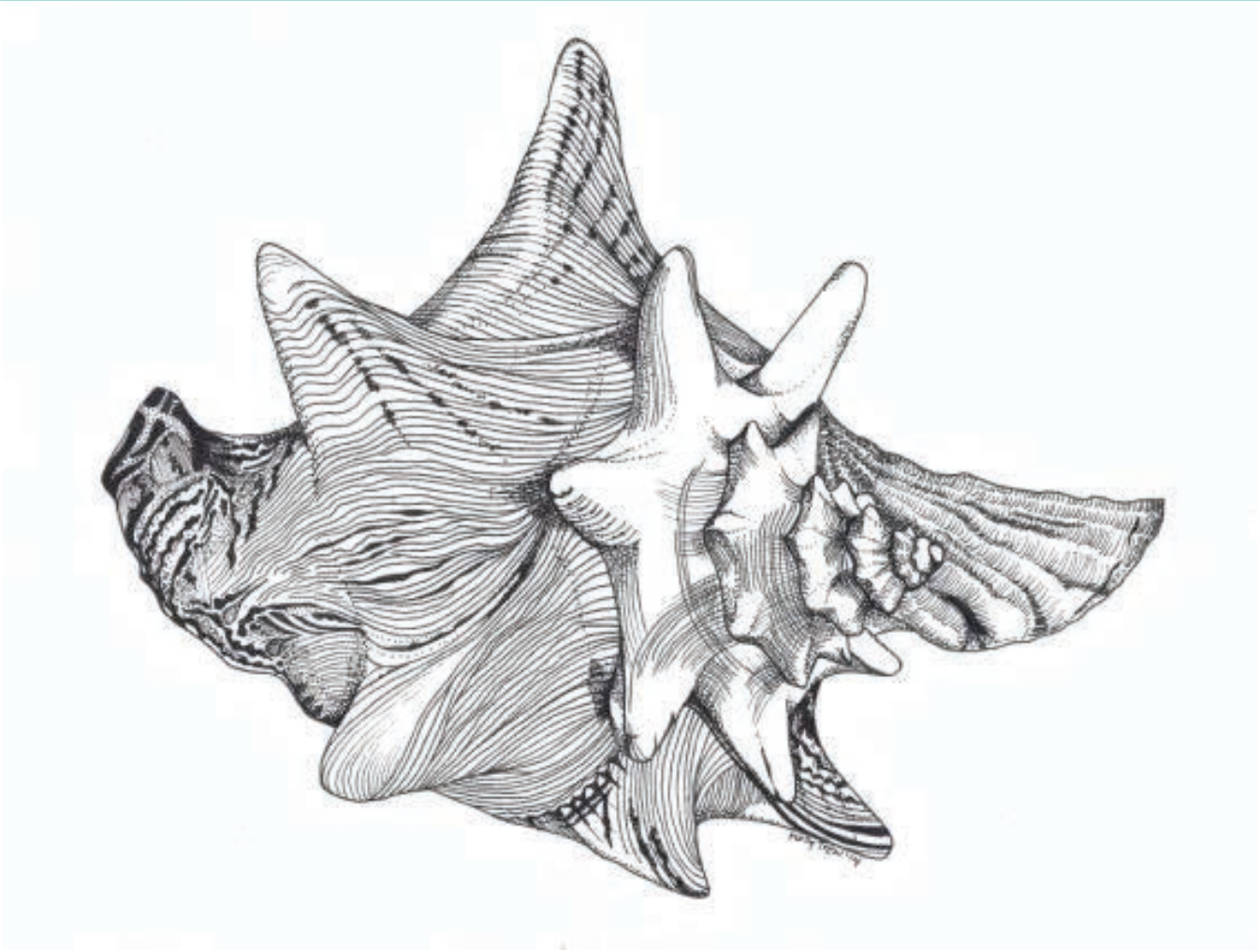
Food and Agriculture Organization of the United Nations

FAO FISHERIES AND AQUACULTURE TECHNICAL PAPER

610

ISSN 2070-7010

Regional Queen Conch Fisheries Management and Conservation Plan



Cover photograph:
Queen Conch drawing by Ms. Holly Trew (2014).

Regional Queen Conch Fisheries Management and Conservation Plan

FAO
FISHERIES AND
AQUACULTURE
TECHNICAL
PAPER

610

by
Martha C. Prada
Coralina, San Andres, Colombia

Richard S. Appeldoorn
University of Puerto Rico, Mayagüez, Puerto Rico

Sjef van Eijs
Panama City, Panama

Manuel Pérez M.
Managua, Nicaragua

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2017

ISBN 978-92-5-109931-5

Contents

Preface

This document presents the Regional Queen Conch Fishery Management and Conservation Plan, following the recommendations of the first meeting of the WECAFC/CFMC/OSPESCA/CRFM Working Group, held in Panama from 23 to 25 October 2012. The initiative is funded by the Food and Agriculture Organization of the United Nations (FAO), its Western Central Atlantic Fishery Commission (WECAFC) and the Caribbean Fisheries Management Council (CFMC), in partnership with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Caribbean Fisheries Regional Mechanism (CRFM) and the Organización del Sector Pesquero y Acuícola del Istmo Centroamericano (OSPESCA).

The need for coordinated management of the queen conch (*Strombus gigas*) has long been recognized by fisheries scientists and managers in the Wider Caribbean region. In 1986, the FAO/WECAFC Technical Cooperation Programme, the Organization of the Eastern Caribbean States (OECS) and the Caribbean Regional Fisheries Mechanism (CRFM) initiated an effort to develop a harmonized subregional plan for the management of queen conch, inspired by the recognition of the shared habitats of this transboundary resource, as well as the extent and importance of its international exploitation and trade (Mahon, 1990).

In 1991, at the Workshop on Biology, Fisheries, Mariculture and Management of Queen Conch (*Strombus gigas*), held in Caracas, Venezuela, many scientific and management officers expressed their concern about the status of the resource in the Caribbean region and pointed out the need to implement a common regional management strategy for the fishery (Daves and Field, 2006).

In 1996, the First International Queen Conch Conference was convened in San Juan, Puerto Rico, from 29 to 31 July 1996, supported by CFMC, US NMFS, the Government of the Commonwealth of Puerto Rico and FAO. The participants adopted the Declaration of San Juan, which called for a common international management strategy for the queen conch resource in the Caribbean region (Daves and Field, 2006). Unfortunately, until now, the tangible results of regional and subregional initiatives of this nature have been scarce because of the lack of cooperation and political support across the region.

More recently, the Sistema de la Integración Centroamericana (SICA) countries agreed on a Fisheries and Aquaculture Integration Policy for the Central American Isthmus (OSPESCA/CIRSA Resolution 14/2005), which focuses on regional fishery management and conservation. In addition, in 2012, OSPESCA and CRFM agreed on a Memorandum of Understanding which included the implementation of a Joint Action Plan (SICA/CARICOM, 2013), based on the 2010 Castries Declaration on Illegal, Unreported and Unregulated (IUU) Fishing, in the CARICOM and SICA regions (Regulation OSP 08 2014, OSPESCA 2012). Although most of the above initiatives are not specific to queen conch, they still benefit queen conch fishery management.

Two Caribbean ACP Fish II Projects on queen conch were completed in 2013. Both were allocated through the CARIFORUM/Caribbean Fisheries Regional Mechanism (CRFM). They provided significant contributions towards regional management and capacity building through case studies, recommendations for improved monitoring, assessment and harmonized management actions, and regional training in underwater visual queen conch census techniques.

This Regional Queen Conch Fishery Management and Conservation Plan proposes to implement a set of management measures that can be applied at the regional or subregional level for the sustainability of queen conch populations, the maintenance of a healthy fishery and the sustenance of fishers and fishers' communities. This Regional Plan recommends an ecosystem-based management approach that enhances partnership and collaboration throughout the Wider Caribbean region. In addition, as the Regional Queen Conch Fishery Management and Conservation Plan will be progressively implemented, it should lead to improvements in the long-term governance of queen conch fisheries across the Caribbean, as stated in strategy 4B of the Strategic Action Plan (SAP) of the Caribbean Shared Living Marine Resources and Adjacent Regions (CLME).

The 14 management measures recommended in this Regional Queen Conch Fishery Management and Conservation Plan were analysed by experts participating at the Second Meeting of the WECAFC/CFMC/OSPESCA/CRFM Working Group, held in Panama from 18 to 20 November 2014. There was consensus that these measures may strengthen regional management of the queen conch fishery despite the fact that, at this point, the Plan is not binding. The adoption of the Regional Queen Conch Fishery Management and Conservation Plan by the relevant authorities of the queen conch range states received the support of a vast group of experts and the Plan's implementation can be achieved through existing national and regional management arrangements. In fact, the majority of the proposed regional management measures are already being applied at national levels in most Caribbean countries and territories involved in the queen conch fishery.

The review, approval and adoption process of this Regional Queen Conch Fishery Management and Conservation Plan took place at the 17th Conference of Parties of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and at the 16th Western Central Atlantic Fishery Commission (WECAFC) meeting, in 2016.

WECAFC is the only umbrella organization that covers all Caribbean countries and territories, with CRFM and OSPESCA acting as subregional organizations. The regional involvement of the Caribbean Fisheries Management Council (CFMC) in dealing with the queen conch management issues has been highly relevant and accepted throughout the Wider Caribbean. This involvement was complemented by the CITES role, which has been key to promoting sustainable exploitation and exports for the species. The complexity of regional queen conch fisheries management is not only reflected in the large number of countries and management organizations involved, but it also illustrates the degree of coordination needed to avoid duplication in the efforts and to achieve the sustainable management of this transboundary fishery resource in the region.

Prada, M. C.; Appeldoorn, R. S.; Van Eijs, S. & Pérez, M. M. 2017. *Regional Queen Conch Fisheries Management and Conservation Plan.* FAO Fisheries and Aquaculture Technical Paper No. 610. Rome, FAO. 70 pp.

Acronyms

ACP	Group of African, Caribbean and Pacific Nations
CARIFORUM	Caribbean Forum for the European Union Agreement
CFMC	Caribbean Fisheries Management Council
CIRSA/OIRSA	International Regional Committee of Agricultural Health
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLME	Caribbean Large Marine Ecosystem
CRFM	Caribbean Regional Fisheries Mechanism
FAO	Food and Agriculture Organization of the United Nations
IUU	Illegal, Unreported and Unregulated Fishing
LFA	Logical Framework Approach
MCS	Monitoring, Control and Surveillance
NDF	Non-Detriment Finding
OLDEPESCA	Organización Latinoamericana de Desarrollo Pesquero (Latin American Organization for Fisheries Development)
OECS	Organization of Eastern Caribbean States
OSPESCA	Organización del Sector Pesquero y Acuícola del Istmo Centroamericano (Central American Fisheries and Aquaculture Organization)
SICA	Sistema de la Integración Centroamericana (Central American Integration System)
SPAW	Specially Protected Areas and Wildlife
UNEP	United Nations Environment Program
VMS	Vessel Monitoring System
WECAFC	Western Central Atlantic Fishery Commission
WCMC	World Conservation Monitoring Center

Definitions

Definitions employed in this document are presented in APPENDIX 1.

SUMMARY OF THE REGIONAL QUEEN CONCH FISHERIES MANAGEMENT AND CONSERVATION PLAN: MEASURES VALIDATED BY THE CFMC/WECAFC/ CRFM/OSPESCA QUEEN CONCH WORKING GROUP

I. RECOMMENDED SHORT-TERM MANAGEMENT MEASURES

1. Harmonized and simplified categories of queen conch meat conversion factors

Justification: In the queen conch fishery, the main commodity is the meat fillet or muscular foot of the gastropod. Differences in the processing of queen conch meat affect the estimation of its catch data in terms of overall yield and numbers of individuals. Therefore, uniform conversion factors need to be determined and applied to catch data so that more accurate and precise, regionally comparable landing estimates can be generated. Specific conversion factors exist only in some countries (i.e. Antigua and Barbuda, the Bahamas, Belize, the Dominican Republic, Jamaica, Honduras, Martinique, Mexico and Nicaragua), but they are necessary for all countries.

Implementation advice: All countries and territories should report their queen conch landings and imports/exports utilizing standardized definitions and conversion factors; these factors are preferable if available at the national level. In absence of national conversion factors, data should be expressed utilizing agreed regional conversion factors. FAO has proposed the following regional conversion factors:

Processing grade	Processing definition	Conversion factor
Dirty meat	Animal without the shell	5.3
50% clean	Removal of the operculum (claw) and the visceral bag	7.9
100% clean	Only the white meat remains	13.2

Countries should continue to collect weight data by processing grade in order to update and improve the proposed conversion factors.

2. Improvement of catch and effort monitoring programmes

Justification: Queen conch catch data are often poor or incomplete, as they are often not organized with statistical rigour, represent only short time periods and/or are based on processors' purchase reports. Local consumption is seldom included in the catch statistics. Fishing effort is a key variable, particularly because most models use catch per

unit of effort (CPUE) as a measure of abundance. The efficiency of effort often changes over time by virtue of changes in fishing techniques and fishing grounds.

Implementation advice: Agree to form a regional advisory group that will carefully analyse catch and effort databases existing at subregional levels, and propose strategies and applications for the improvement of data collection and processing, including optimizing possibilities for collaborative work and increasing compliance for reporting. Resulting strategies may need to include: (1) design of better-structured queen conch survey formats; (2) improving mechanisms to facilitate and increase fishers' reporting; (3) compiling, organizing and digitizing historical queen conch fishery data from analogue formats; (4) applying conversion factors and determining the degree of queen conch products used for local consumption; (5) interviewing experienced fishers and recreating a history of changes in typical fishing techniques and the likely effects on the efficiency of fishing effort; and (6) work on improving existing digital databases at the national and subregional level.

3. A synchronized regional closed season

Justification: Queen conch can potentially reproduce all year round. High water temperature (28–29 °C) is associated with the peaks in queen conch reproduction and gametogenesis. A harmonized regional closed season would help reduce overall fishing mortality and contribute to the success of queen conch mating and spawning, thereby supporting reproduction and population replenishment, while at the same time facilitating the monitoring and patrolling needed to counteract illegal fishing. Most countries have a closed season at some time during the calendar year. The maximum benefit is only achieved if the temporal limitation in fishing effort is exercised equally over broad areas, thus allowing for population resilience and connectivity.

Implementation advice: The adoption of a closed season at regional or subregional levels can be developed through existing mechanisms like CRFM, CFMC, OSPESCA, OLDEPESCA and WECAFC. It can be adjusted in response to variability in spatial/temporal patterns once monitoring data become available. Special protocols should be in place in order to enforce this regulation. Fisheries managers can facilitate compliance through better communication and education within the communities concerned and beyond. Biological studies on the spawning seasons in the western central Caribbean (e.g. Cuba, Haiti and the Cayman Islands) provide a good indication of when queen conch are congregating to spawn and, therefore, most vulnerable to overfishing. Enforcement will be vastly improved if the trading of queen conch during the closed season is limited, in order to validate inventories (all kind of fishers, processors and traders), following the OSPESCA Resolution OSP 02 09. This regulation can be extended across the Wider Caribbean.

4. Non-Detriment Finding (NDF) for export of queen conch meat and its by-products

Justification: Any country wanting to export queen conch specimens, in whatever form, is required under CITES to provide a permit based on an updated NDF, which demonstrates that the level of export is not detrimental to the queen conch stocks of the country concerned and that the product is obtained in accordance with the prevailing laws of that country. Thus, in order to export queen conch, a country must develop and demonstrate sustainable management and ongoing monitoring of the stock.

Implementation advice: It is recommended that the queen conch range states of the region develop mutually-agreed standardized NDF guidelines, to be considered a minimum standard for complying with the NDF export requirement. A proposal for

NDF guidelines was presented and supported by the Regional Queen Conch Working Group at the 2014 meeting.

5. Licensing of all queen conch fishers, processors and exporters

Justification: Through national licensing or permit schemes it will be possible to estimate the number of people involved in the fishery and ensure their compliance with reporting and management measures. Licensing will enhance efforts for data and information collection and enforcement. In the fight against Illegal, unreported an unregulated (IUU) fishing, the use of licences can prove to be instrumental and essential.

Implementation advice: Information on the national licensing programmes should be shared at the regional level to promote queen conch conservation. This information should be in a format which is acceptable to all countries.

6. Adoption of stricter regulations on autonomous diving techniques

Justification: Diving for queen conch has implications for the safety of fishers. There is ample anecdotal evidence of many diving-related accidents in the region. Lack of training, improper equipment, poor maintenance and work under strenuous physiological conditions all contribute to the accident rate.

Implementation advice: Several measures are proposed: a) require dive certification and training (oxygen provider, emergency first response, etc.) for all queen conch fishers as a condition for licensing; b) require training in diving equipment and maintenance; c) require annual equipment safety inspections of queen conch fishers who scuba dive; d) display a dive flag on the dive site; and e) require scuba divers to dive with a buddy.

7. Coordination in patrolling

Justification: As with any open water marine fisheries, the enormous size of the region's maritime area represents a challenge. IUU fishing is a serious problem and regional cooperation in coordinated patrolling is greatly needed, as many countries in the region lack the resources to enforce their maritime space.

Implementation advice: To address this issue, bilateral and multilateral agreements should be put in place between range states, possibly by subregion. This protocol should include, inter alia, linkages between enforcement/coastguard, customs, fisheries and port authorities and relevant fisherfolk groups.

8. Extended use of satellite-based VMS systems for boats with a length exceeding 10 metres

Justification: Caribbean fisheries are increasingly relying on satellite-based vessel monitoring systems (VMS) because the technology facilitates rescue responses to emergencies at sea as well as the identification of potential illegal fishing activities, while at the same time providing data to analyse the spatial/temporal patterns of the fishery. Regional coordination is required and if it is to be effective, systems and data information have to be compatible regionally.

