00	Presentation of Spawning Aggregation Working Group findings and proposed recommendations to conserve spawning aggregations and Nassau grouper
10:00	Identify next steps for implementation of regional management measures for harmonizing regional management and conservation of spawning aggregations and Nassau grouper
10:30	<i>Break</i>
11:00	Review and adopt Working Group findings and recommendations; finalize Working Group Recommendations to WECAFC SAG
11:30	Any other matters
12:00	Closure of the Meeting

APPENDIX D – PRELIMINARY STATUS UPDATE ON FSAS IN THE WECAFC REGION

Preliminary Status Update on Fish Spawning Aggregation sites in the Western Central Atlantic

William D. Heyman and Tyler C. Loughran

15 October 2018

Introduction

The Second meeting of the CFMC/WECAFC/OSPESCA/CRFM Spawning Aggregations Working Group (SAWG) was held in Miami, Florida on 27–29 March 2018. Fisheries conservationists, scientists, and officers convened to discuss the continued decline in certain stocks of aggregating fish species and recommendations for further management and conservation efforts. Aggregation sites throughout the Western Central Atlantic have long been exposed to high fishing pressure, lack of regulation, enforcement, and inadequate management, all of which has exacerbated the population decline of vulnerable aggregating species (Aguilar-Perera 2013). Site specific protection measures have the potential to spur local fish population recovery following the overexploitation of a species (Erisman *et al.*, 2017). In spite of their obvious importance to the fisheries and socioeconomics in the region, the present status of FSAs in the region is unknown.

To address this knowledge gap in a comprehensive way will require an in-depth study that includes some amount of field validation. As a preliminary step towards a proper regional assessment, we developed a survey instrument and conducted a survey of regional experts, in an effort to test the utility of the survey and to produce a preliminary snapshot of the status of FSAs in the region. Prior to the meeting, selected scientists and managers, perceived by the senior author to possess knowledge of FSA status in their focal research areas, were asked to complete a survey. Participants were asked to provide FSA site locations, species composition and abundance, and research techniques utilized at each site were described and quantified by each of the respondents. The results from these surveys shed light on regional aggregation status, highlighted sites in need of further management measures, and points to the urgent need for a truly comprehensive status update of the FSAs in the WECAFC region, that can be used to identify knowledge gaps and prioritize urgent management needs and actions.

Methods

A brief survey was sent to workshop participants, known to the first author to have data and first-hand information in an effort to determine the location and status of spawning aggregations throughout the Western Central Atlantic region for the purpose of prioritizing regional management and research. The survey focused on three main topics surrounding spawning aggregations: Site Data, Species, and Research Techniques. Upon completion and consolidation of the surveys, we used pivot tables to summarize the present knowledge of regional site characteristics and species abundance.

Results

Representatives from Brazil, The Bahamas, Mexico, continental United States, US Virgin Islands, Puerto Rico, Cayman Islands, Cuba, and the Turks and Caicos responded to the survey. 111 sites were reported across the Western Central Atlantic region, with the highest number of sites located in the United States and Cuba who both have 21 sites each (Figure 1). Of the 111 sites reported, 58 percent were mapped using hydroacoustic methods (Figure 2) and 53 percent of the sites had multiple

aggregation species present (Figure 3). Thirteen aggregating species were documented throughout the region. Goliath grouper (*Epinephelus itajara*) and Nassau grouper (*E. striatus*) were reported across 31 sites each, or 28 percent of the sites (Figure 4). Other species such as mutton snapper (*Lutjanus analis*) and lane snapper (*L. synagris*) were reported at 10 and 9 percent of sites, respectively (Figure 4).

Respondents were asked to define each site's fish abundance status as increasing, decreasing, same, gone, or unknown. Unknown abundance status accounted for 51 of 90 sites. Twenty-three of the remaining sites were classified as decreasing status, 16 sites as same status, seven sites as gone, and three sites as increasing, Little Cayman West End, Cayman Brac East End (both in the Cayman Islands), and Grammanik Bank (USVI) (Figure 5). FSA status was determined using a variety of research techniques. The most common research technique used were fisher interviews/port surveys (conducted at 80 sites), Underwater Visual Assessments (72 sites) and Fishery Dependent Data collection, reported for 48 sites (Figure 6).