Implementation advice: Queen conch range states should implement a satellite-based VMS system for fisheries management. The region should explore ways to integrate these systems. Development and implementation of satellite-based VMS systems should be linked in order to organize monitoring, control and surveillance (MCS) activities.

9. Continuous education and outreach programmes for stakeholders

Justification: Despite the cultural and economic importance of the queen conch fishery, there are few and isolated activities being developed to create public awareness about queen conch fisheries and the related environmental and conservation issues. As a result, progress in fisheries management, compliance and the implementation of co-management strategies remains low.

Implementation advice: Develop education and outreach programmes aimed at: a) convincing decision-makers of the importance of data collection, scientific analysis, research, training, and capacity building to manage a shared living marine resource; b) explaining to inspectors/enumerators the purpose and use of the data collected and why they need to be accurate; c) increasing awareness among fishers and processors of the queen conch ecology, its role in the ecosystem and the impact of fishing and market demand on the sustainability of the stock; and d) teaching school children and the general public about the need for environmental protection and conservation of marine resources.

II. MID-TERM RECOMMENDED MANAGEMENT MEASURES

10. National level queen conch conservation and management plans

Justification: In order to implement this Regional Queen Conch Fisheries Management and Conservation Plan effectively, fisheries authorities, queen conch fishers and other relevant stakeholders must develop national management plans, which include strategies for ministerial endorsement, and implementation and enforcement of these Management Plans by the fisheries departments and other authorities.

Implementation advice: National plans are required to guide queen conch fisheries towards sustainability, to generate findings for certain measures and to communicate joint goals, measures and efforts to all stakeholders in the sector. The use of an Ecosystem Approach to Fisheries is essential to create buy-in and ownership for these Plans, and to ensure implementation after the planning phase. National management plans will benefit from guidelines given in this Regional Queen Conch Fisheries Management and Conservation Plan.

11. Traceability of queen conch throughout the value chain

Justification: Export markets and consumers increasingly demand traceability of food products throughout the supply chain. In the joint efforts to reduce IUU fishing of queen conch, traceability plays an important role. Documentation on traceability is required by various export markets. Traceability has the advantage that legal and illegal fishing practices can be separated and allows legally harvested products to fetch higher prices. Traceability provides additional benefits in terms of supporting hygienic handling of the product, quality and food safety. The introduction of standard catch certification forms is preferred, to facilitate trade in conch as well as other fish species. The adoption of the EU catch certificate format, as presented in Appendix II of EC REGULATION 1005/2008 "To Prevent, Deter and Eliminate Illegal, Unreported and Unregulated (IUU) Fishing", would facilitate trade and traceability, using a best-practice approach.

Implementation advice: Agree to develop a traceability system following existing international guidelines and protocols, such as the application of the EC catch certification, which is already used by various countries.

12. Develop collaborative arrangements needed to generate habitat maps at the scale needed for better fisheries management

Justification: Few queen conch fishing grounds have had their habitats or bathymetry mapped to a useful scale. The lack of proper maps has limited the application of spatially defined fisheries management measures. Mapping efforts should begin at the national level and be scaled through regional cooperation mechanisms.

Implementation advice: Work collaboratively to join human, technical and financial resources that result in better habitat mapping, including studies of deeper water areas where most queen conch fishing is currently taking place.

13. Adoption of subregional mechanisms to evaluate the fishery potential of queen conch using fishery dependent and independent factors

Justification: Determining reliable indices of stock abundance is challenging for queen conch because of the complex biology of the species – notably its highly variable rates of growth, natural mortality and recruitment, which may be density and habitat-dependent. Progress can be made through regionally defined priorities in research and monitoring, time series data for more sophisticated stock assessments and further studies of the species' role in the ecosystem, climate change effects, genetic connectivity and other issues related to an ecosystem-based management approach. Currently, there are significant differences in the survey methods applied.

Implementation advice: Agree to create a regional advisory group under the Queen Conch Working Group to analyse existing survey protocols and adopt the most convenient subregional efforts. Look for mechanisms for international cooperation in conducting queen conch surveys, including the formation of teams integrated by scientists, managers and fishers. This group can advise on the selection of priorities in research and monitoring at the subregional level, enhancing the collaborative mechanisms already in place.

III. LONG-TERM RECOMMENDED MANAGEMENT MEASURES

14. Progressive inclusion of co-management strategies

Justification: Decisions regarding fisheries in general, and the queen conch fishery in particular, are being taken by high-level government officials, often with insufficient involvement from the different stakeholders. Fishers understand problems in the fishery and are usually eager to express their concerns and recommendations. However, these inputs can go unheard because of fishers' low levels of organization and empowerment. Fisheries co-management in the Caribbean remains largely at the pre-implementation phase.

Implementation advice: Agree to define a proper legal framework for the promotion of co-management in fisheries, and work with the local communities to increase their willingness to participate.

The full text of these fourteen (14) management measures, analysed and technically endorsed by the experts participating at the Second Meeting of the WECAFC/CFMC/OSPESCA/CRFM Working Group, held in the Republic of Panama from 18 to 20 November 2014, can be found in Appendix 3.

Background

1. DESCRIPTION OF THE RESOURCE

General information on the biology, ecology and status of this fishery resource can be found in APPENDIX 2

2. DESCRIPTION OF THE FISHERY

2.1 Catch

The main product of the queen conch fishery is the white conch meat, with recent regional annual production estimated at about 7 800 tonnes. However, total queen conch production is difficult to estimate because of incomplete and/or incomparable data across the region. For example, the statistics of many countries are incomparable as the countries lack and/or do not apply fishery-specific conversion factors for the different processing grades that can be found throughout the Wider Caribbean. Additionally, local consumption of queen conch is often not monitored and/or not included in the catch statistics. In some cases the subsistence and locally marketed catches are small, but they can be highly significant in others.

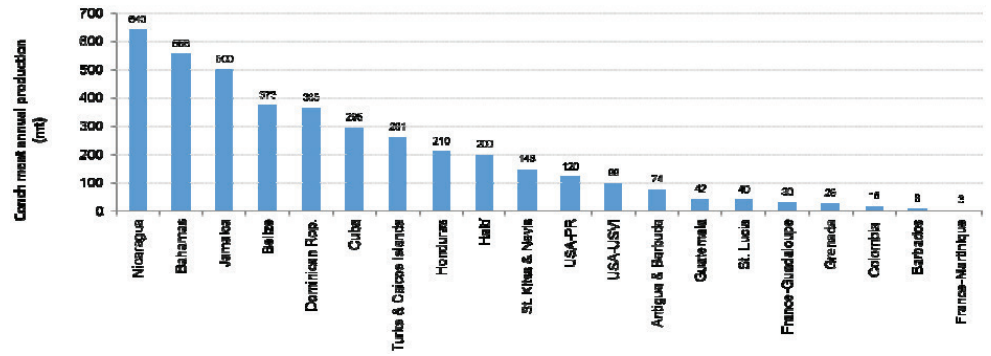
At present, the majority of the queen conch is landed in the Bahamas, Nicaragua, Belize and Jamaica (Figure 1, Table 1). In the artisanal fishery, queen conch is landed alive or fresh, sometimes with the shell, but mostly as unclean meat with the majority of organs still attached. In the industrial operations, queen conch is landed as frozen semi/clean meat fillets in plastic bags.

Queen conch production shows a negative trend over time and the decrease can largely be attributed to overfishing. Some stocks have collapsed and have yet to recover (Appeldoorn, 1994; Theile, 2003; Aldana *et al.*, 2003). In other cases, e.g. Pedro Bank (Jamaica) and Serrana Bank (Colombia), reductions in landings followed the imposition of management measures aimed at improving production and promoting conservation; specifically, these involved closed areas, longer closed seasons and/or reductions in the total allowable catch (TAC).

Overall queen conch landings also declined following the temporary moratoria on trade as a result of the application of CITES Significant Trade Review findings (CITES Resolution Conf. 8.9; revised in 2002 as CITES Resolution Conf. 12.8). Queen conch exports from Antigua and Barbuda, Barbados, Dominica, Saint Lucia and Trinidad and Tobago were suspended as a result of the first CITES Significant Trade Review in 1995.

Under the second CITES *Strombus gigas* Significant Trade Review (2003), a temporary export moratorium was imposed on Honduras, the Dominican Republic and Haiti. In response to this measure, Honduras and the Dominican Republic conducted studies designed to demonstrate the sustainability of their fisheries. Currently, Honduras operates under a substantial scientific quota of 210 tonnes of cleaned meat, together with improved management controls on the trade. The trade suspensions for the other countries remain in effect, with the exception of that for Saint Lucia (Daves and Field, 2006).

FIGURE 1
Recent queen conch meat production in the wider caribbean



The figure represents the most recent queen conch meat landings estimate (100% clean meat) for most countries. Data originate from National Reports available at CRFM, FAO and OSPESCA, and from fisheries managers. See Table 1 for additional information on the queen conch fishery.

Queen conch pearls are rare and their production and trade remain largely unknown across the region. In Colombia, one of the few countries with relevant data, exports of 4 074 pearls, valued around USD 2.2 million, were reported between 2000 and 2003 (Prada *et al.*, 2008). With the reduction of the fishing effort in Colombia, the number of exported queen conch pearls went from 732 units in 2000 to 123 units in 2010 (Castro *et al.*, 2012). Japan, Switzerland and the United States of America are the main queen conch pearl importers.

The large and pinkish queen conch shells are brought to the landing sites only in a few places. In most cases, shells are discarded at sea, generating several underwater sites with piles of empty conch shells. According to Theile (2001), from 1992 to 1999 a total of 1 628 436 individual conch shells, plus 131 275 kg of shells were recorded in international trade. Assuming that each queen conch shell weighs between 700 and 1 500 g, the total reported volume may have been equivalent to between 1 720 000 and 1 816 000 shells. Despite these figures, generally speaking very little is known about the production of queen conch shells and its trade. Queen conch shell is used for jewellery or for manufacturing tourist souvenirs. It is also offered to tourists in its natural or polished form.

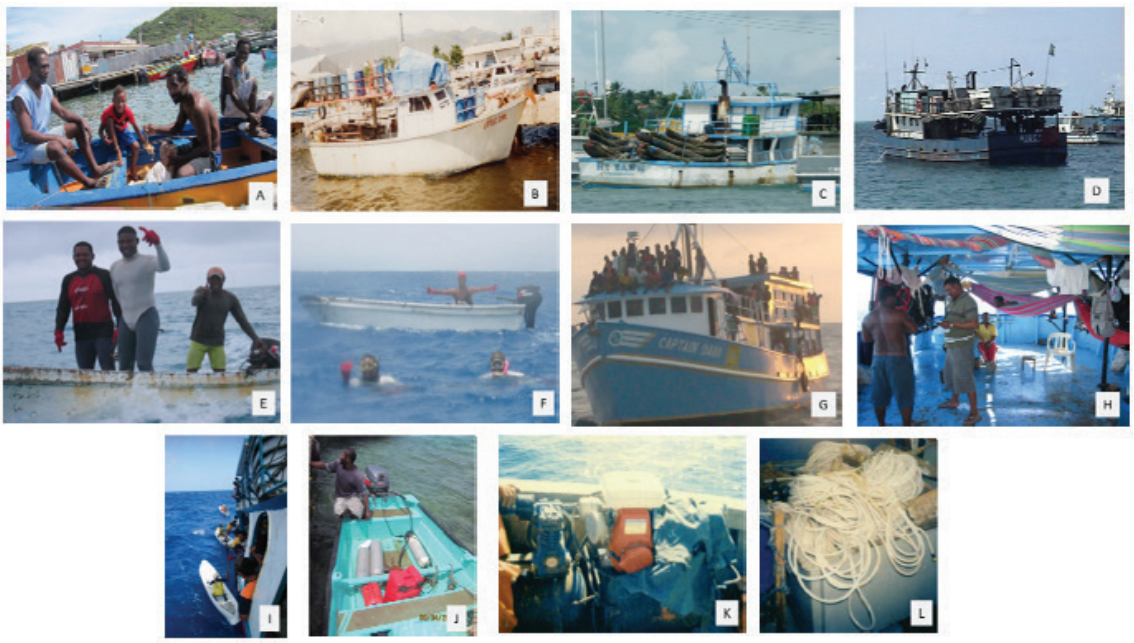
Little is known about the operculum trade, which has developed more recently. China is the major importer and it is believed to be used in traditional Chinese medicine. There is a limited exploitation of both queen conch shell and operculum as souvenirs in the tourism industry.

2.2 Fishing effort

Queen conch is frequently caught by divers and in the majority of the Caribbean countries, though queen conch fishing remains an artisanal occupation (e.g. Eastern Caribbean States, Belize and Colombia). For instance, fishers in the Eastern Caribbean use small canoes or dories of 7 to 10 metres long, powered by outboard engines, or sail and oars, and carrying one to four divers. A regular journey for a queen conch fishing is a day trip which lasts approximately eight hours.

Divers easily collect queen conch by hand because they move slowly, form large aggregations and have no defence mechanisms. Queen conch divers operate with or without the support of a larger mother ship for transport and with pre-processing facilities (Figure 2). Queen conch fishing is ranges from very small scale (subsistence) to larger commercial scale (several GRT per mother ship). Abundance typically decreases first in shallower water (Laughlin and Weil 1984; Glazer and Kidney 2004; Lovell 2012), inducing divers to go further and use scuba gear more regularly. As a result, fishing frequently depletes fishing grounds rather rapidly, leading to reductions

FIGURE 2
Artisanal and industrial methods used in the Caribbean queen conch fishery



A. Artisanal fishers using a small boat (less than 20ft long); **B.** Artisanal fishers using a medium size boat (20-25ft long); **C.** Industrial mother boat carrying small canoes; **D.** Larger industrial mother boat carrying more canoes; **E.** Free divers using outboard boats to reach fishing grounds; **F.** Free divers fishing queen conch; **G.** Industrial boat carrying scuba divers to remote fishing zones; **H.** Registering individual queen conch daily production; **I.** Scuba divers leaving an industrial mother boat; **J.** Scuba gear utilized in artisanal queen conch fishery; **K.** and **L.** Hookah system utilized in industrial fishing operations. *Photo credits:* Stephen Smilke, Martha Prada, Oscar Ortegón, Reinaldi Barnutty, Jose Antonio Romero and Martha Inés García.

in the spawning potential and affecting recruitment capabilities over the long term. This species may have low resilience to high fishing mortality (Appeldoorn et al., 2011), and once depleted it may not recover easily.

Fishing for queen conch by artisanal fishers is sometimes also conducted in distant fishing grounds with the use of small mother boats (10 to 15 metres long), that transport small canoes. These operations typically involve seven to ten divers, with trips lasting approximately four to seven days.

In contrast, industrial fishing for queen conch reaches distant offshore banks (40 to 160 nautical miles from the landing sites) and takes place with the support of larger mother boats made of steel hulls, up to 35 metres long, and powered by inboard engines. These vessels can carry in excess of 40 divers (some times more than 60 divers), plus canoe handlers, for several weeks or months at a time. These vessels provide housing to the crew and divers and are used as a floating base for daily fishing trips with fishers using the smaller canoes with outboard engines or oars that can carry one to two divers. In addition to free diving, industrial divers use surface compressors (hookah) and/or individual scuba gear. Industrial fishing takes place in Jamaica, Honduras and Nicaragua. In Colombia this activity was terminated in 2012. The normal practice on industrial vessels is for the meat to be extracted from the conch underwater using a hammer ("knocking") and a knife; once a board the mother ship, the meat is pre-processed and stored on ice or frozen.

In the French Antilles and other eastern island-states, queen conch is also captured by bottom gillnets and trammel nets (300-400 metres long), with approximately three to six nets being pulled by the tide. In Martinique, there was a slight increase in net fishing between 1986 and 2006 (7 to 17 ships), and a significant decrease in diving for queen conch (7 ships at the most, instead of 23). In Guadeloupe, fixed bottom gillnets and trammel nets are used to catch queen conch. Nets are used in both shallow and deep water (between 18 to 32 metres deep).

The queen conch fishery provides income for approximately 20 000 fishers, mostly artisanal; it is an important and traditional source of low-fat protein for the Caribbean population, while also providing a taste of traditional local food and flavour to the millions of tourists that visit the Caribbean annually.

2.3 Trade

White conch meat is the principle product in the queen conch fishery, followed by queen conch shell and pearls (Figure 3). More recently, the trade of queen conch opercula has taken off (e.g. exported from Jamaica and Nicaragua).

Data from Theile (2003) estimated the overall 2003 value of queen conch meat at around USD 60 million. Based on the most up-to-date statistics presented in this document, this value is currently more likely to be around USD 74 million. The economic importance of queen conch production is highly variable across the region. For instance, queen conch is Jamaica's most important fishery, but in areas with limited shelf – such as Barbados and Saint Lucia – it represents no more than 2 percent of total fishing production. Approximately 60 percent of the overall queen conch meat production is exported to the United States of America and EU market; 29 percent is exported to the French West Indies (UNEP–WCMC CITES Trade database 2010–2011), and approximately 21 percent is used for local consumption.

FIGURE 3

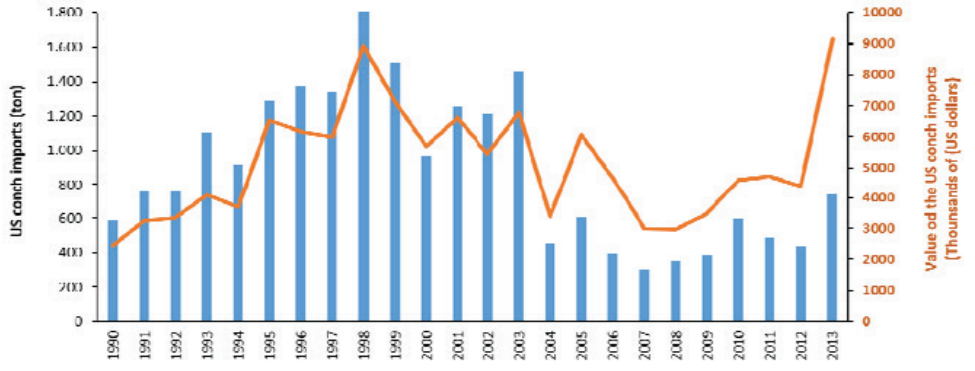
Meat, shell and pearls from the queen conch fishery used as export commodities

A. Manual extraction of queen conch meat; **B.** Pre-processing of queen conch meat on board of industrial vessel. **C.** 100% clean queen conch meat at the processing plant; **D.** Unfrozen fillets of queen conch meat; **E.** Final presentation of frozen queen conch meat fillets in 5kg box; **F.** Queen conch shell with potential to become a tourist souvenir; **G.** Extraction of a queen conch pearl; **H.** Collection of queen conch pearls of high international value.
Photo credits: Oscar Ortegón and Martha Prada.