Discussion

Surveys were completed by a limited number of scientists and managers, with a demonstrated working knowledge of the FSA status in the areas in which they work. This study was implemented in large part as a validation for the survey technique and was not expected to produce a complete region-wide status update on FSAs. The survey was conducted with very limited time and resources. The resulting data and observed trends may be artifacts of the limited geographic scope of the survey and the lack of field validation. Nonetheless, the survey technique appears to serve as a valuable method for rapid, desktop assessments of the status of FSAs. We received completed surveys for nine geographic areas and a total of 111 sites in the WECAFC region (Figure 1).

The survey results have allowed for a snapshot of the status of available information for known sites. If site data are available, the survey can be used to determine which species aggregate at each site and their relative abundance, the status of characterization and monitoring, and protection and management status for each site. Survey responses are particularly helpful for pinpointing aggregation locations in need of further protection (Grüss *et al.*, 2018). Site data can in turn be compiled by nation or geographic region and the results can be rolled-up into a region-wide assessment. Some amount of field work (i.e. site visits that include interviews of local fishers and managers) will be required to validate survey results. Results can help prioritize and focus research and management efforts at local, national and regional levels. Monitoring data will be needed to track FSA site status and trends over time, in relation to fishing pressure, local environmental conditions, regional climatic changes, and new protection measures as they are implemented.