The United States of America has been one of the major importers of queen conch products for some time. According to the Fisheries Statistics and Economic Division of the National Marine Fisheries Service (www.st.nmfs.noaa.gov), the country's largest queen conch imports were registered in 1998, when they amounted to 1 833 Mt, valued at USD 8.94 million, followed by 1999 and 2003 (Figure 4). In recent years (2013), imports decreased to 743 Mt, but with a significantly higher value of USD 9.16 million. This database also reveals that the major exporting countries to markets within the United States of America initially consisted of Jamaica, Honduras, the Dominican Republic, Colombia, Turks and Caicos Islands, Cayman Islands and Belize. However, in recent years the major exporting countries to the United States of America have become the Bahamas, Nicaragua, Belize, Honduras and Saint Kitts and Nevis.

Theile (2005) shows that Belize, Jamaica, Colombia, Nicaragua, Turks and Caicos Islands and Saint Kitts and Nevis are the main countries exporting conch; while the French West Indies territories, the Netherlands Caribbean and the USA are the major importers. However, all countries in the region consume queen conch. Countries where domestic consumption is high are Mexico, the Bahamas, Grenada and Anguilla.

FIGURE 4
Historical variations in USA queen conch imports by volume and market value



Data obtained from National Marine Fisheries Service, Fisheries Statistics and Economic Division. It may include trade information from other species.
Data taken from: http:/www.st.nmfs.noaa.gov/pls/webpls/trade_alldstrct_byproduct.results?qtype=IMP&qyearfrom=1990&qyearto=2014qsort=DISTRICT&quotput=PRINTER&qproduct=CONCH)

Unfortunately, historical data on queen conch product imports/exports to the European Union – an expanding market for this species – were not available for this document. As a consequence, the total value of the fishery may be significantly higher than that described above.

2.4 Socio-economic aspects

With approximately 20 000 queen conch fishers across the Wider Caribbean, the socio-economic benefits of this fishery are widespread, although they vary between countries. In most countries, queen conch fishers are artisanal and have a high dependence on this resource for income and/or high-quality meat for their families. Unfortunately, there have been no major studies to determine the benefits and dependency of local communities on artisanal queen conch fishing.

The reduction in the queen conch production in the last five to eight years has been at least partially mitigated by increase in the price of queen conch products in international markets. However, nowadays many fishers need to explore further and deeper fishing grounds in search of sufficiently high queen conch abundance, resulting in increased production costs, especially because of the high price of gasoline and the substantial fuel consumption levels by outboard engines in artisanal fisheries.

The growing tendency of artisanal fishers operating in remote areas has increased conflicts with industrial fishers, not only because of the high level of extraction by the latter, but also because both kinds of fishers are competing for the same resource. The expected growth in demand for queen conch products, as a result of the increases in the local human population and the number of tourists in the region, requires the formulation and execution of specific management measures to address this conflict of interest between artisanal and industrial fishers.

As a result of an overall decline in queen conch production – because of, among others, overall diminishing queen conch abundance, closed geographical areas and/or periods and reductions in annual catch quotas – there are fewer jobs in the queen conch processing and trade industries. For instance, in Jamaica there are around 3 000 people active in the processing and packing sector (Theile, 2005), while in the Bahamas the queen conch fishery – valued at approximately US$4.5 million – accounts for nearly 9,800 seasonal jobs (Chakalall *et al.*, 2007). Unfortunately, there is very little quantitative information on this specific sector's employment in the majority of countries in the Wider Caribbean.

The closed areas and closed seasons for queen conch sometimes overlap with similar measures for other stocks (spiny lobster, several reef fishes), with negative consequences for fishers´ income.

2.5 Current management measures and governance structures

Many Caribbean countries have been implementing their own national fishery management programmes, partly in response to advances in coordinated regional efforts in recent years. Countries like Bermuda, Bonaire, Sint Eustatius and Saba, the United States of America, Mexico and Venezuela have kept their queen conch fisheries largely closed. Colombia has dramatically reduced its fishing effort, eliminated industrial fishing and has conducted stock enhancement pilot projects on banks with low queen conch densities. Belize has established a series of no-take marine reserves and only allows free diving (Gongora, 2012). Cuba has delimited only six fishing areas where the queen conch fishery can legally operate and not all are open every year, or at the same time (Alvarez Lemus, 2012). Jamaica has reduced its landings from Pedro Bank substantially (Aiken *et al.*, 2006), instituted water quality surveys and now uses control rules to link production to abundance levels, which are determined by periodic surveys. Increased patrolling within Tobago Marine Park in Saint Vincent and the Grenadines has resulted in an abundant queen conch population (SOFRECO, 2013). As a result of the CITES Review of Significant Trade Process, Honduras has implemented a monitoring programme based on a 210 tonne/year scientific quota which, although measured as cleaned meat, is effective in limiting their exports to this amount. This programme has provided important biological parameters for queen conch over the four-year duration of the programme (Ehrhardt, 2008; Ehrhardt and Valle, 2008).

To control queen conch fishing in the Caribbean region, countries variably regulate minimum shell length and minimum unclean or clean meat weight, impose restrictions on fishing techniques, establish permanent or temporal closed areas or seasons, and/or determine annual catch and export quotas (Table 1 and Table 2). The Organization of Eastern Caribbean States (OECS) succeeded in harmonizing rules (i.e. minimum shell length of 178 mm and 225 g unclean meat weight) as part of the 1991 OECS Common Fisheries Surveillances Zones Agreement, which is designed to improve regional cooperation between Member States (Anon., 2007). Table 3 shows a summary of the most recent estimates of queen conch densities in the Wider Caribbean.

Implementation of these kinds of management regulations seeks to overcome or account for various difficulties, such as:

1. While regulations exist to prohibit the taking, sale or possession of immature queen conch and a minimum queen conch shell length (17.8 cm to 22.0 cm) and lip thickness (5 mm to 10 mm) have been defined, the majority of queen conch fisheries do not land the shells. Therefore, compliance cannot be assessed easily. Additionally, these morphometric measurements do not always indicate sexual maturity.
2. Minimum queen conch clean or dirty meat weights (100 g to 225 g) generally do not constitute a correct and reliable indicator of individual maturity, or any other relevant biological criteria, but are consistent with the most common catch data.
3. Queen conch meat processing shows a substantial degree of diversity within the region, which makes agreement on the reference points for regional processing yields very challenging. Several countries have developed their own conversion factors, but many others have not. The Queen Conch Working Group has agreed with regional conversion factors to solve this situation. These conversion factors need to be adopted in order to improve data quality and analysis for better regional queen conch management.
4. A range of closed fishing seasons for conch are applied, but several countries allow trade during this period, creating confusion and complicating surveillance and enforcement.

5. Restrictions on diving techniques exist in various countries, particularly for scuba or hookah, but these are difficult to control due to low enforcement capabilities and the remoteness of many fishing grounds. Restrictions of this kind are often triggered by diving accidents and casualties in the queen conch fishery.
6. A non-detriment finding (NDF) is required by CITES for all international shipments of queen conch products from range states. To produce an adequate NDF requires expertise, research, regulations and financial resources, which are not always available in the exporting countries. In the event of limited and/or insufficient data, the application of the Precautionary Principle should prevail (Dayton *et al.*, 1995). As a result of a Queen Conch Working Group initiative, a draft non-detriment finding format, with guidelines to facilitate the NDF processing, has been developed.
7. In most countries, the queen conch fishery is an open access fishery and the number of fishers tends to increase with time, putting additional pressure on the resource and making effective and adequate compliance of management measures more difficult to achieve.
8. Temporal closures have proven effective in recovering queen conch populations, but production and marketing becomes highly variable, affecting the profitability of the fishery.
9. The prohibitions to capture reproductive individuals (spawning or copulating), requires a great deal of voluntary cooperation from the fishers to reach an acceptable compliance level.
10. Protection of deep-water queen conch populations, and more recent protection of queen conch within no-take areas, appear to contribute to increases in population densities. Success in this area can be secured with full implementation of the conservation actions, which is not easily achievable.
11. Currently, there are still shortcomings in the sanitary conditions of queen conch processing activities and facilities. Compliance with the regulations will require access to adequate inputs, good manufacturing practices and quality assurance schemes. Financial resources for these activities and schemes are not always available to fishers, processors and/or management agencies.
12. An increasing number of countries demand satellite-based vessel monitoring systems (VMS) to be installed on industrial boats, but the resulting data are not always made available to fisheries management authorities.

Queen conch fisheries are believed to be fully developed in most areas, and the alleged increase in levels of illegal fishing often occurs due to a lack of knowledge, awareness and enforcement (Theile, 2005). Intentional and concealed illegal queen conch fishing and trade appear widespread, and seriously undermine the management and conservation of queen conch fisheries (Theile, 2005).

For instance, illegal fishing and trade within the southwestern Caribbean (Nicaragua, Honduras, Jamaica, the Dominican Republic, Haiti and Colombia) is a common complaint, as exemplified by the famous case known as operation Shell Game, where more than 20 Mt of queen conch fillets were confiscated. Nine individuals were sentenced in the USA and Canada, while more than US$200 000 was collected in fines. In another example, from 1999–2001, the Dominican Republic and Honduras almost doubled their queen conch production, elevating concerns about illegal fishing, and this resulted in the imposition of a CITES moratorium. Illegal fishers can have connections to drug trafficking, increasing the complexity of the issue for fisheries managers and the legal efforts in terms of enforcement.

In recognition of these challenges, combating illegal, unreported and unregulated (IUU) fishing is now a priority in several countries. The progressive strengthening

of subregional collaboration can therefore be mainly attributed to coordinated work among stakeholders. Additional activities to combat illegal fishing are still needed, however.

TABLE 1
Overview of the queen conch fishery

Source: National Reports presented at First and Second Meeting of CFMC/WECAFC/ OSPESCA/CRFM (Panama, 2012 and 2014, resp.) Country / Territory	Approx. No. fishers	No. small boats (dories)	No. industrial boats	Only free diving	Compressor	Average trip duration (days)	Approx. annual production (Mt)*	USD annual production (millions)	% export
Antigua and Barbuda	65–76	17–21				1	582 (2012) (50% clean)	4.1 (2012)	
Bahamas	9300	4000					5 613 (2013)	3.18 (2013)	31
Barbados	25						8-13 (2008)		
Belize	2 759–2 000	800		yes			439 (2013) (85% clean)	5.47 (2013)	98
Cayman Islands	100								
Colombia	90	15		yes			16 (2013)		0
Cuba				yes			295 (2012)		
the Dominican Republic	1 680–2 018	247	40		yes	2–3	355 (2011)		0
Grenada						1	28 (2012) (dirty)	2.03 (2012)	20–30
Guadeloupe		126		yes			30		
Martinique		27					3		
Guatemala**							42 (2007)		
Haiti	626	300–400		yes			200 (2012)		0
Honduras	2000		13			22	210		90
Jamaica			6–7		yes	6–12	400–500 (2012)		90
Nicaragua	1650	70	22		yes	5–22	640 (2013)	9 (2013)	90
Saint Kitts and Nevis	30	10				1	148 (2012) (dirty)		
Saint Lucia***	40	20				1	30–40 (2008) (dirty)	1.5(2008)	
Saint Vincent and The Grenadines	45	17				1	22 (2012) (dirty)		oct-20
Turks and Caicos Islands	253	146				3–4	261 (2013)	3.8(2013)	46–51
Puerto Rico	128 (2008)					1	120(2011)		
United States Virgin Islands**						1	99(2009)		

* = If not stated, assumed to be clean conch meat. ** = *Source*: CCAD-USDOI (2010). ***= Additional data taken from King *et al.* (2008). **** = *Source:* Gordon (2010).

TABLE 2
Variations in closed queen conch fishing seasons in the Wider Caribbean

Countries	Months of Closed Fishing Seasons											
	J	F	M	A	M	J	J	A	S	O	N	D
Antigua and Barbuda, Anguilla, British Virgin Islands, Dominica, Grenada, Montserrat, Saint Vincent and The Grenadines, Saint Kitts and Nevis, Saint Lucia.							X	X				
Belize							X	X	X			
Cayman Islands					X	X	X	X	X	X		
Colombia						X	X	X	X	X		
Cuba					X	X	X	X	X			
Dominican Republic							X	X	X	X		
France (Guadeloupe)	X	X	X	X	X	X	X	X	X			
France (Martinique)				X	X	X	X	X				
Haiti				X	X	X	X	X	X			
Jamaica	X							X	X	X	X	X
Nicaragua						X	X	X	X			
Saint Barthélemy / Saint-Martin (French Part)		X	X	X	X	X	X	X	X			
Turks and Caicos Islands							X	X	X	X		
United States Virgin Islands							X	X	X			
Puerto Rico								X	X	X		

Source: National Reports presented at First and Second Meeting of CFMC/WECAFC/OSPESCA/CRFM (Panama, 2012 and 2014, resp.)

*: Most countries or territories not listed here maintain a closed queen conch fishery or have a relatively insignificant queen conch fishery that operates without being time restrictions. The Bahamas applies closed areas, but not closed seasons.

TABLE 3
Summary of the most recent estimates of queen conch densities in the Wider Caribbean

Countries	Bank area (km^2)	Adult density (ind/ha)	Juvenile density (ind/ha)	Total density (ind/ha)	Primary Queen Conch fishing banks:	Additional references
Antigua and Barbuda	3 400	17.2 (2001)	3.7–25.6 (2002)			
Aruba					EPICOL North & South, EPICAI, EPOISAN, EPISUR, EPINIO	
the Bahamas	45 000				Little Bahamas, northern and central sections of the Great Bahamas, Cay Sal Bank	
Barbados	74.6	1.39 (2010)	7.34 (2010)	8.73 (2010)	Southern and Western Island shelves	
Belize		123 (2013)			Northern banks	
Bonaire, Sint Eustatius and Saba				57–115 (2012-2013)	Survey only at St. Eustatius Marine Park	Meijer (2014)
Cayman Islands				70–260 (2002)		Botwell (2009)
Costa Rica	45				Punta Malaquive	CCAD-USDOI (2010)
the Dominican Republic	2013		53 (1997)		Pedernales, Beata Island, Jaragua National, Parque Este and Plata	SOFRECO (2013)

TABLE 3 (*Continued*)

Countries	Bank area (km^2)	Adult density (ind/ha)	Juvenile density (ind/ha)	Total density (ind/ha)	Primary Queen Conch fishing banks:	Additional references
Grenada	900				North, northeast, and southern banks	SOFRECO (2013)
Guadeloupe				57–115 (2012-2013)	Video transects, 8 sites in Grand Cul-de-Sac Marin, 4.7 ha	Heyliger (2012)
Haiti		8 (2009)	37.6 (2008)	54 (2009)	Canal du Sud and Anse a Pitres; Shelfs around Gonave Island and Les Arcadins, Rochelois bank, Petite Goave and Grand Goave areas; Les Cayemites	MRAG (2013)
Jamaica	8000			20–378 (2010)	Pedro Bank	
Honduras	10000	92–196 (2011)			Rosalinda, Middle, Oneida, Gorda	
México	293				Alacranes	De Jesús-Navarrete (2013)
Nicaragua	4000	85–112 (2006)			Northern & Southeastern Miskitos, offshore banks	Barnutty y Castellon (2012)
Panamá		1.43			Guna Yala bank	CCAD-USDOI (2010)
Colombia	3200	194.9 (2013)	157 (2013)	351.9 (2013)	Serrana bank	Castro *et al.* (2012)
Saint Kitts and Nevis					Northern and southern ends	Heyliger (2012)
Saint Lucia	790	242.9 (2008)			Northern and southern banks	Hubert and Wiliams (2014); King *et al.* (2008)
Saint Vincent and The Grenadines	3000	50 (2013)	254.4 (2013)		Survey only at Union Islands shelves in the Grenadines Banks	SOFRECO (2013)
Turks and Caicos Islands				50–100 (2008)	Over 860 stations simple each year, snorkel, shallow sites	Department of Environment & Marine Affairs (2013)
Puerto Rico		7.32 (2013)	6.73 (2013)	14.05 (2013)	Western insular platform, also south and east platform	Barker (2014)
United States Virgin Islands		135 (2010)	90 (2010)	225 (2010)	St. Croix	Gordon (2010)

Source: National Reports presented at First and Second Meeting of CFMC/WECAFC/OSPESCA/CRFM (Panama, 2012 and 2014)

2.6 Challenges for the queen conch fishery

Managing queen conch fisheries presents a broad range of challenges, including the complex biology of the species, uncertainty of catch and effort data, illegal trade, weak surveillance and enforcement mechanisms, unsustainable fishing practices, and even the frequency of severe dive accidents impacting on the quality of life and living conditions of entire towns. Problems in the fishery are dynamic, adding to the complexity of the issues which fishery sector managers have to face and for which they typically do not have enough human, technical and/or financial resources. Table 4 presents a summarized description of these challenges after a careful analysis of the queen conch fishery across the Wider Caribbean.