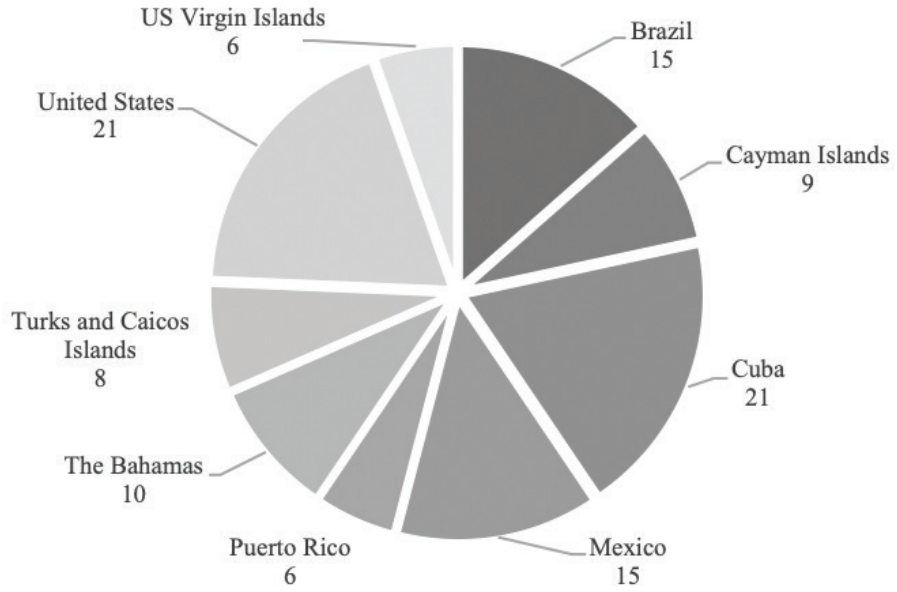


Figure 1: The identified 111 reported sites grouped by country

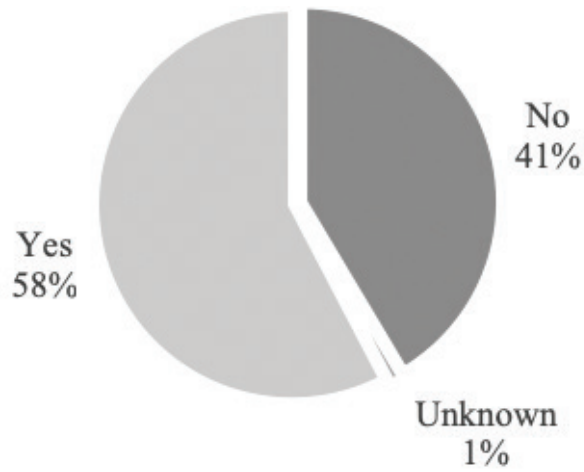


Figure 2: The percentage of sites that have been adequately mapped

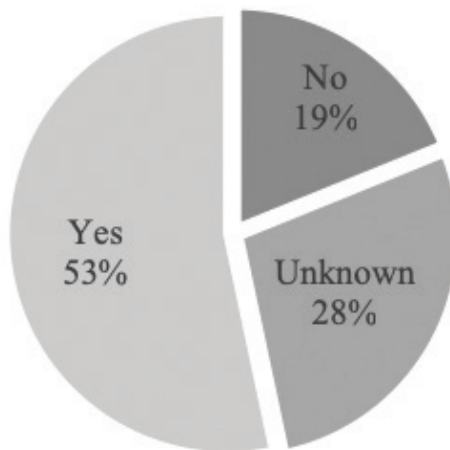


Figure 3: The percentage of multi species, unknown, single species sites within the 111 reported sites

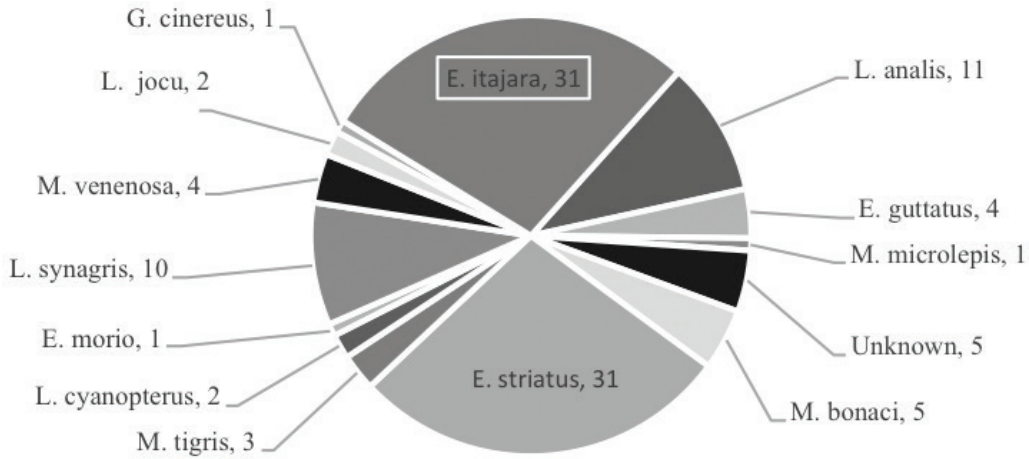


Figure 4: The most commonly identified FSA-forming species from the 111 reported sites

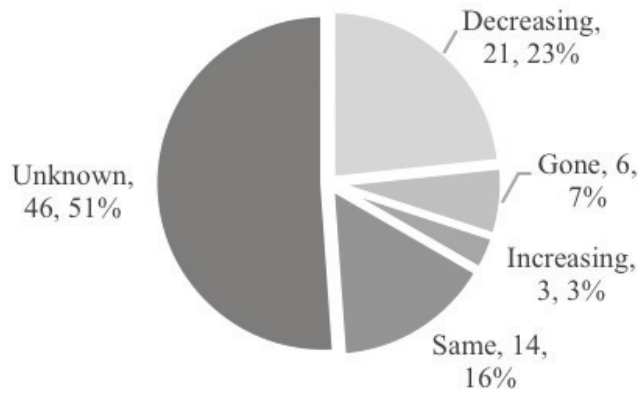


Figure 5: The abundance status from each of 111 identified sites, categorized by respondents as unknown, gone, decreasing, same, or increasing. Data are reported as the number of sites for each category and the percentage of the total represented

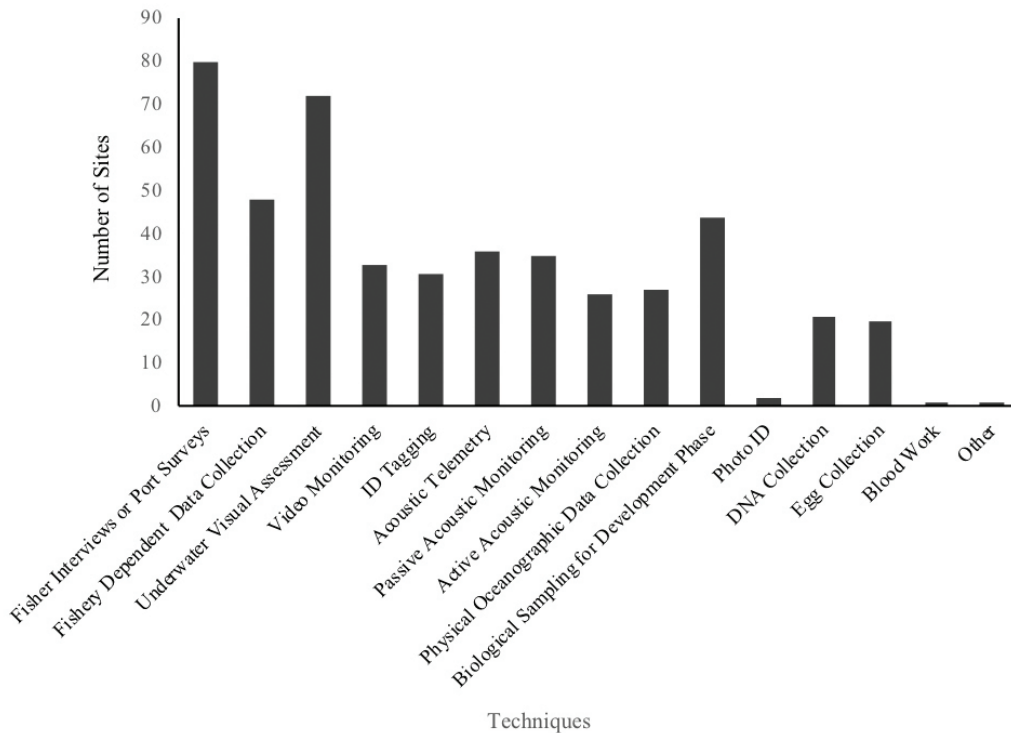


Figure 6: Research techniques most commonly used at each of the 111 sites

Acknowledgements

We are grateful to the following contributors of data contained within completed surveys: Michelle Schärer, John Claydon, Ken Lindeman, Krista Sherman, Rodolfo Claro, Bradley Johnson, Rick Nemeth, Alfonso Aguilar, Stuart Fulton, Chris Koenig, Alejandro Acosta, Vinicius Giglio, and Áthila Bertoncini. We also thank Brad Erisman for travel support for the junior author.

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APPENDIX E – MANAGEMENT SURVEY RESULTS

WECAFC Spawning Aggregations and Nassau grouper Management Survey

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Introduction

The second meeting of the CFMC/WECAFC/OSPESCA/CRFM Spawning Aggregations Working Group (SAWG) was held in Miami, Florida on 27 and 29 March 2018. Fisheries conservationists, scientists, and managers convened to discuss the ways to conserve fish spawning aggregations and recommendations for further management and conservation efforts. Aggregation sites throughout the Western Central Atlantic have long been exposed to high fishing pressure, lack of regulation enforcement, and inadequate management, all of which has exacerbated the population decline of vulnerable aggregating species (Aguilar-Perera 2013), particularly Nassau grouper (*Epinephelus striatus*) (Sadovy de Mitcheson 2012). Prior to the meeting, fisheries managers from WECAFC member countries attending the Working Group meeting were asked to complete a survey in order to fill in knowledge gaps and gain insight into the adequacy of existing management measures and enforcement for spawning aggregations and in particular Nassau grouper within the Western Central Atlantic. Complementing this survey geared toward fishery managers, a survey was sent to researchers regarding spawning aggregation site locations, species composition and abundance, and research techniques utilized at each site. Summarized here are results from some key questions. The full survey is presented in Appendix 6.