To address these challenges adequately will require an increase in the levels of compliance by fishers and processors, in addition to more effective cooperation between all stakeholders. The latter will need to develop a solid understanding of the problems at hand and work together to propose recommendations for their solution. To facilitate the acceptance of management measures and generate change, managers should implement a more bottom-up approach. It is important to recognize the high dependence fishers have on queen conch, both as a way of generating family income and as a means of providing quality food for many local communities across the region.

Fisheries co-management allows for greater participation by fishers in the management of the fisheries, but its success requires a proper legal framework, an awareness of conservation and sustainable use, constraints and a willingness to participate. At present, fishers' organizations are not sufficiently empowered, and the fishery's co-management in the Caribbean generally remains at the pre-implementation phase in the Caribbean as a result (Lovell, 2012). Continuous education programmes are needed to sensitize the public and create awareness about environmental issues and the conservation of marine resources (McConney *et al*., 2003).

TABLE 4
Summary of topics to be addressed in order to achieve a sustainable (regional) queen conch fishery

Topic	Description of the problem	Consequences
Biology of the species	– The species has multiple forms to calculate shell growth (length, flared lip thickness). – Morphology is highly variable depending on local environmental conditions. – Size (and hence fecundity) is primarily fixed at time of maturation. – The species has variable growth and high natural mortality rates. – Successful recruitment is highly variable and may not happen every year.	– Dynamic population models are difficult to apply.
Catch data	– Data is incomplete and not organized with statistical rigour. – In many cases historical data exist only in hard copies, if at all. – Data are available only for short periods of time. – Processors provide reports, but data are incomplete and difficult to verify. – Electronic reporting of purchased landings has not been evaluated yet and does not account for total landings (the Bahamas). – Fisheries managers do not have the information to estimate unreported catches, believed to account for an important proportion of total captures (the Bahamas, Eastern Caribbean countries, the Dominican Republic and Colombia, among others). – Local consumption is often not monitored and/or included in the catch statistics. – There are differences in the processing of conch meat (unclean to semi– clean to clean), with slight but important variations among countries. Processing degrees are usually not incorporated in the estimation of the queen conch production. – Catch data from certain sites/times need to incorporate an extrapolation factor to calculate total production and this factor changes through time.	– Total queen conch production is estimated with a high degree of uncertainty. – Surplus production models difficult to apply. – Difficult to determine sustainably harvestable biomass.
Conversion factors	– Conversion factors for queen conch meat are available only from a few countries (i.e. Antigua and Barbuda, Bahamas, Belize, the Dominican Republic, Jamaica, Honduras, Martinique, Mexico and Nicaragua). – Until very recently a simple definition of conversion factors – in order to accommodate various degrees of processing across the region–did not exist.	– Difficulties in comparing time series of catch data or data from multiple sites. – A default regional conversion factor is now available for countries that do not have their own conversion factors calculated.
Fishing effort	– Difficult to account for a potential increase in number of fishers in response to increases in the human population. – Continuous and non– quantified improvements/changes in diving and other production techniques. – Licences and fishing authorization systems for queen conch fisheries are not well applied or not enforced. – Continuous changes in the number and size of the mother vessels. – Frequent changes or expansion of queen conch fishing grounds. – High spatial variability in the allocation of fishing effort in small areas (queen conch aggregations).	– Difficult to standardize effort/ catchability over time. – Difficult to standardize effort/ catchability across methods. – Inclusion of spatial parameters needed, but often not available. – Number of vessels active in the fishery is largely unknown and thus difficult to manage.

TABLE 4 (*Continued*)

Topic	Description of the problem	Consequences
Queen conch surveys	– Largely different survey methods are used relative to the number of sites, areas surveyed per site, information collected (spatial/habitat distribution, number, size/age class, reproductive activity). – Large differences in the areas surveyed (e.g. whole shelf, just known fishing grounds, with deep water areas not always included). – Surveys demand access to habitat maps, nautical charts, trained divers, safe diving protocols and availability of proper working platforms, which are not always available. – Surveys require good statistical design, clear data analysis and access to the appropriate level of statistical expertise. – Queen conch appear to seek refuge in deep water areas (30–50 m); sampling at these depths may require special underwater video systems or use of rebreathers and mixed– gas diving, both based on specialized training and dependent on securing enough funding. – Greater success of queen conch surveys is achieved with the participation of scientists and fishers, but this type of collaboration is not always possible.	– Poor statistical survey design may result in biased or variable estimates of population size/density and age structure, and not track changes in these over time – Poor logistical survey design may waste time and effort, resulting in variable estimates and a lack of necessary information. – Standardized surveys within a country may track density, but estimates may not be comparable across countries. – Standardized surveys may track density, but estimates are not comparable to suggested target densities, such as those based on maintaining effective reproduction. – Capabilities and experience may not exist within agencies/country. – Recurrent funds need to be identified if surveys are to be integrated as a monitoring programme. – The deeper the area to be surveyed, the greater the costs.
Habitat degradation and effects of climate change	– Increase in sedimentation and other land– based sources of pollution can alter coastal benthic habitats utilized by queen conch through ontogeny. – Unsustainable increase of tourism activities may accelerate habitat degradation, especially in shallower and coastal habitats. – Increase in storms and hurricanes can negatively affect the queen conch production by impacting on recruitment, and disturb juvenile and adult queen conch grounds. – Increases in seawater temperatures have direct implications for queen conch reproduction. – Increases in pH in the ocean have negative consequences on the queen conch shell formation and resistance because its shell is made out of aragonite, a substance that can dilute in acidic environments.	– Reduction in queen conch habitat quality will be reflected in the reduction in recruitment and reproduction of the natural population, thus diminishing their capability to sustain fishing. – Queen conch shell is negatively affected by an acidic environment.
Socio-economic impacts	– Queen conch fishers often have a high dependence on this resource as a way of generating family income and to provide quality food for many local communities across the region. – There are conflicts between artisanal and industrial fishers because of the level of extraction and the competition for fishing grounds. – Closed areas and closed seasons in several queen conch fisheries in the Caribbean have serious repercussions for fishers' income. – Reduction in queen conch extraction to favour stock recovery will negatively affect the number of jobs generated in the queen conch processing and trading sectors.	– Fisheries management has a direct impact on fishers' income, and effective implementation and compliance in the field when alternative livelihood programmes are in place. Such programmes are not always considered. – Management measures in the queen conch fishery require planning and coordination, with measures in place for other fisheries.
Unsustainable fishing practices/ habitat concerns	– Where queen conch populations have declined, a rebuilding plan is required, but this is generally not considered. – Habitat degradation through siltation, sedimentation or pollution may negatively affect queen conch populations. Adequate habitat restoration efforts are not always in place. – In many places, queen conch nursery areas have not been identified. – In many places, queen conch spawning populations have not been identified – There are fishing areas where subadults are being targeted. – Stocks in deeper waters are assumed to be unexploited, but divers have increased their range of operations because of a lack of alternatives and/ or the introduction of new diving technology. – Many Marine Protected Areas are too small to protect the various queen conch life stages through ontogeny. In various cases these Marine Protected Areas are not adequately enforced and, therefore, may not be effective in preserving sufficient reproductive stock biomass.	– Low density of spawning stock may lead to recruitment failure. – Inshore nursery areas are at risk from habitat degradation and loss of nursery function. – Management has not incorporated precautionary principles, and stock and fishery are at risk. – Management does not have an ecosystem basis, and stock and fishery are at risk. – Sites with reduced queen conch population may not recover with a reduction of fishing pressure alone.

TABLE 4 (*Continued*)

Topic	Description of the problem	Consequences
CITES export permits	– Queen conch exports need to be well documented, with a certification of origin and legality, issued only if the queen conch were taken without negatively affecting the natural queen conch populations. This is mostly difficult to determine with certainty. – Not every country in the region has the capacity to make robust non–detriment findings. – Catch and health certification for the export of fisheries products, including queen conch, is often below standard and non– acceptance by import markets can result in an increase of IUU trade and a loss of traceability. – Although CITES covers all specimens of queen conch, not all export products (pearls, shells, trimmings, opercula) are being regulated to determine their legality. – Trade at sea among neighbouring countries without proper CITES documentation can occur. – CITES permits are issued without proper scientific backup from the Scientific Authority.	– In the absence of guidance for making NDFs and proper regulations of all queen conch commodities, pertinent CITES Scientific and Management Authorities find it difficult to certify the non–detrimental nature of the export. – Guidelines and tables for making NDF have been reviewed by the Queen Conch Working Group in order to strengthen capacity building and are in the process of being approved. – Use of non– compliant/non–standard catch and health certification causes loss of export opportunities and reduced income for fishers and exporters.
Illegal, Unreported, Unregulated (IUU) fishing	– Regulations exist on minimum shell sizes and meat weight, but frequently shells are not landed and alternative metrics based on landed meat (e.g. weights) are not established, defined or complied with. – Many aspects of the fishery remain unregulated (e.g. meat trimmings, pearl trade, proper conversion factors, diving safety, etc.). – Lack or insufficient inspections to verify queen conch restrictions or indications to account for illegal production/trade. – Existence of complex network of smugglers that trade out at sea and involve operations in several countries. – Lack of traceability due to falsified catch and CITES certificates, which decreases export opportunities and increases illegal practices in import and export markets. – Lack of application of forensics in investigation of illegal fishing operations and trade. – In some places there are links between the illegal queen conch trade and drug trafficking, introducing complexity and extending the jurisdiction beyond the fisheries manager's competence and reach.	– The proportion of illegal fishing or trade remains undefined in the majority of countries. – Complex networks of conspirators can put enforcers at risk and cause honest fishers to start illegal practices as well. – Regional collaboration is needed among stakeholders if IUU fishing is to be adequately addressed. – Difficulties in establishing the origin of the product, and thus, to fulfil CITES requirements. – Drop in user support and compliance with the fisheries/conservation managers due to the limited success in prosecuting illegalities and the inability to form multidisciplinary teams to investigate fishing violations. – Underreporting makes it impossible for managers to optimize fisheries production in a sustainable manner, causing economic losses to the sector, countries and the region as a whole.

TABLE 4 (*Continued*)

Topic	Description of the problem	Consequences
Surveillance and enforcement	– It is not clear whether existing regulations are sufficient or effective because of poor monitoring and few enforcement mechanisms in place. – Patrolling of fishing grounds is often conducted by maritime/military personnel who need clear instructions and specific training to recognize legal versus illegal fishing activities. – Enforcement officers need to verify compliance with diving regulations, which is sometimes difficult. – As the fishing grounds move towards more distant sites, the logistics and funding for patrolling become important limiting factors. – Military/enforcement personnel are frequently rotated: training therefore needs to be incorporated during their basic courses, a decision that requires the participation of high– level officials. – Fisheries managers process fishing violations through civil or penal judicial systems, so they need to be aware of: a) the importance of collecting good evidence; b) how to keep a good chain of custody; and c) how to interact within the national and international legal systems. Unfortunately, in few cases do they have the required power. – National regulations often have penalties that are too low or inappropriate, which negatively affects the fishers' compliance, thus undermining the effectiveness of the legislation. – Where fishing violations involve people of different nationalities, the procedures and involvement of foreign affairs ministries, health departments and migratory authorities are necessary, but their role is not always considered. – Evaluation of regulatory effectiveness frequently requires collection of data in the field and not just at landing sites, but this kind of programme is rare in the region. – Establishment of observer programmes allowing the collection of good data is difficult because of the need for trained personnel and sufficient funds. – Satellite– based VMS information is in place in some countries; however, real– time data are not always available for fisheries managers and other government entities participating in surveillance and enforcement. – Effective patrolling often depends on coordination between enforcement personnel and fisheries managers to catch (potential) law–breakers at the right site and time. – Enforcement success requires regional cooperation, which can be affected by complex geopolitical issues, or issues in other sectors (e.g. oil & gas). – Drug or immigration control and not fishing are the highest priorities during enforcement patrols. – With such a broad involvement of government offices attending to illegal fishing issues there is need for a protocol, which is usually unavailable. – Administrative/judicial processes can take longer than expected. – Benefits of available technology are not always maximized because of technological, administrative or political issues.	– Enforcement can become inefficient and ineffective. – Enforcement costs are increasing, while cost recovery (through licences, fines and confiscations) is hardly possible as a result of outdated fisheries legislation. – Repeat violators continue to fish illegally. – Inability to prosecute/fine offenders, particularly foreign fishers, which affects credibility and reduces the incentive for voluntary compliance. – The partnerships between enforcement authorities (coastguard, customs, police, and port authorities and fisheries inspectors), managers and fishers which are needed for effective management are not established.

TABLE 4 (*Continued*)

Topic	Description of the problem	Consequences
Human safety	– Repetitive scuba diving has resulted in severe health problems, accidents and casualties in some countries. – Queen conch divers are five times more likely to have repeat incidents than other divers. – Lack of training, proper equipment, maintenance and work under strenuous physiological conditions are key factors which contribute to a vast array of diving diseases. – The development and enforcement of governmental controls and preventive protocols are needed to prevent diving accidents and permanent injury. – Diver training programmes are needed to prevent diving accidents and permanent injury. – In industrial fisheries (i.e. with mother boat), parties responsible for enforcing protocols need to be identified and held accountable. – Access to hyperbaric treatment has been proven to significantly reduce the extent of diving– related injuries, but facilities of this kind are not readily available. – Due to cultural factors and illiteracy, divers in some countries are reluctant to follow proper diving procedures. – Drug abuse and alcoholism is high among fishers and divers in some countries. – Fishers and divers are often self– employed and are in most cases not included in the social security system. – Very few queen conch fishers and divers have health or life insurance, which means that if something happens to them their family has to cover the high costs of treatment. – Queen conch meat can deteriorate during transit, processing or at point of sale due to the lack of ice or live wells.	– Diving and fishing accidents, permanent injury and casualties lead to human suffering in families and communities and to the loss of efficiency and income. – Diving accidents and permanent injury increase burden on health facilities and programmes. – Programmes providing financial means to access hyperbaric treatments are needed. – Unsanitary practices can lead to contamination of queen conch meat with E. coli bacteria. – Unsanitary practices and contamination can lead to products being rejected, loss of customers and market share, as well as a bad image for the sector. – Contamination increases the burden on health facilities and programmes.
Participation in the decision-making process	– Low participation of fishers in fisheries planning and management decision– making processes. – Fishers are not empowered to participate more actively in fisheries management. – Fishery managers do not have adequate resources to respond to the complexity of the fishery. – The limited organization of fishers in groups, cooperatives or associations makes it difficult for fisheries authorities to involve them in management. – Most fishers understand the problems, but require continuous education and outreach programmes to fully support the management strategies. – Actions towards improvements in the ecosystem– based management in the queen conch fishery is progressively being introduced, however more work is needed.	– Fisheries co– management in the Caribbean remains at the pre–implementation phase. – Incentives for voluntary compliance are lost and enforcement costs increase. – This regional fishery and conservation plan offers the possibility to improve the adaptive management based on ecosystem criteria. – Without organizational unity, fishers are not represented in important management and decision– making processes in fisheries.

Logical Framework Approach

The overall objective of this ten-year Regional Queen Conch Fishery Management and Conservation Plan is to guide the implementation of a set of identified management measures that can be applied at the regional or subregional level for the sustainability of queen conch populations, as well as for the maintenance of a healthy fishery and the livelihoods of the people involved in the fishery.

The ecosystem approach forms the basis of this Regional Queen Conch Fishery Management and Conservation Plan, enhancing partnerships and collaboration throughout the Wider Caribbean region to improve the long-term governance of queen conch fisheries across the Caribbean.

As part of the Logical Framework Approach (LFA), this chapter provides a Stakeholders Analysis and a Strategy Progress Analysis in table format. The core of the LFA, the Logical Framework Matrix (LFM) for the implementation of the Regional Queen Conch Fishery Management and Conservation Plan, is presented in Table 5 and Table 6. The matrix follows the conventional format, with indicators and activities to reach the planned outputs.

The Activity Schedule which forms part of the LFA is provided in Table 7 and contains the 14 management measures endorsed by the WECAFC/CFMC/CRFM/OSPESCA Regional Queen Conch working group at the 2014 Meeting in Panama. Each management measure is further explained in APPENDIX 3. Table 8 contains the Stakeholders Analysis.

The Regional Queen Conch Fishery Management and Conservation Plan was formulated with the following specific objectives:

1. To improve the collection and integration of the scientific data needed to determine the overall queen conch population status, as the basis for applying ecosystem-based management.
2. To harmonize measures aimed at increasing the stability of the queen conch population and to implement best-management practices for a sustainable fishery.
3. To increase coordination and collaboration in order to achieve better education and outreach, monitoring and research, co-management and strengthening, optimizing and harmonizing regional governance arrangements.
4. To adopt regional management measures, which incorporate a precautionary approach.

TABLE 5
Proposed logical framework matrix for the implementation of the regional queen conch fishery management and conservation plan

Overall Objectives	Outputs	Indicators	Means of Verification	Assumptions
To guide the implementation of a set of management measures that can be applied at the regional or subregional level for the sustainability of queen conch populations, and for the maintenance of a healthy fishery and livelihood of the people involved in the fishery.	To achieve a harmonized adaptive, ecosystem-based regional management plan, enhancing partnership and collaboration in measures resulting in improved long-term sustainability and governance in the Caribbean queen conch fisheries.	Agreements and resolutions on regional cooperation and collaboration brokered by the Regional Queen Conch Working Group and other international organizations. Bilateral and multilateral agreements on marine resource conservation issues. Economic and trade statistics of queen conch. Agreement on Regional Queen Conch Fishery and Conservation Management Plan and a time frame for the implementation of joint measures. Compliance with CITES Convention within three years of approval of the Plan by WECAFC. Total of five harmonized management measures implemented in five years. Bilateral agreements on monitoring subpopulations in first five years.	Agreements and resolutions registered by Regional Queen Conch Working Group and other international organizations in Meeting Reports and year reports. National economic performance data. National fisheries and trade legislation. National economic and trade statistics. Progress reports from the Queen Conch Working Group and International Organizations. CITES reports from the Animal Committee, Standing Commission and STR reporting.	Environmental issues remain the prime concern in national politics. Political will by countries' legislators, defence forces and environmental authorities. Funding for critical components like scientific research, monitoring and enforcement. Continuous active participation by stakeholders in decision-making processes. Willingness of fisheries departments to commit funds and staff. Inertia on the part of government and stakeholders.
To improve the collection and integration of the scientific data needed to determine the overall queen conch population status, as the basis for the application of ecosystem-based management.	Integrated national and regional databases with population status data, based on accepted research and survey protocols.	National databases for queen conch ready for regional integration. Protocols agreed upon to calculate population dynamics. Harmonized and integrated catch and fishing effort monitoring programmes. Level of reporting by respective sectors. Number of (sub)regional habitat maps.	Framework design of an integrated regional database. Agreements on protocols for population dynamics and monitoring. Volume and quality of production reports by respective sectors. Habitat maps.	Availability of skilled labourers to keep database running with up-to-date data. Ability within the region to agree between various models/protocols on data gathering and monitoring. Traditional resistance to providing quantitative production data. National security issues in the elaboration of marine habitat maps.

TABLE 5 (*Continued*)

Specific Objectives	Outputs	Indicators	Means of Verification	Assumptions
To harmonize measures aimed at increasing the stability of the queen conch population and to implement best-management practices for a sustainable fishery.	Set of harmonized, practical, best management measures in the region to guarantee the sustainability of the resource, which form the basis for a regional conservation policy.	Harmonized regional closed season. Harmonized regional meat conversion factors. Protocol to establish adequate adult density per hectare. Standardized NDF format for all countries and all queen conch products.	Number of countries with a national regulation on annual closed seasons. National statistics applying conversion ratios. FAO and CITES official statistics. Annual NDF reports in consensus formats submitted to CITES. Implementation, level and historic trend of applied precautionary principle.	Lack of collaboration from stakeholders. Delays in legislative processes for issuance of national regulations. National data gathering systems which allow for quantification of landings in different product forms.
To increase coordination and collaboration towards achieving better education and outreach, monitoring and research, co-management and strengthening, optimizing and harmonizing regional governance arrangements.	Regional resource governance scheme supported by an ecosystem-based management approach.	Licence systems for artisanal and industrial fishers. Regional agreement on use of different fishing gears and protocols on its application. Multilateral agreements on joint application, monitoring and enforcement of VMS systems. Number of bilateral and multilateral agreements to counteract and eliminate IUU fishing and trade. Traceability protocols to determine origin and combat IUU fishing and trade.	Data bank with information on licence owners. National legislation and international agreements on the use of types of gear and their geographical application. Protocols on the use of diving gear. Number of countries with VMS obligation for fishing vessels. Cases of integrated VMS system and data exchange. Signed treaties for joint patrolling and enforcement. Number of coordinated and/or joint patrols. National traceability schemes implemented by countries according to international requirements.	Collaboration of stakeholder groups to comply with licence requirements and due diligence. Delicate national security issues can be mitigated in coordinated (joint) activities, data exchange and enforcement issues. Patrolling for IUU fishing is subordinate to drug controlling efforts. Lacking and/or inadequate monitoring of reports on traceability.
To adopt regional management measures, which incorporate the precautionary approach.	Regional clearing house on the biological, economic, social and cultural issues related to the extraction, processing and trade in queen conch and its derivatives.	Educational programmes and outreach activities tailored to specific stakeholder groups, applicable in countries of the region. Level of participation by stakeholders. Adaptive, participative and ecosystem-based Regional Queen Conch Fishery Management and Conservation Plan.	Educational programmes incorporated in national educational curriculums. Co-management agreements. Meeting and course reports with list of participants and evaluation of activities. Significant number of signatory parties to Regional Queen Conch Fishery Management and Conservation Plan	Interest from stakeholders. Time required to reach consensus on regionally developed educational and outreach programmes.

TABLE 6
Strategy progress analysis of the implementation of the regional queen conch fishery management and conservation plan

Expected Overall Results	Expected Outputs	Current State	Responsible	Execution Period	Forums for Evaluation	Coordinators
Integrated national and regional databases with population status data, based on accepted research and survey protocols.	Regional database	Incipient	Producing countries	1–3 years	QC Working Group. CITES CoP.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES
	Population dynamics protocols	Incipient	Producing countries	1–3 years	QC Working Group.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES
	Harmonized monitoring programmes	Deficient	Producing countries	1–3 years	QC Working Group.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES
	Regional habitat maps	Non-existent	Producing countries	1–6 years	QC Working Group.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES
Set of harmonized, practical best management measures in the region to guarantee the sustainability of the resource, which form the basis for a regional conservation policy.	Harmonized regional closed season	Incipient	Producing countries	1–3 years	QC Working Group.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES
	Harmonized meat conversion rates	In progress	Producing countries	1–3 years	QC Working Group.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES
	Protocol adult per hectare density	Incipient	Producing countries	1–3 years	QC Working Group.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES
	Standardized NDF format	In progress	Producing countries	1–3 years	QC Working Group. CITES CoP.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES
Regional resource governance scheme supported by an ecosystem-based management approach.	National licensing systems	Incipient	Producing countries	1–6 years	QC Working Group. National authorities.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES
	Fishing gear protocols	Incipient	Producing countries	1–6 years	QC Working Group. National authorities.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES
	Satellite-based VMS systems	Incipient	Producing countries	1–6 years	QC Working Group.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES
	IUU fishing and trade counteract measures	Deficient	Producing countries	1–6 years	QC Working Group. CITES CoP.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES
	Traceability methodology	Deficient	Producing countries	1–6 years	QC Working Group. National authorities.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES

TABLE 6 (*Continued*)

Expected Overall Results	Expected Outputs	Current State	Responsible	Execution Period	Forums for Evaluation	Coordinators
Regional clearing house on biological, economic, social and cultural issues related to the extraction, processing and trade in queen conch and its derivatives.	Regional stakeholder educational programmes	Incipient	Producing countries	1–10 years	QC Working Group.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES
	Regional stakeholder outreach programmes	Incipient	Producing countries	1–10 years	QC Working Group.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES
	Regional Queen Conch Fishery & Conservation Management Plan	In progress	Producing countries	1–3 years	QC Working Group. CITES CoP.	CFMC/ WECAFC/ OSPESCA/ CRFM/CITES

TABLE 7
Proposed specific regional objectives and management activities/measures in the queen conch fishery

Objectives	Proposed Regional Activities/Measures	Years - Expected implementation		
		1–3	1–5	1–10
To improve the collection and integration of scientific data needed to determine the overall queen conch population status, as the basis for the application of ecosystem-based management	Improvement in the collection, storage and analysis of biological, socio-economic and commercial data (e.g. population dynamics, catch and fishing effort, commercial aspects).			
	Put in place (sub)regional mechanisms for the rapid assessment of appropriate exploitation potential and the level of queen conch stocks, using fishery-dependent and independent data.			
	Determine inputs and the design of habitat maps at a scale and with details needed for improved fisheries management through collaborative arrangements between countries and respective institutions.			
To harmonize measures aimed at increasing the stability of the queen conch population and to implement best-management practices for a sustainable fishery	Harmonization of queen conch meat conversion factors.			
	Harmonization of a closed queen conch fishing (and trade) season for all countries in the region.			
	Elaborate and adopt a generic Non-Detriment Finding Format to solidify the CITES export permit process for all exports of queen conch meat and by-products.			
To increase coordination and collaboration towards achieving better education and outreach, monitoring and research, co-management and strengthening, optimizing and harmonizing regional governance arrangements.	Establish a comprehensive, transparent and harmonized licensing system for queen conch fishers, processors and traders.			
	Elaborate regional proposals for the effective and coordinated patrolling of fishing grounds by national maritime defence forces and other pertinent institutions.			
	Implementation of obligatory and regionally compatible VMS systems for queen conch fishing boats larger than 10 metres long, and reach regional agreement on system's data exchange between the countries of the region.			
	Establish national queen conch product traceability scheme in line with catch certification standard requirements.			

TABLE 7 (*Continued*)

Objectives	Proposed Regional Activities/Measures	Years - Expected implementation
To adopt regional management measures, which incorporate the precautionary approach.	Formulate national queen conch fishing and conservation management plans with elements of the ecosystem approach and regionally harmonized measures.	
	Elaborate and reach regional consensus on education and outreach programmes, tailored for each group of stakeholders.	
	Establish joint policy and actions to progressively increase the participation of stakeholders in the management of the resource, using co-management strategies.	
	Establish regional diving protocols and training aimed at human health and safety as well as appropriate and optimum resource sustainability.	

Activities	Indicators	Means of Verification	Risks & Assumptions
Activity 1: Improvement in the collection, storage and analysis of biological, socio-economic and commercial data (e.g. population dynamics, catch and fishing effort, commercial aspects).	Design of a regional queen conch stocks and fisheries database. Seminars on data gathering, analytical skills and data processing. Criteria for regionally comparable data.	National statistics with regional dynamics. Seminar reports.	Availability of funds and skilled manpower. Quality of collected national data adequate for a regional analysis. Quality of collected national data allows specialized analysis.
Activity 2: Put in place (sub)regional mechanisms for rapid assessment of an appropriate exploitation potential and level of queen conch stocks, using fishery-dependent and independent data.	Periodic regional queen conch stock assessment bulletins. Data analysis models.	Published assessment bulletins.	Countries unwilling to share data for national security reasons. Insufficient or incomplete data.
Activity 3: Determine inputs and design of habitat maps at a scale and with details needed for improved fisheries management, through collaborative arrangements between countries and institutions.	(Sub)regional habitat maps made available Definition of habitat map criteria and legend.	Habitat maps published. Habitat maps referenced in management plans and species specific scientific publications.	Unwillingness of stakeholders to collaborate on data collection. Lack of stakeholder enforcement capacity to assure compliance.
Activity 4: Harmonization of queen conch meat conversion factors.	Reliable national production statistics in nominal weight.	National and international (CITES and FAO) statistics.	Lack of stakeholders' interest to correct reporting of landed product. Limited stakeholders' interest to apply conversion factors.
Activity 5: Harmonization of a closed queen conch fishing (and trade) season for all countries of the region.	Drop in national production (and trade) statistics during closed seasons.	National regulations or decrees announcing a closed season. National statistics on production and trade.	Lack of consensus among scientists. Socio-economic consideration of fishers. Awareness among local authorities to not give export permits/catch certificates in the closed season.

TABLE 7 (*Continued*)

Activities	Indicators	Means of Verification	Risks & Assumptions
Activity 6: Elaborate and adopt a generic Non-Detriment Finding Format to solidify the CITES export permit process for all exports of queen conch meat and by-products.	Countries to submit an NDF each year in the agreed format and information categories. Data gathering as part of the NDF requirements.	NDFs submitted timely to CITES. Export permits expedited.	Interest and willingness by officials and other stakeholders to submit confinable NDF. Inadequate national CITES Scientific and Administrative Authority set-up.
Activity 7: Establish a comprehensive, transparent and harmonized licensing system for queen conch fishers, processors and traders.	All subsector participants provided with role-specific licence. Management decisions based on subsector importance in overall queen conch sector.	Database with details per licence. Identification card in hands of fishers and traders.	Fishers' and traders' resistance to register. Lack of funds and logistics to maintain register.
Activity 8: Elaborate a regional proposal for effective and coordinated patrolling of fishing grounds by national maritime defence forces and other pertinent institutions.	Major fishing banks under more intensive monitoring, control and enforcement regime. Bi- and multilateral cooperation in joint production areas.	Bi- and/or multilateral treaties or agreements.	National defence forces show little interest in queen conch and are focused on drug control efforts. Coordinated efforts between coast guard, port authorities, and customs and fisheries inspectors initiated.
Activity 9: Implementation of obligatory and regionally compatible VMS systems for queen conch fishing boats larger than 10 metres long; reach regional agreement on theses systems' data exchange between the countries of the region .	Countries in position to monitor larger fishing vessels. Compliance of management measures improved because of more effective enforcement.	Vessels log-books. Printouts of national VMS data. Fines for IUU fishing Exchange of information protocols in place	Incompatible VMS systems between countries. Unwillingness to share "sensitive" data.
Activity 10: Establish national queen conch product traceability scheme in line with catch certification standard requirements.	Origin of queen conch product can be traced back to origin. IUU fishing and trade discouraged.	Traceability forms/ catch certificates for each product batch. Reports on confiscated products and fines.	Insufficient primary source information. Market requirements in the EU and USA drive catch certification compliance. Fraud.
Activity 11: Formulate national queen conch fishing and conservation management plans with elements of the ecosystem approach and regionally harmonized measures.	Enhanced stakeholder participation in resource management. Formation of effective fisheries advisory committees is encouraged. Stakeholders feel empowered.	Stakeholder meeting reports. Management plans endorsed and published	Lack of capacity to formulate a Management Plan. Government willing to share decision-making. Fishers' organizations established for participation in management decisions.
Activity 12: Elaborate and reach regional consensus on the education and outreach programmes, tailored for each group of stakeholders.	Fishers' knowledge and involvement increased. Stakeholders feel more empowered.	Training and seminar evaluation reports. Stakeholder participation in decision-making processes (lists of participants in meetings).	Education and outreach programmes (traditional and generic). Institutional inertia. Adequate capacity building materials and process.

TABLE 7 (*Continued*)

Activities	Indicators	Means of Verification	Risks & Assumptions
Activity 13:			
Establish joint policy and actions to progressively increase the participation of stakeholders in the management of the resource, using co-management strategies.	Stakeholders knowledgeable on co-management concepts.	Stakeholder participation in decision-making debates, workgroups and councils. Published joint activities and decisions.	Stakeholder distrust in government. Institutional inertia.
Activity 14:			
Establish regional diving protocols and training aimed at human health and safety and appropriate and optimum resource sustainability.	Use of safe practices by divers has increased. Destructive fishing practices contained.	Reports of accidents and casualties. Local clinic, hospital and hyperbaric treatment reports. Certificates of completion of training courses for scuba diving and first-aid.	Fishers and large vessel operators reluctance to abandon productive but unsafe fishing practices. Regulations with adequate enforcement, including high penalties for operators of vessels engaged in illegal practices, will lead to a mentality change.

TABLE 8

Stakeholder analysis in the implementation of the regional queen conch fishery management and conservation plan

Parties	Activities & Responsibilities	Expected Outputs Management Plan	Level of participation
Artisanal fishers	Exploit the resource in a sustainable manner using traditional and modern techniques. Continue to fish in order to supply consumer markets. Take care of health and apply safety measures while fishing and diving. Ensure food safety and hygiene while working with conch on board. Keep log-books and supply catch data and information to the authorities. Comply with rules and regulations, although there may be poor enforcement and open access.	Improved job and income stability. Growth in socio-economic well-being. Training. Empowerment. Increased organizational levels Decrease in diving- and fishing-related accident rate Increased and continued access to export markets.	Participation in outreach activities. Influence on decision-making processes through fisherfolk organizations and/or community leaders.
Industrial fishers	Continue resource exploitation by using large vessels, modern technology and specific diver arrangements that are sustainable. Exploit deeper water resources and further off shore banks in a sustainable manner. Process the meat in a hygienic way, meeting food safety requirements. Compliance with rules and regulations in place. Keep log-books and supply catch and effort information to the authorities. Increase safety-at-sea, through training, and practise healthy and safe fishing and diving methods.	Improved resource access stability and sustainability. Decrease in diving-related accident rate. Increased and continued access to export markets	Participation in outreach activities. Influence on decision-making processes through union or federation leaders. Contribution through data gathering and research activities.

TABLE 8 (*Continued*)

Parties	Activities & Responsibilities	Expected Outputs Management Plan	Level of participation
Government	Formulate sector-related rules and regulations, NDFs and national management plans. Carry out and support resource and ecosystem-related research. Facilitate trade in legal products and ensure adequate penalties for IUU fishing. Ensure the licensing of seaworthy and safety-at-sea compliant vessels only. Monitoring and enforcement of pertinent and prevailing directives. Comply with regional and international conventions/ agreements. Training and outreach activities.	Improvement in ecosystem and resource sustainability and conservation. Improvement of the economic stability of the sector and opportunities for legal trade. Regional collaboration and coordination in resource conservation and enforcement efforts. Effective monitoring and enforcement. An ecosystem-based management plan in place. Decrease in diving-related accidents and casualties.	Government is the main force within an ecosystem driven management system. Direct participation in the formulation and execution of national and international policies related to resource and ecosystems. Principal promoter of synergies between the various parties involved in resource conservation and exploitation.
Processing industry and commercial sector	Purchase of catch and processing according to market and consumer/ food safety requirements. Do not buy or process illegally caught queen conch. Export of processed product applying traceability requirements, catch and CITES certification. Apply agreed conversion factors in data and statistics reporting. Coordination with government in research and compliance of international conventions.	Stability in production and trade. Clear cut regulations in processing, sanitary and trade related issues.	Influence decision-making processes through union or federation leaders. Contribute through data gathering and research activities.
NGOs	Project formulation and execution with fishers, government and the public in general, regarding resource and ecosystem management. Educational activities. Scientific surveys and research. Lobbying for improved conservation of the resources and assisting in livelihood diversification of coastal fishery-dependent communities	Acceptable level of ecosystem and resource sustainability and conservation. Sector stability. Regional collaboration and coordination in resource conservation efforts. Decrease in diving-related accident rate	Through projects with fishers and fishers' communities. Training activities. Contribute to dialogue and the formulation of policies through scientific research data. Political lobbying.