Methods

A detailed survey was sent to each participant in an effort to identify existing fisheries management measures and regulations for the protection of spawning aggregations and Nassau grouper in particular throughout the Wider Caribbean Region, potential gaps in management, and key issues that may be impeding successful conservation. The survey (form attached at the end of this document) focused on the following topics surrounding management of spawning aggregations and Nassau grouper: existing fisheries management measures and their efficacy, domestic compliance and illegal fishing, and local issues impeding conservation. Upon completion and consolidation of the survey, we summarized the percentage of responses to identify the most pressing management issues facing spawning aggregations and Nassau grouper in the Wider Caribbean Region.

Results

Representatives from Belize, Brazil, The Bahamas, Cayman Islands, Guatemala, Mexico, Turks and Caicos Islands, the continental United States, and US Virgin Islands responded to the survey. Across the region, existing fisheries management regulations were most prevalent for Nassau grouper and mutton snapper (*Lutjanus analis*). Closed areas and seasons were the most common fishery management measures for the management of spawning aggregations and certain species. Most countries have a closed season during for Nassau grouper during at least part of their spawning season, with the exception of Brazil and Mexico. In Mexico, regulations for red grouper may provide some benefits for

Nassau grouper. One of the main issues identified is the timing of closed seasons varies considerably across the region and may not sufficiently cover the spawning period. Aside from the United States, where Nassau grouper is prohibited year-round, the Cayman Islands' closed season is the longest and runs from 1 December – 30 April. The shortest closed seasons were in The Bahamas, and Turks and Caicos, running from 1 December – 28 February.

When asked to rank the importance of various issues for ensuring management measures are effective to conserve spawning aggregations, enforcement, adequacy of existing regulations, and domestic compliance were ranked as the top three issues, respectively. With respect to Nassau grouper, when asked whether countries had a National or Local Plan of Action or Management Plan for Nassau grouper, only two countries (Cayman Islands and the United States) responded positively, with one plan drafted and the other plan adopted, respectively. The other countries that responded (The Bahamas, Belize, Brazil, Guatemala, Mexico, and Turks and Caicos) indicated that they did not have a specific management plan drafted or in place for managing Nassau grouper.

Discussion

The compilation of survey results provided by fisheries managers has proven to be a valuable resource for identifying existing fisheries management measures in place for spawning aggregations and various aggregating species across the Western and Central Atlantic. Additionally, the survey results provide valuable insight into the perceived efficacy of these measures and clearly identified areas for improvement. Additional surveys from other countries in the region would be useful to pinpoint gaps in management and focus on the most pressing issues for conserving and managing spawning aggregation sites and species across the region. Updates to the surveys are also valuable. For example, it was determined that The Bahamas now (December 2018) has a conservation and management plan drafted and under consideration for adoption, though that was not the case at the time the survey was conducted. Given the broad distribution of Nassau grouper and the ability of both adults and larvae to move beyond spatial range of individual countries, a Caribbean-wide plan is essential for conservation. This survey information will assist in establishing a regional conservation and management strategy for these sites and species.

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TABLE 1
Ranked list of issues important to the effective management of spawning aggregations ranked from 1 (most important) to 8 (least important)

Issue	Importance Ranking
Enforcement	1
Adequacy of existing regulations	2
Domestic compliance	3
Awareness of regulations	4
Outreach and education	5
Foreign IUU fishing	6
Domestic IUU fishing	7
Data sharing	8

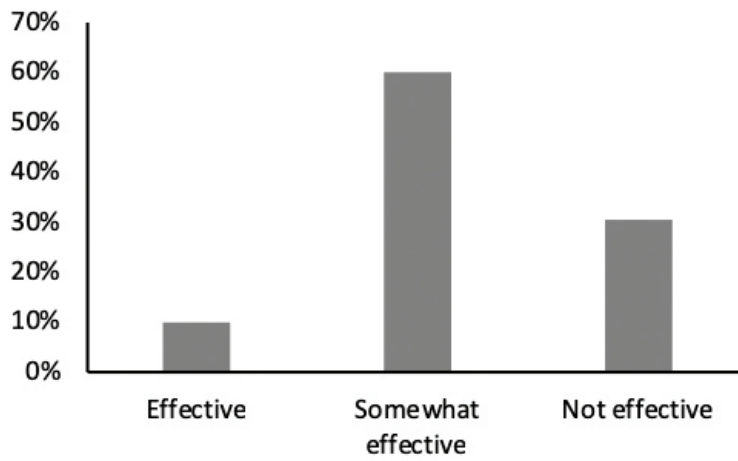


Figure 1. Effectiveness of regulations to conserve spawning aggregations based on survey responses, (n=10)