Strategies for the adoption and implementation of the Regional Queen Conch Fishery Management and Conservation Plan

The first step in the process towards the adoption and implementation of this Regional Plan is to utilize the existing mechanisms for the formal adoption of the Regional Queen Conch Fishery Management and Conservation Plan. This Regional Plan responds to the needs expressed by the 16th Conference of the Parties of CITES and the 15th Session of WECAFC. More than 50 experts belonging to the CFMC/WECAFC/OSPESCA/CRFM Queen Conch Working Group have sought to overcome the constraints to improving the status of Queen Conch stocks by increasing the collaborative work across the Wider Caribbean region, in the so-called queen conch range states. Indeed, the Queen Conch Working Group has been assessing a range of potential measures to increase sustainability of the stocks and queen conch fisheries, including the development of queen-conch-specific regional conversion factors and guidelines for making NDFs.

Given that queen conch is already a relatively highly regulated fishery stock in the majority of Caribbean countries, the harmonized regional measures presented in this document will generally require only minor adjustment in order to achieve the broader objectives set out in this Regional Queen Conch Fishery Management and Conservation Plan.

The adoption of this Regional Plan may require several steps to ensure the participation of all countries in the Wider Caribbean. As WECAFC is the only umbrella organization that covers the entire set of Caribbean countries and territories (see APPENDIX 4), its action is required. The next WECAFC meeting will be the 16th session, scheduled to take place in 2016.

Presenting the Regional Plan at international meetings that relate to the joint work on the sustainable management of queen conch fisheries can benefit the building of regional support for its adoption and implementation. For instance, the Regional Plan could be presented for review or information to the 17th Conference of the Parties of CITES, also to be held in 2016. This approach would strengthen both the context and sponsorship of the Regional Plan formally, and promote its eventual adoption.

Further support and the formal adoption of this Regional Queen Conch Fishery Management and Conservation Plan could be achieved by presenting the recommended technical measures to the various subregional bodies, such as:

- The Central America Fisheries and Aquaculture Organization (OSPESCA), including the Ministerial Council, the Steering Committee and the Commission of Fisheries Directors of the SICA countries. These are responsible for the establishment of regional policies and programmes, projects and agreements on fisheries and aquaculture-related matters. In addition, OSPESCA can issue and adopt binding regulations under the SICA legal framework.
- The Caribbean Regional Fisheries Mechanism (CRFM) where the Ministerial Council, the Forum and the Executive Committee are responsible for the promotion of efficient fisheries management, as well as the conservation and development of aquatic resources in the CARICOM States. The Forum and

Council can review and approve any proposed co-operative arrangement which supports fisheries monitoring, research and management, in addition to encouraging cooperation betweenMember States.

- The Caribbean Fisheries Management Council (CFMC), which is responsible for the creation of management plans for fishery resources in the US Caribbean Exclusive Economic Zone off Puerto Rico, and the United States Virgin Islands. Formal adoption in the United States of America may require the approval of the United States of America's Secretary of Commerce, in addition to the approval from the State Governments of Puerto Rico and the United States Virgin Islands.

The implementation of the Regional Queen Conch Fishery Management and Conservation Plan at the regional level will be promoted by the above-mentioned regional and subregional organizations. At the national level it will be promoted by the fisheries and CITES authorities. The Regional Plan can also be progressively promoted once support through subregional, or even bilateral, agreements is secured. Progress may be made through agreements that are not exclusive to the queen conch fishery, but have been considered a priority, such as the combating of IUU fishing, research, monitoring and education, and outreach. Regional initiatives on these topics are included in the proposed regional measures and their implementation will strengthen the application of ecosystem-based management approaches in the queen conch fishery.

The CFMC/WECAFC/OSPESCA/CRFM Queen Conch Working Group will continue to monitor the implementation of the Regional Queen Conch Fishery Management and Conservation Plan and will be responsible for designating and creating technical subcommittees to address specific issues, as and when these are required. For instance, one advisory, technical subcommittee could focus on stock assessment to determine sustainable harvestable biomass. Its role could also include: a) the establishment of regional technical reference points in this fishery; b) the provision of training and advice on similar surveys, protocols, together with anestimation of regional indicators on population abundance and status; c) the definition of a research agenda that includes the queen conch role in the ecosystem, the effects of climate change, or the causes and consequences of genetic connectivity (or lack thereof); and d) increase funding by projects that support and fund regional/subregional needs.

A second regional, technical subcommittee could deal with outreach and education, in addition to providing inputs on the following: a) development of educational materials in the many languages utilized across the Wider Caribbean; b) development of education programmes directed at various stakeholders, from decision-makers to fishers, and at the overall community level; and c) publication of scientific findings and monitoring in formats that are accessible to a non-technical audience.

A third regional subcommittee could work on improving governance issues related to queen conch fisheries, and provide advice through activities such as: a) the organization of regional meetings to share technical information and receive feedback from various stakeholders; b) promoting collaboration to improve data collection, analysis, participation in monitoring and research, and elaboration of habitat maps; c) supporting enforcement and surveillance mechanisms; and d) creating the mechanisms to empower fisherfolk organizations, and allowing their participation in fisheries management.

References

Acosta, CA. 2001. Assessment of the functional effects of a harvest refuge on spiny lobster and queen conch populations at Glover's Reef Belize. *Proc. Annu. Gulf Caribb. Fish. Inst*., 52: 212-221.

Acosta, CA. 2006. Impending trade suspensions of Caribbean queen conch under CITES: a case study on fisheries impacts and potential for stock recovery. *Fisheries*, 31(12): 601-606.

Aiken, K., Kong, A., Smikle, S., Appeldoorn R. & Warner, G. 2006. Managing Jamaica's queen conch resources. *Ocean and Coastal Management,* 49: 332-341.

Alcolado, PM. 1976. Crecimiento, variaciones morfológicas de la Concha y algunos datos biológicos del cobo *Strombus gigas L.* (Mollusca, Mesogastropoda). Acad Cien Cuba Ser Oceanol. No 34. 36 pp.

Aldana-Aranda, D., Baqueiro-Cárdenas, E.R., Martínez-Morales, I., Ochoa, R.I. & Brulé., T. 2003. Reproductive patterns of *Strombus gigas* from Alacranes Reef versus Chinchorro Bank of México. *Proc. Gulf Caribb. Fish. Inst.* 54: 202-225.

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

Álvarez Lemus, J.A. 2012. Informe de Cuba al grupo de trabajo CFMC/OSPESCA/ COPACO/ CRFM sobre el estado de la pesca del caracol reina (cobo). In *Report of the first meeting of the CFMC/OSPESCA/WECAFC/CRFM Working Group on Queen Conch, Panama City, Panama, 23–25 October 2012*. FAO Fisheries and Aquaculture Report No. 1029. pp. 99-102. Rome, FAO. 167 pp.

Appeldoorn, RS. 1994a. Spatial variability in the morphology of queen conch and its implications for management regulations. In RS Appeldoorn & B. Rodríguez, eds. *Queen conch biology, fisheries, and mariculture*. Caracas, Fundación Científica Los Roques.

Appeldoorn, RS. 1997. Deep Water Spatial Variability in the morphology of Queen Conch and its implication for management regulations. In CFRAMP, ed. Lobster and Conch subproject specification and training workshop, 9-12 October 1995, Kingston, Jamaica, CARICOM Fishery Research Document No. 19, pp.

Appeldoorn, RS. 1988. Age determination, growth, mortality and age of first reproduction in adult queen conch, *Strombus gigas* L., off Puerto Rico. *Fish. Res*. 6: 363-378.

Appeldoorn RS, Arango, L. Cabeza, F. Castro, ER. Glazer, R. Marshak, T. & Peñaloza, G. 2003. *Queen conch distribution and population assessment of the northern banks of the San Andres Archipelago, Colombia. Final report Northern expedition, CORALINA.* San Andrés, The Ocean Conservancy. 27 pp.

Appeldoorn, R.S., Castro Gonzalez, E., Glazer, R., Prada, M. 2011. Applying EBM to queen conch fisheries in the Caribbean. In L. Fanning, R. Mahon,P. McConney, eds. *Towards Marine Ecosystem-based Management in the Wider Caribbean*, pp. 177-186. Amsterdam, Amsterdam University Press.

Ávila-Poveda, O.H. & Baqueiro-Cárdenas, E.R. 2009. Reproductive cycle of *Strombus gigas* Linnaeus 1758 from archipelago of San Andres, Providencia and Santa Catalina Colombia. *Invertebr. Reprod. Dev*., 53(1): 1-12.

Baker, N. 2014. *Effectiveness of Management Regulations and Updated Analysis of Population Health and Trends of Queen Conch, Strombus gigas, in Puerto Rico.* Office of Graduate Studies, Marine Sciences, Universidad de Puerto Rico. (Thesis)

Berg, C.J. Jr. 1975. Behavior and ecology of conch (Superfamily Strombacea) on a deep subtidal algal plain. *Bull. Mar. Sci*., 25: 307-317.

Borrell, B. 2013. Ocean conservation: a big fight over little fish. *Nature*, 493: 597-598.

Bothwell J. 2009. Conch in the Cayman Islands: CITES, IUU and Fishery Status. In Prada, M.C. & Castro, E.R., eds. *Proceedings of the Regional Workshop for the Improvement of the Queen Conch Collaborative Management and Enforcement in the Southwestern Caribbean Sea, 28-31 July 2008, San Andres Island, Colombia*, pp. 43-45..

Brito, M.N., Aldana-Aranda, D. Cruz, L.E. & Estrada B., M.A. 2006. Organogénesis larvaria de *Strombus gigas* (*Mesopoda:Strombidae*) en el arrecife Alacranes durante el periodo máximo de su época reproductiva. *Univ. Cienc.*, 22:75-82.

Caddy, J.F. & Mahon, R. 1995. References points for fisheries management. FAO Fisheries Technical Paper No. 347. Rome, FAO. 83 pp. (also available at www.fao.org/docrep/003/v8400e/v8400e00.HTM).

Cala de la Hera, Y.R., de Jesús-Navarrete, A., Oliva-Rivera, J.J. & Ocaña-Borrego, F.A. 2012. Auto-ecology of the Queen Conch (*Strombus gigas* L. 1758) at Cabo Cruz, Eastern Cuba: Management and Sustainable Use Implications. *Proc. Annu. Gulf Caribb. Fish. Inst*., 64: 342-348.

CCAD- USDOI. 2010. *Informe de resultados del Taller de Fomento de Capacidades sobre Dictámenes de Extracción No Perjudicial para Centroamérica y República Dominicana.* 15-17 Noviembre 2010, Santo Domingo, República Dominicana. 28 pp.

Caribbean Fishery Management Council (CFMC). 1999. *Report on the queen conch stock assessment and management workshop.* Belize City, CFMC.

Campton, D.E., Berg Jr, C.J., Roblson, L.M., Glazer, R.A. 1992. Genetic patchiness among populations of the queen conch *Strombus gigas* in the Florida Keys and Bimini. *Fish. Bull.*, 90: 250-259.

Castro, E.R, Prada, M.C., Caldas, J.P. & Puentes, V. 2012. Manejo Pesquero y Conservación del Caracol Pala (*Strombus gigas*) en Colombia. In *Report of the first meeting of the CFMC/OSPESCA/WECAFC/CRFM Working Group on Queen Conch, Panama City, Panama, 23-25 October 2012*, pp. 92–98. FAO Fisheries and Aquaculture Report No. 1029. Rome, FAO. 167 pp.

Chakalall B., Crispoldi, A., Garibaldi, L., Lupin, H. & Mateo, J. 2007. Caribbean queen conch (*Strombus gigas*). In C. Catarci, 2004. *World markets and industry of selected commercially-exploited aquatic species with an international conservation profile*. FAO Fisheries Circular. No. 990, pp. 63–102. Rome, FAO. 186 pp (also available at www.fao.org/3/a-y5261e.pdf).

Clerveaux, W. & Vaughan, D. 2003. An investigation of the effects of increasing fishing efficiency on the productivity of queen conch (*Strombus gigas*) and Caribbean spiny lobster (Panilurus argus) fisheries within the Turks and Caicos Islands. *Proc. Annu. Gulf Caribb. Fish. Inst.*, 54: 285–296.

Cochrane, K.L., ed. 2002. *A fishery manager's guidebook. Management measures and their application*. FAO Fisheries Technical Paper. No. 424. Rome, FAO. 231 pp.

Coulston, M.L., Berry, R.W., Dempsey, A.C., Obum, P. 1987. Assessment of the queen conch, *Strombus gigas*, population and predation studies of hatchery reared juveniles in Salt River Canyon, St. Croix, U.S. Virgin Islands. *Proc. Annu. Gulf Caribb. Fish. Inst*., 38: 294–305.

CRFM. 2010. Report of the Sixth CRFM Scientific Meeting, 7–16 June 2010, Saint Vincent and the Grenadines. CRFM Fishery Report 2010, Volume 1. Belize, CRFM Secretariat (also available at www.crfm.int/~uwohxjxf/images/Report_of_the_Sixth_Annual_Scientific_Meeting.pdf).

D'Asaro, C.N. 1965. Organogenesis, development and metamorphosis in the queen conch, *Strombus gigas* with notes on breeding habits. *Bull. Mar. Sci*., 15: 359–416.

Daves, N. & Fields, J. 2006. Recent developments in CITES Concerning the International Trade in Queen conch (*Strombus gigas*). *Proc. Gulf Caribb. Fish. Inst*., 57: 763-770.

Davis, M. 1998. *The effects of natural foods, temperature and salinity on the length of larval life for the tropical gastropod Strombus gigas.* Florida Institute of Technology, Melbourne, Florida. (PhD dissertation)

Dayton, P.K., Thrush, S.F., Agardy, M.T. & Hofman, R.J. 1995. Environmental effects of marine fishing. Aquatic Conservation: *Marine and Freshwater Ecosystems*, 5(3): 205–232.

Delgado, G.A.,. Glazer, R,A., Hawtof, D. Aldana Aranda, D. Rodríguez-Gil, L.A. & De Jesús-Navarrete, A. 2008. Do queen conch (*Strombus gigas*) larvae recruiting to the Florida Keys originate from Upstream sources? Evidence from Plankton and drifter studies. In R. Grober-Dunsmore & B.D. Keller, eds. Caribbean connectivity: Implications for marine protected area management. *Proceedings of a Special Symposium, 9–11 November 2006, 59th Annual Meeting of the Gulf and Caribbean Fisheries Institute, Belize City, Belize*, pp. 29–41. Marine Sanctuaries Conservation Series ONMS-08-07. Silver Springs, MD, Office of National Marine Sanctuaries.

De Jesus-Navarrete, A. & Aldana-Aranda, D. 2000. Distribution and abundance of *Strombus gigas* veligers at six fishing sites of Banco Chinchorro, Quintana Roo, Mexico. *J. Shellfish Res*., 19(2): 891–895.

Doney, S.C. 2006. The dangers of ocean acidification. *Sci. Am*., 294(3): 58–65.

Egan, B.D. 1985. *Aspects of the reproductive biology of Strombus gigas*. Department of Zoology, University of British Columbia. (MSc Thesis)

Ehrhardt, N.M. 2008. The queen conch *Strombus gigas*: biology and population dynamics with low compatibility with traditional standards in fisheries management. In Prada, M.C. & Castro, E.R., eds. *Proceedings of the Regional Workshop for the Improvement of the Queen Conch Collaborative Management and Enforcement in the Southwestern Caribbean Sea, 28-31 July 2008, San Andres Island, Colombia*, pp. 85–110.

Ehrhardt, N.M. & Valle-Esquivel, M. 2008. *Conch (Strombus gigas) stock assessment manual*. San Juan, Puerto Rico, CFMC. San Juan PR. 128 pp.

FAO. 2002. I*mplementation of the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing*. FAO Technical Guidelines for Responsible Fisheries. No. 9. Rome. 122 pp.

FAO. 2005. *Putting into practice the ecosystem approach to fisheries.* Rome, FAO. 2005. 76 pp.

FAO/WECAFC/COPACO/CFMC. 2012. *Report of the first meeting of the CFMC/ OSPESCA/ WECAFC/CRFM Working Group on Queen Conch*. FAO Fisheries and Aquaculture Report No. 1029. Ciudad de Panamá, Panamá, 23–25 de octubre de 2012. 171p.

FAO, WECAFC, COPACO & CFMC. 2016. *Report of the second meeting of the CFMC/ OSPESCA/WECAFC/CRFM Working Group on Queen Conch, Panama City, Panama, 18–20 November 2014*. FAO Fisheries and Aquaculture Report No. 1097, Bridgetown, Barbados, FAO. 444 pp. (also available at www.fao.org/3/a-i5587t.pdf).

Frenkiel L., Laurent, P. Zetina Zarate, A. & Aldana Aranda, D. 2009. Reproduction Cycle of the *Strombus gigas*, L. 1758 in Guadeloupe, FWI. *Proc. Annu. Gulf Caribb. Fish. Inst*.,61: 518–520.

García-Sais, J.R., Sabater-Clavell, J. Esteves, R. & Carlo, M. 2012. Fishery independent survey of commercially exploited fish and shellfish populations from mesophotic reefs within the Puerto Rican EEZ. Submitted to Caribbean Fishery Management Council. San Juan, Puerto Rico, CFMC. 91 pp.

Glazer, R. A., & Kidney, J. A. 2004. Habitat associations of adult queen conch in an unfished Florida Keys back-reef: applications to essential fish habitat. *Bull. Mar. Sci.,* 75:205–224.

Glazer, R. & Delgado, G. 2012. Response to the Petition made to the US Department of Commerce to list the queen conch, *Strombus gigas*, as "threatened" or "endangered" under the Endangered Species Act. Submitted to NMFS on October 26, 2012.

Gordon, S. 2010. USVI Queen Conch Stock Assessment, 2008–2010. Final Report to Southeast Area Monitoring and Assessment Program - Caribbean (SEAMAP-C). U.S. Virgin Islands, Bureau of Fisheries, Department of Planning and Natural Resources. 29 pp

Haftof, D.B., McCarthy, K.J. & Glazer, R.A. 1998. Distribution and abundance of queen conch, *Strombus gigas*, larvae in the Florida Current: Implications for recruitment to the Florida Keys. *Proc. Annu. Gulf Caribb. Fish. Inst.*, 50: 94–103.

Iversen, E.S., Jory, D.E. & Bannerot, S.P. 1986. Predation on queen conch (S. gigas) in the Bahamas. *Bull. Mar. Sci.*, 39(1): 61–75.

Jory, D.E. & Iversen, E.S. 1983. Queen conch predators: not a road block to mariculture. *Proc. Annu. Gulf Caribb. Fish. Inst.*, 35: 108–111.

Kamat S., Su, X., Ballarini, R., & Heuer, A.H. 2000. Structural basis for the fracture toughness of the shell of the conch *Strombus gigas*. *Nature*, 405: 1036–1040.

King-Joseph A., Lendor-Gabriel G., Serieux N., & St. Omer A. 2008. *Conch resource assessment study*. Technical document, Ministry of Economic Affairs, Economic Planning, Investment & National Development.. Saint Lucia, Department of Fisheries. 124 pp.

Kjerfve, B., ed. 1999. *Caribbean coral reef, seagrass, and mangrove sites.* Coastal Regions and Small Islands Papers 3. Paris, UNESCO.

Liu, Y., Lee, S., Muhling, B.A., Lamkin, J.T. 2012. Significant reduction of the Loop Current in the21st century and its impact on the Gulf of Mexico. *J. Geophys. Res*., 117: C05039, doi: 10.1029/2011JC007555.

Laughlin, R.A. & Weil, E. 1984. Biology, population dynamics and reproduction of the queen conch, *Strombus gigas* Linne in the Archipelago de Los Roques National Park. *J. Shellfish Res*., 4(1): 45–62.

Lovell, T. 2012. *Towards a management plan for Antigua and Barbuda' Queen conch fishery: A Co-management approach*. Reykjavik, United Nations University Fisheries Training Programme, Iceland. (Final project). (also available at www.unuftp.is/static/fellows/document/tricia12prf.pdf.

Mahon, R. 1990. F*ishery management options for Lesser Antilles countries (Antigua and Barbuda, Barbados, Dominica, Grenada, Saint Christopher and Nevis, Saint Lucia, Saint Vincent and the Grenadines*). FAO Fisheries Technical Paper. No.313. Rome. FAO. 126 pp.

Márquez, E., Lanlíndez-García, R.M., Ospina-Guerrero, S.P., Segura, J.A., Prada, M.C., Castro, E.R., Correa, J.L., & Borda, C. 2013. Genetic analysis of queen conch *Strombus gigas* from the Southwest Caribbean. *Proc. Annu. Gulf Caribb. Fish. Inst*., 65: 410–416.

McCarthy, K.J., Bartels, C.T., Darcy, M.C., Delgado, G.A. & Glazer, R.A. 2002. Preliminary observation of reproductive failure in nearshore queen conch, *Strombus gigas* in the Florida Keys. *Proc. Annu. Gulf Caribb. Fish. Inst*., 53: 674–680.

McConney, P., Pomeroy, R. & Mahon, R. 2003. *Guidelines for coastal resource co-management in the Caribbean: Communicating the concepts and conditions that favour success*. Barbados: Caribbean Conservation Association. 56 pp..

Medley, P. 2008. *Monitoring and managing queen conch fisheries: a manual.* FAO Fisheries Technical Paper No. 514. Rome. FAO. 2008. 78 pp.

Meijer, M. 2014. *Population status and reproductive biology of queen conch (Lobatus gigas) in the coastal waters around St. Eustatius*. Aquaculture and Fisheries Group, Wageningen University, the Netherlands. (MSc. Thesis).

Mianmanus, R.T. 1988. *Induction of settlement and metamorphosis in larvae of Aplysia brasiliana and Strombus gigas (Mollusca: Gastropoda)*. Department of Marine Biology and Fisheries, University of Miami. (PhD dissertation)

MRAG. 2013. *Support to improve and harmonize the scientific approaches required to inform sustainable management of queen conch (Strombus gigas) by CARIFORUM States*. ACP Fish II Project CAR/3.2/B.15, Final Report. London, MRAG. 287 pp.

Mitton, J.B., Berg Jr, C.J. & Orr, K.S. 1989. Population structure, larval dispersal, and gene flow in the queen conch, *Strombus gigas*, of the Caribbean. *The Biological Bulletin,* 177(3): 356–362. National Marine Fisheries Service.

Odum, E.P. 1953. *Fundamentals of Ecology.* Philadelphia, PA. WB Saunders.

Pérez-Pérez, M. & Aldana-Aranda, D. 2003. Actividad reproductiva de *Strombus gigas* (Mesogasteropoda: Strombidae) en diferentes hábitats del Arrecife Alacranes, Yucatan. *Rev. Biol. Trop.*, 51(4): 119–121.

Prada, M., Castro, E., Taylor, E., Puentes, V., Appeldoorn, R. & Daves, N. 2008. Non-detrimental findings for the Queen Conch (*Strombus gigas*) in Colombia. Presentation at the International Expert Workshop on CITES Non-Detriment Findings, 17-22 November 2008, Cancun, Mexico, NDF Workshop Case Studies Working Group 9 Aquatic Invertebrates.

Randall, J.E. 1964. Contribution to the biology of the queen conch *Strombus gigas*. *Bull. Mar. Sci*., 14: 246–295.

Richardson, P.L. 2005. Caribbean current and eddies as observed by surface drifters. *Deep Sea Res*., Part II, 52(3–4):429–463.

Rodriguez, L.A. 1995. *Biochemical composition of larval diets and larvae, temperature, and induction of metamorphosis related to the early life history of the milk conch, Strombus costatus Gmelin*. Universidad de Puerto Rico. (Ph.D. Dissertation).

Sen, S. & Nielsen, J.R. 1996. Fisheries co-management: a comparative analysis, *Marine Policy*, 20(5), 405–418.

Sheppard, C.R.C., ed. 2000. *Seas at the Millennium: An Environmental Evaluation.* Amsterdam, Pergamon Press of Elsevier Science.

SOFRECO. 2013. Training in underwater visual survey methods for evaluating the status of *Strombus gigas*, queen conch stocks. ACP Fish II – Strengthening fisheries management in ACP states 9 ACP RPF 128 Accounting No. RPR/006/07 – EDF IX, final report. Saint Vincent and the Grenadines. 359p.

Spade, D.J., Griffitt R.J., Liu L., Brown-Peterson, N.J., Kroll, K.J., Feswick, A. Glazer, RA., Barber,,D.S. & Denslow, N.D. 2010. Queen Conch (*Strombus gigas*) Testis Regresses during the Reproductive Season at Nearshore Sites in the Florida Keys. *PLoS ONE*, 5(9): e12737. [online]. [Cited] https://doi.org/10.1371/journal.pone.0012737

Stoner, A.W. 1995. Developmental plasticity in the shell of the queen conch *Strombus gigas*. *Ecology*, 76: 981–994.

Stoner, A.W. 1989a. Winter mass migration of juvenile queen conch *Strombus gigas* and their influence on the benthic environment. *Mar. Ecol.: Prog. Ser.*, 56: 99–104.

Stoner, A.W. 1989b. Density dependent growth and grazing effects of the juvenile Queen conch *Strombus gigas* L. in a tropical seagrass meadow. J. Exp. *Mar. Biol. Ecol.*, 130: 119–133.

Stoner, A.W. & Sandt, V.J. 1992. Population structure, seasonal movements and feeding of queen conch, *Strombus gigas*, in deep water habitats of the Bahamas. *Bull. Mar. Sci.,* 51: 287–300.

Stoner, A.W. & Ray-Culp, M. 2000. Evidence for Allee effects in an overharvested marine gastropod: density dependent mating and egg production. *Mar. Ecol.: Prog. Ser*., 202: 297–302.

Stoner, A.W., Sandt, V.J. & Boidron-Metairon, I.F. 1992. Seasonality in reproductive activity and larval abundance of queen conch. *Fish. Bull.*, 90: 161–170.

Stoner, A.W. & Schwarte, K.C. 1994. Queen conch, *Strombus gigas*, reproductive stocks in the central Bahamas: distribution and probable sources. *Fish. Bull*., 92: 171–179.

Stoner, A.W., Glazer, R.A. & Barile, P.J. 1996. Larval supply to queen conch nurseries: relationships with recruitment process and population size in Florida and the Bahamas. *J. Shellfish Res.*, 15(2): 407–420.

Stoner, A.W., Mehta, N. & Lee, T.N. 1997. Recruitment of Strombus veligers to the Florida Keys reef tract: relation to hydrographic events. *J. Shellfish Res.*, 16: 1–6.

Stoner, A.W., Davis, M. & Booker, C. 2009. Queen Conch Stock Assessment Proposed MPA and Fishing Grounds Berry Islands, Bahamas. Bahamas, Community Conch.

Stoner, A.W. & Davis, M. 2010. *Queen Conch Stock Assessment: Historical Fishing Grounds, Andros Island, Bahamas*. [Cited 1 October 2012]. www.communityconch.org/wpcontent/uploads/2010/10/AndrosReport.pdf.

Stoner, A.W., Davis, M. & C. Booker. 2011. *Surveys of queen conch populations and reproductive biology at Lee Stocking Island and the Exuma Cays Land and Sea Park, the Bahamas*. Bahamas, Community Conch.

Stoner, A.W., Mueller, K.W., Brown-Petersen, N.J. Davis, M.H.& Booker, C.J. 2012. Maturation and age in queen conch *Strombus gigas*: Urgent need for changes in harvest criteria. *Fisheries Research*, 131–133: 76–84.

Tello-Cetina, J.A. Rodríguez-Gil, L.A., & Rodríguez-Romero, F. 2005. Population genetics of the pink snail *Strombus gigas* in the Yucatan Peninsula: Implications for its management and fisheries. *Ciencias Marinas*, 31(2): 379–386.

Theile, S. 2003. *Progress on the implementation of the Review of Significant Trade (phases IV and V). Report to the nineteenth meeting of the CITES Animals Committee*. AC19 Doc. 8.3. (unpublished).

Theile, S. 2005. Status of the queen conch, *Strombus gigas* stocks, management and trade in the Caribbean: A CITES review. Proc. Annu. Gulf Caribb. *Fish. Inst*., 56: 675–694.

Torres-Rosado, Z.A. 1987. *Distribution of two mesogastropods, the queen conch, Strombus gigas (Linnaeus), and the milk conch, Strombus costatus (Gmelin), in La Parguera, Lajas, Puerto Rico*. Universidad de Puerto Rico. (MSc Thesis)

APPENDIX 1: Glossary

Anthropogenic impact: Human impact on the environment, or anthropogenic impact on the environment, includes impacts on biophysical environments, biodiversity, and other resources. The term anthropogenic designates an effect or object resulting from human activity.

Assortative mating: A mating pattern in which individuals with similar genotypes and/or phenotypes mate with one another more frequently than would be expected, in a random mating pattern.

Ecosystem approach to fisheries: The purpose of the EAF is to plan, develop and manage fisheries in a manner that addresses the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by marine ecosystems (FAO, 2005).

Enforcement: Personnel and mechanism(s) available to ensure the compliance with fishery regulations. It involves a broad suite of stakeholders, including administrative personnel, the judiciary and the armed forces.

Fisheries management: The integrated process of information gathering, analysis, planning, consultation, decision-making, resource allocation, formulation and implementation, followed by the enforcement of rules that govern all fisheries activities in order to ensure the continued productivity of the resources (FAO, 2002).

Fisheries co-management: A management arrangement whereby government and user groups share responsibility for the management and utilization of fisheries resources, with the goal of achieving a balance between economic and social goals, within the framework of preserving the ecosystem and fisheries resources (Sen and Nielsen, 1996).

Fore reefs: The fore reef is the area from the seaward edge of the reef crest downwards (slope = lower than 45 °). The fore reef acts to dissipate the tremendous force of constant waves and stabilizes the reef structure; it also drains debris and sediment off the reef and into deeper water (SEOS Project,).

Harvest control rules: A predefined set of rules used to set the exploitation rate as a function of important considerations, such as current stock size, and to reduce the chance of a resource being overfished. Controls usually include some limit on fishing effort or, at the very least, controls on fishing capacity (Medley, 2008).

Harvest strategy: Management actions needed to achieve biological or economic objectives for a single stock or group of stocks. These include the use of control rules that regulate the level of fishing activity, monitoring and assessment procedures to inform both the setting and progress of the harvest strategy objectives.

IUU fishing: Illegal, Unreported and Unregulated fishing conducted within areas under national jurisdiction or on the high seas, which poses a direct and significant threat to effective conservation, the management of exploited stocks, and undermines

their economic and social benefits. IUU fishing tends to promote further IUU fishing, creating a downward cycle of management failure (FAO, 2002).

Legal acquisition: The conclusion that a specimen was obtained in accordance with the laws and regulations of the country of origin. It is part of the respective NDF by the scientific authority, and the export permit/certificate extended by the country's CITES Management Authority, and needed for all CITES-approved exports.

Monitoring system: The effective supervision of fishing activities and the collection, measurement and analysis of data on fishing-related activities – including, but not limited to: catch volumes, species composition, fishing effort, bycatch, gears, discards, area of operations, etc.

Non-detriment findings: The conclusion that an export will not be detrimental to the survival of the species. The NDF are established by the CITES scientific authority of the exporting state and approved by the national administrative authority. An export permit based on an approved NDF is necessary for all exports of species listed under CITES Appendix II.

Precautionary principle: A set of agreed cost-effective measures and actions, including future courses of action, which ensures prudent foresight and reduces or avoids risk to the resources, the environment and the people to the extent possible. The principle explicitly takes into account existing uncertainties and the potential consequences of being wrong. The Fishery Manager's Guidebook issued by FAO in 2009 advises that the precautionary approach or principle should be applied when ecosystem resilience and human impact (including reversibility) are difficult to forecast, and hard to distinguish from natural changes. The precautionary principle suggests that when an action risks harm, it should not be proceeded with until it can be scientifically proven to be safe.

Queen conch: Large marine gastropod of the Strombidae family with the scientific name *Strombus gigas*. Current suggested synonyms for *Strombus gigas* include Lobatus gigas and *Eustrombus gigas*. The resolution of these nomenclature issues awaits more detailed study.

Queen conch survey: A field survey for the direct observation and quantification of a queen conch population in nature, which can be performed by divers or underwater video camera systems. It allows for an estimation of queen conch morphometrics, as well as an estimation of the relative abundance, densities, and size/age structure of queen conch. Queen conch survey data make the determination of a queen conch biomass and total allowable catch quotas possible, following the pre-defined criteria required for sustainability purposes.

Reference points: Management-oriented thresholds based on the biological or economic characteristics of the fishery (Caddy and Mahon 1995). The choice and level of these broadly outlines a fishery's management objectives. For example, harvest control rules typically contain thresholds at which allowable fishing levels change abruptly.

Regional: In this document the word "regional" refers to the Wider Caribbean region, which consists of the insular and coastal states and territories that boarder the

Caribbean Sea, the Gulf of Mexico, and the Western Central Atlantic Ocean and that have, have had or potentially could have natural populations of queen conch.

Subregional: This refers to a set of countries, typically contiguous, within the Wider Caribbean Region, selected on the basis of shared criteria; these could be based, on governance for example, or cultural, biological or physical oceanographic characteristics, e.g. Central America, Lesser Antilles.

Surveillance: Involves the regulation and supervision of fishing activities to ensure that national legislation and terms, conditions of access, and management measures are observed. Surveillance is critical to ensure that resources are not overexploited, poaching is minimized and management arrangements are implemented.

Sustainable development: The management and conservation of the natural resource base, as well as the orientation of technological and institutional changes, in such a way as to ensure the continued satisfaction of human needs for present and future generations. Such sustainable development conserves land, water, plants and animals and genetic resources, and is environmentally non-degrading, technologically appropriate, economically viable and socially acceptable.

Sustainable fishing: The rate of harvest that does not result in a decline in the natural population over time due to fishing practices. Sustainability in fisheries combines theoretical concepts of population dynamics – such as maximum sustainable yield or spawning potential ratio – with practical fishery regulations that control fishing effort to avoid overfishing.

Vessel Monitoring System: A satellite-based surveillance system primarily used to monitor the location and movement of commercial fishing vessels.

APPENDIX 2: General information on the biology, ecology and status of queen conch

GENERAL INFORMATION

Queen conch (*Strombus gigas*) is a large gastropod mollusk, endemic to the Caribbean and utilized across its range since pre-Columbian times; it therefore has an important fishery and cultural significance. The Caribbean Sea is a semi-enclosed ocean basin of some 2.6 million km^2, which makes it the second largest sea in the world (Bjorn, 1997; Sheppard, 2000). This area encompasses 26 countries and 45 state entities, and is home to several ethnicities and language groups. This considerable number of nations, and the diversity of people within this enclosed maritime environment – where most of the resources are shared and/or interact in a common ecosystem – requires regional management arrangements to achieve an optimal and sustainable use of available marine resources.

Queen conch goes by many common names, including caracol rosa, caracol rosado, caracol reina, caracol pala, lambi, carrucho, botuto, guarura, cambombia, cambute, queen conch, pink conch and giant conch. This iconic and transboundary species inhabits algal, shallow or deep seagrass plains, sandy rubble or reef habitats, depending on its life history stage. Queen conch is distributed across the Wider Caribbean[1], with Bermuda at the northernmost edge of the species' distribution, Panama at the southwestern and Barbados at the eastern edge (Figure A2.1). Most islands located between these extremes have reported queen conch populations and production.