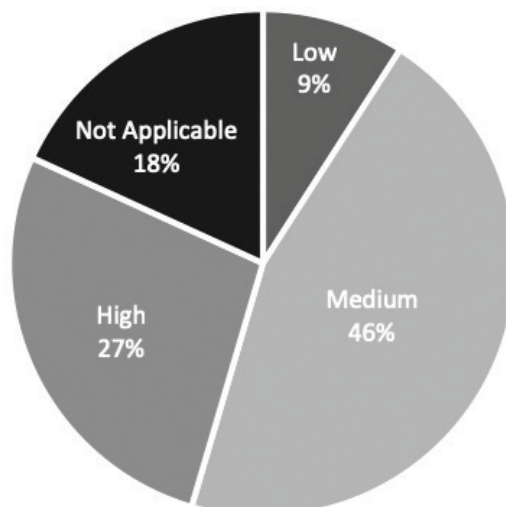


Figure 2. Enforcement capacity of closed seasons for Nassau grouper by percentage of the number of respondents (n=11)

TABLE 2
Status of National Plan of Action or Management Plan for Nassau grouper by country

Country	No plan	First Draft	Developed draft	Final draft	Submitted	Adopted
The Bahamas					x	
Belize	x					
Brazil						
Cayman Islands			x			
Guatemala	x					
Mexico	x					
Turks & Caicos	x					
United States						x

*The following **survey** was sent to fishery managers prior to the 2018 Spawning Aggregation Working Group Meeting held 27-29 March in Miami, Florida.*

Spawning Aggregations Working Group Survey

Fisheries Management for Spawning Aggregations and Nassau grouper

Name:

What country and/or island do you represent?

What is your position or title?

Section I. Fisheries Management for Spawning Aggregations:

1. Check all that apply: Fisheries management measures that are currently in place for spawning aggregations in your country: Closed areas (e.g., MPAs, national parks); Closed seasons (e.g., time restrictions); Gear restrictions (e.g., trawling, spearfishing, hookah/scuba); Effort restrictions (e.g., limited entry); Licenses/permits; Other.
2. Check all that apply: Species that benefit from protective regulations checked in Question 1: Nassau grouper; red hind; rock hind; goliath grouper; red grouper; black grouper; yellowfin grouper; mutton snapper; dog snapper; lane snapper; cubera snapper; gray snapper; Red snapper; Schoolmaster; Yellowtail snapper.

****Please provide details for each of the regulations and species you checked in Questions 1 and 2 above (e.g., types/locations of closed areas; timing of closed seasons; specific gear restrictions, etc.).**

3. How effective are your country's current fishing regulations for protecting spawning aggregations: rank between 1 (not effective) and 5 (effective).
4. Please rank each of the following issues in order of importance (1 being most important issue, and 8 being the least important issue) for ensuring that management measures are effective for protecting spawning aggregations (please use each rank number only once): Adequate regulations (i.e., ensure effective regulations are sufficient for protection); Increased awareness of existing management

measures and regulations; Enforcement capacity; Domestic compliance/buy-in from fishermen; Combating foreign illegal unreported and unregulated (IUU) fishing; Combating domestic IUU fishing by nationals; Outreach and education; Data/information sharing on spawning aggregations and their importance for fisheries.

5. To the best of your knowledge, what is the level of domestic compliance with national/local fisheries regulation for spawning aggregations in your country? Very high; High; Moderate; Low; Very low.
6. To the best of your knowledge, please indicate level of foreign IUU fishing on spawning aggregations that occurs in your country: Very high (far greater than domestic levels); High (greater than domestic levels); Moderate (more or less equal to domestic levels); Low (less than domestic levels); Very low (minimal or not occurring).
7. Are there any other issues within your country that may be impeding management/conservation efforts of species that aggregate to spawn?
8. Does your country have a National or Local Plan of Action or Management Plan for species that aggregate to spawn? Choose one: No; First draft; Developed draft; Final draft; Submitted; Adopted; Other.

II. Fisheries Management for Nassau grouper

9. If available, please provide your country's annual landings of Nassau grouper over the past 10 years.
10. During what time of year is the majority of Nassau groupers caught and landed?
11. Check all that apply - Fisheries management measures currently in place for Nassau grouper in your country: Closed areas (e.g., MPA's national parks); Closed seasons (e.g., time restrictions); Gear restrictions (e.g., trawling, spearfishing, hookah/scuba); Effort restrictions (e.g., limited entry); License/permits; Minimum size/weight limit; Maximum size/weight limits; Bag/catch limits (e.g., daily harvest and quotas); Sale/market restriction (e.g., prohibit sale during closed season); Trade restriction (e.g., prohibition/regulations form import/export); Landing requirements (e.g., whole fish vs fillet); Other.
12. **Please provide details for each of the regulations you checked in the question above.
13. Please indicate the current status of the following regulations for Nassau grouper in your country as Draft, Enacted, Implemented, Enforced, Monitored/evaluated: Closed areas/MPAs, national parks); Closed seasons (e.g., time restrictions); Gear restrictions; Effort restrictions; Licenses/permits; Maximum size/weight; Minimum size/weight; Bag catches/limits; Sale/market restrictions; Trade restrictions; Landing requirements.
14. Please indicate enforcement capacity of each management measure using high, medium or low. If a management measure is not in place within your country, select "Non applicable": Closed areas; Closed seasons; Gear restrictions; Effort restrictions; Licenses/permits; Minimum sizes/weight limits; Bag/catch limits; Sale/market restrictions; Trade restrictions; Landing requirements; Other (as specified in Question 1).
15. How effective are your country's current regulations for protecting Nassau grouper? Rank between 1 (not effective) and 5 (effective).

16. To the best of your knowledge, what is the level of domestic compliance with national/local fishing regulations for Nassau grouper in your country? Very high; High; Moderate; Low; Very low
17. To the best of your knowledge, please indicate the level of foreign IUU fishing targeting Nassau grouper in your country: Very high (far greater than domestic levels); High (greater than domestic levels); Moderate (more or less equal to domestic levels); Low (less than domestic levels); Very low (minimal or not occurring).
18. How would you best describe the level of domestic consumption of Nassau grouper compared to foreign exports in your country? Choose one: All domestic consumption; Mostly domestic consumption; About equal (some domestic, some foreign exports); Mostly foreign exports; All foreign exports.
19. Does your country have a National or Local Plan of Action or Management Plan for Nassau grouper? Choose one: No, First draft; Developed Draft; Final Draft; Submitted; Adopted.
20. In addition to completing this survey, please provide copies of any legislation/regulations relevant to spawning aggregations and/or Nassau grouper within your country to Miguel Rolon at miguel_rolon_cfm@yahoo.com.

Thank you for your participation!

The Second meeting of the CFMC/WECAFC/OSPESCA/CRFM Spawning Aggregations Working Group (SAWG) was held in Miami, Florida on 27 and 29 March 2018. The meeting brought together more than 35 fisheries experts, conservationists, marine biologists and fisheries officers from 15 WECAFC member states, national fisheries bodies, fisheries technical advisory institutions, non-governmental organizations, academic scientists, fishers, and other relevant stakeholders.

The experts at the meeting recognized the continued decline in stocks of many aggregating species, particularly groupers and snappers in the Western Central Atlantic. Participants re-affirmed and updated the recommendations of the Miami Declaration that Members of WECAFC made during the 1st SAWG meeting (2013). The SAWG developed a work plan and agreed to roles, responsibilities and timelines for key activities and actions. SAWG members have been extremely active in completing these activities between the time of the meeting and the publication of this report.

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