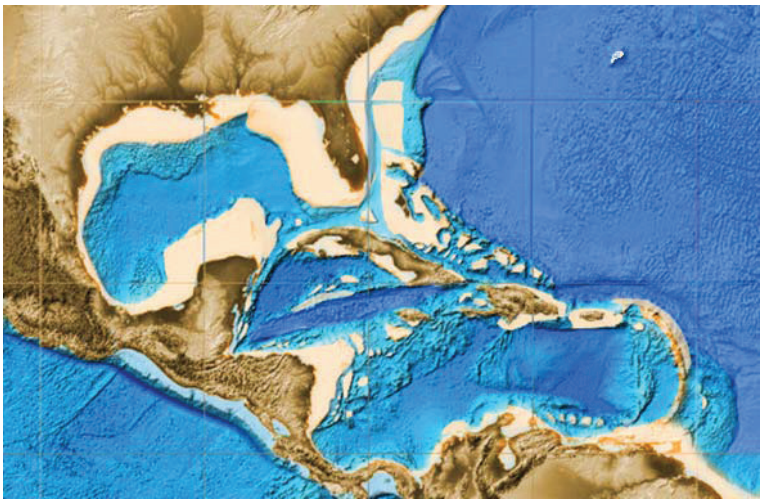
Different queen conch life stages occupy different habitats, which extend over a broad depth spectrum (Figure A2.2). The flow of currents through major cuts in fore-reefs are believed to favour larval retention and deposition in nearshore reef and seagrass habitats (Appeldoorn *et al.*, 2003). Veliger larvae can be found in surface waters, but they approach the sea floor when ready to settle. Early juveniles (usually of the first year class) are found buried in coarse sandy habitats, near to reefs and seagrass beds (Robertson, 1959; Randall, 1964; D'Asaro, 1965; Brownell, 1977; Weil and Laughlin, 1984; Sandt and Stoner, 1992). Extensive fieldwork in Colombia identified the back reef, the adjacent lagoon, and the deeper leeward pre-reef terrace as juvenile nursery habitats (Prada *et al.*, 2009). These structural habitats provide both nutrition and protection from predators (Ray and Stoner, 1995; Stoner and Davis 2010). Adults prefer sandy algal flats, but can also be found on gravel, the hard bottom rubble, rodoliths, smooth hard coral, or beach rock bottoms (Torres-Rosado, 1987; CFMC, 1996a; Acosta, 2001; Stoner and Davis, 2010). When reproducing, queen conch prefer coarse sand substrates (Glazer and Kidney 2004). Older adults can be found in coral and sand-patch habitats, as well as the deeper leeward reefs. Adult queen conch

[1] Anguilla, Antigua and Barbuda, Aruba, the Bahamas, Barbados, Belize, Bermuda, Brazil, British Virgin Islands, Cayman Islands, Colombia, Costa Rica, Cuba, Dominica, the Dominican Republic, Grenada, Guadeloupe, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Bonaire, Sint Eustatius and Saba, Nicaragua, Panama, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago, Turks and Caicos Islands, the United States of America, United States Virgin Islands, Venezuela (Bolivarian Republic of).

specimens are rarely, if ever, found on soft bottoms composed of silt and/or mud, or areas with high coral cover (Acosta, 2006).

In general, queen conch move progressively away from inshore nursery areas towards deeper habitats as they increase in size and age. Nursery areas are usually very shallow (less than 5 metres), while mature and old individuals are found in deeper waters, as far down as mesophotic depths of up to 59 metres (Stoner and Schwarte, 1994; Garcia-Sais *et al.*, 2012; Appeldoorn pers. obs.). It is believed that the species' depth limitations are based mostly on light attenuation, which has a detrimental effect on their photosynthetic food source (Randall, 1964).

FIGURE A2.1
Queen conch distribution in the Wider Caribbean



Highlighted colours illustrate the insular/continental shelves where queen conch is most likely to be found. Based on map from NOAA National Geophysical Data Center. SOFRECO, 2013.(http://maps.ngdc.noaa.gov/viewers/bathymetry/).

FIGURE A2.2
Queen conch habitats through ontogeny

A. Juvenile in dense seagrass habitat; **B.** Juvenile in sparse seagrass habitat; **C.** Juvenile in hard bottom and rubble habitat: **D.** Subadult in coarse sand with invertebrates habitat; **E.** Subadult in medium-sized grain sand and rubble habitat; **F.** Adult in hard bottom habitat; **G.** Adult in sand plain habitat; and **H.** Adult in deep sand channel habitat.

Photo credits: Harvey Robinson, Felipe Cabezas, Heins Bent, Martha Prada, Bárbara Reveles, and Ricardo Morris.

LIFE HISTORY

Queen conch has two life stages: The first is the planktonic stage, comprised of microscopic, free-swimming larvae. The second is the benthic stage, associated with the seafloor (Figure A2.3). The planktonic cycle begins with the hatching of the larvae from a crescent-shaped egg mass laid by adult females. Each egg mass contains between 400 000 and 1.5 millions eggs (Mianmanus, 1988; Davis 1998; Appeldoorn 1997). Egg masses are camouflaged with sand grains to aid survival over the three-to-four-day incubation period. It is estimated that a reproductive female can lay between 7 and 13 egg masses per season. Females can store eggs for several weeks before laying an egg mass, so it is very possible that multiple males have fertilized the same egg mass (Medley, 2008).

The queen conch larvae or veligers emerge three to five days after spawning and develop a velum with multiple lobes, as well as a transparent shell with one and a half whorls (Stoner *et al*., 1992; Davis, 1998). The veligers stay in the plankton stage for approximately 18 to 60 days. They undergo metamorphosis probably as a response to chemical cues exuded from red algae (Mianmanus 1988; Davis et al., 1990; Rodriguez Gil, 1995; Brito *et al*., 2006).

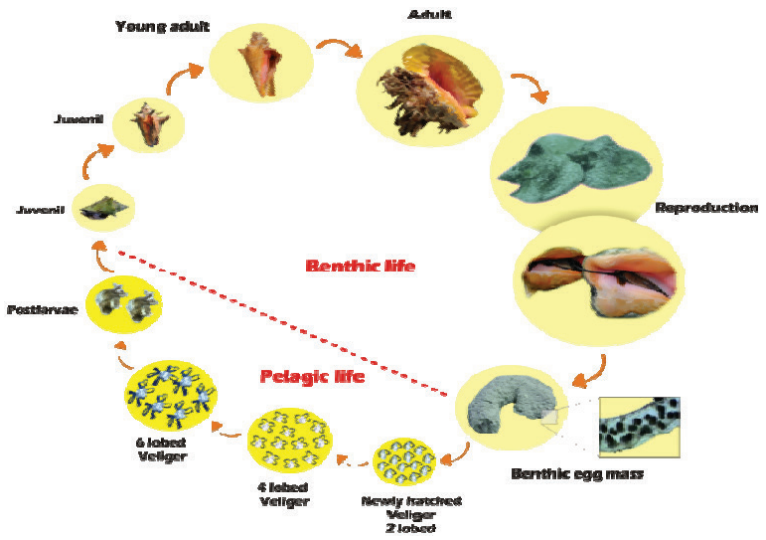
Early juveniles are 3–4 mm siphonal length (SL), usually buried, but sometimes emerging at night to feed. Their shell grows in concert with their body, becoming hard and thick. Queen conch reach sexual maturity at an age of about three and a half to four years (Egan, 1985; Appeldoorn, 1988; Appeldoorn *et al*., 1997; Stoner and Sandt, 1992; de Jesus-Navarrete and Aldana-Aranda, 2000; Stoner *et al*., 2012). At that age, their shell is approximately 22 cm siphonal length (SL), but this size varies greatly and may be dependent on environmental conditions. Recent studies have found that sexual maturity in queen conch does not occur until the shell flared lip thickness reaches 8 mm to 26 mm (Egan, 1985; Ávila-Poveda and Baqueiro-Cárdenas, 2006; Stoner *et al*., 2012).

The length of the shell actually stops increasing at sexual maturity and the spines become blunt and worn, while additional shell deposition is dedicated to augment flared lip thickness (Berg, 1976; Appeldoorn, 1988; de Jesús-Navarrete, 1997). Experimental studies have shown that, for a given shell length, fecundity increases with age – at least until internal shell volume becomes limiting (Appeldoorn, 1997). Similarly, recent studies in the Bahamas indicate that large queen conch have higher reproductive potential than smaller individuals (Stoner *et al.*, 2012). It is believed that conch can live up to 20 years or more.

Shells can vary substantially in size as a result of habitat and geographic nuances. Males and females are distinguished by either a verge or an egg grove, which can be observed once the meat is extracted from the shell. Reproduction occurs during the warmer months (28–29 °C), but exact timing can vary depending on location and annual variations in water temperatures.

Queen conch form reproductive aggregations to spawn, usually in deeper waters (20–45 m) (Frenkiel *et al.*, 2009). However, queen conch reproduction may be greatly affected by low densities as a result of excessive fishing efforts, succumbing to the Allee effect (Odum, 1953). Stoner and Ray-Culp (2000) reported how queen conch reproduction in a Bahamian population was negligible at densities below 50 adults/ha. The relationship of density to probability of successful mating varies in different locations and depends on the level of fishing pressure, as well as how density is measured. A density value of 100 adults/ha within the mating area has been recommended as a minimum reference value to enforce the precautionary principle for successful reproduction, following a recommendation from the Queen Conch Expert Workshop, held in May 2012 in Miami, Florida. Table 3 in the main text of the document shows queen conch densities estimates, where available.

FIGURE A2.3
Queen conch life cycle



Source: SOFRECO 2013.

Queen conch movements between different habitats appear to be associated with reproduction. Initial studies have shown that queen conch migrate from deeper to shallower depths to spawn (Laughlin and Weil 1984; Coulston *et al*., 1987). This migration may be a response to water temperatures, but another and perhaps more important factor may be the distribution of feeding and spawning habitats. Thus, Stoner and Sandt (1992) reported that in the deeper water population in front of Lee Stocking Island in the Bahamas, queen conch moved from a hard bottom mound in the winter to a nearby sand plain during the reproductive season. The sand plain had little algal growth to support feeding and even during the reproductive season queen conch moved back and forth between the sand plain and the hard bottom habitat. Similarly, in Florida, the United States of America, Glazer and Kidney (2004) found that queen conch at two sites moved little, but occupied distinctly different areas during the reproductive (coarse sand) versus the non-reproductive (rubble) seasons. Movement to deeper water during the latter season seemed to be blocked by seagrass habitats, which the queen conch seemed to avoid. It appears that fishing intensity can modify movement patterns.

The annual reproductive cycle of *Strombus gigas* can be variable in space and time across the Wider Caribbean, with temperature being an important factor controlling gametogenesis (Aldana *et al*., 2014). In warmer years, actual spawning can occur year round, while in other years it can be rather seasonal (e.g. Randall 1964; Laughlin and Weil, 1984; Stoner *et al*., 1992; Appeldoorn, 1997). Most areas show a marked seasonal peak during the warmest months, usually from July to September (Aldana *et al.*, 2014). With recent temperature increases, it has been suggested that peak spawning may be shifting or expanding into October (Appeldoorn *et al.*, 2011). Queen conch have been known to refrain from spawning when environmental conditions are not favourable (McCarthy *et al*., 2002), and very high density can reduce overall fecundity (Appeldoorn, 1997).

Growth rates and morphologies vary depending on age class, sex, available food, depth, latitude and shelter. In heavily fished sites, large queen conch disappear rapidly leading to the dominance of smaller individuals, thereby influencing the overall growth pattern of the population (Borrell, 2013). Very old adults are characterized by eroded spines, a very thick and eroded flared lip, darker meat and a shell covered with sessile invertebrates. These queen conch are usually found in deeper waters. Queen conch

of different morphology are often given different names by fishers (Figure A2.4). For example, the very old, large queen conch on Pedro Bank, Jamaica, are called stoned conch. However, very old and small adults are commonly known as samba conch in such places as Belize and the Bahamas.

Variations in queen conch growth can be attributed either to genetics (heritable traits) or phenotypic factors (physiologic response to local conditions). Currently, there is no consensus in terms of the proportion that each factor influences queen conch growth at the population level. Patchy larval settlement may lead to distinct genetic populations, but environmental conditions in different areas are also associated with significant variations in growth and morphology. Therefore, sustainable regional fisheries management will need to incorporate the complex biological, spatial and fisheries characteristics of queen conch to some degree.

The growth of queen conch has also been shown to be density dependent. As the density of queen conch in a given area increases, the growth rate decreases. Queen conch at high densities have been found to have low gut fullness indices and a generally low overall condition (Stoner, 1989b). It is also possible that even small-sized stocks living in shallow and unconsolidated substratum are affected by its potentially lower food concentrations or by competition in cases of high-density queen conch populations (Alcolado, 1976).

Other evidence from Florida, the United States of America, suggests that the male gonads can regress during the reproductive season in nearshore habitats in response to poor water quality, contributing to reproductive failure in those environments. This regression occurs under elevated concentrations of copper and zinc in queen conch tissue and suggests that these metals may be a causative factor in reproductive failure in nearshore queen conch in the Florida Keys (Spade *et al.*, 2010). It is important to note that site-specific differences in metal concentrations and gene expression surely exist.

The effects from major hurricanes can affect the queen conch population in an area, although research on this matter is still sparse. For instance, in the Turks and Caicos Islands, two major hurricanes, Hanna and Ike, struck in September 2008 and caused biological and economical affectation in various fisheries, including queen conch production. The subsequent queen conch production was less than half its normal value (CRFM, 2010) and was largely attributed to habitat degradation.

Increases in ocean acidification from climate change may also impact on queen conch, as this adversely affects the chemical production of calcium carbonate during shell formation, which will result in a less dense and thus weaker shell (Doney, 2006). The solubility of the calcium carbonate (99 percent of the queen conch shell) is increased by acidic pH, and thus the shell becomes more susceptible to dilution by other materials under acidification (Doney, 2006; Kamat *et al.*, 2000). Climate change can also alter the rate and condition of larval dispersal by affecting seasonal current patterns (Liu *et al.*, 2012).

Queen conch's long-lived larvae dispersed by surface oceanic currents appear to have the potential for an extensive gene flow throughout the Caribbean region. However, recent studies using allozymes have revealed quite the opposite, showing isolated genetic structures for queen conch populations either at isolated sites or at the micro-scale in Bermuda, the Alacranes reef in the Yucatán Peninsula, Gros Islet and Vieux Fort in Saint Lucia, Turks and Caicos Islands, Saint Kitts and Nevis, and Saint Vincent and the Grenadines (Mitton *et al.*, 1989; Campton *et al.*, 1992; Tello-Cetina *et al.*, 2005). Using microsatellite techniques, Marquez *et al.* (2013) found four genetic stocks reflecting heterogeneous spatial mosaics of marine dispersion between the San Andres archipelago and the Colombian coastal areas, an area with strong oceanic currents and permanent eddies (Richardson, 2005). Queen conch exhibited an overall deficit of heterozygosity, which was related to assortative mating or inbreeding,

FIGURE A2.4
Variability in queen conch growth and morphology

Typical growth morphometry

Variation in the growth morphometry

Photo credits: Leonardo Arango and Nelson Ehrhardt

leading to a potential loss in genetic variation, particularly in those banks with the lowest queen conch population densities (Marquez *et al.*, 2013).

Geographic isolation combined with limited larval recruitment may contribute to the lack of recovery in some areas such as Bermuda, where queen conch are at the limit of their distribution, or Florida, the United States of America, which receives only occasional influxes of larvae via the Florida Current. The small spawning stock in Florida is not thought to be able to produce the amount of late-stage larvae required in these times (Stoner *et al.*, 1996; Hawtof *et al.*, 1998). It is believed that queen conch larvae from Belize, Mexico and Honduras are the upstream sources of queen conch located in Florida (Stoner *et al.*, 1997). Under this scenario, locally produced larvae would significantly contribute to the stability of the queen conch population (Delgado *et al.*, 2008; Glazer and Delgado, 2012).

In summary, more than two decades of research have indicated that shell length and flared lip thickness are two useful measurements to discriminate adult from juvenile queen conch and as a means to calculate growth. Observations of growth rates, juvenile-to-adult ratios, as well as reproductive activity – especially in relation to adult specimen per hectare densities – form the biological basis for making scientific recommendations towards the sustainable harvest of queen conch. Unfortunately, populations in heavily fished areas do not always meet conditions necessary for reproduction and sustainability (i.e. densities in many sites are currently below 100 adults/ha) (Appeldoorn, 1994; Clerveaux *et al.*, 2003; Stoner *et al.*, 2012; Cala *et al.*, 2012; Aldana *et al.*, 2014).

ECOLOGICAL ROLE AND POPULATION STATUS

Queen conch is categorized as a specialist, being primarily an algal/detritus feeder as an adult; in large numbers it can therefore, have a major influence upon benthic productivity processes (Stoner, 1989a, b). For example, young individuals feed on seagrass remains, seagrass epiphytes and macroalgae, which may influence the composition of seagrass beds (Randall, 1964; Stoner *et al.*, 1995).

When they are an abundant species, queen conch play an important role in shallow marine trophic dynamics as they form part of the regular diet of an array of predators, such as the true tulip snail (*Fasciolaria tulipa*), apple murex (*Murex pomun* or *Phyllonotus pomum*), and other carnivorous species like octopus (*Octupus* spp), spiny lobster (*Panulirus* spp), queen triggerfish (Balistes vetula), spotted eagle ray (Aerobatus narinari), tiger shark (*Galeocerdo cuviei*), nurse shark (*Ginglymostoma cirratum*) and Atlantic loggerhead turtle (*Caretta caretta*) (Jory and Iversen, 1983; Iversen *et al.*, 1986; Cervigón *et al.*, 1992).

The status of many stocks within the region is unknown or at least highly uncertain (MRAG, 2013). There are gaps in the estimation of queen conch densities in environments less than 25 m deep, where they can be monitored relatively easily. There is extremely limited information from deeper habitats, where the major part of the queen conch fishing currently takes place, mainly because of the difficulty and associated costs of sampling in these environments. Stock assessments often rely on population abundance estimates from fisheries-dependent data, which are also uncertain because of gaps in catch and effort data across the Wider Caribbean.

In countries such as Belize, Honduras, Nicaragua, Colombia and Cuba, queen conch populations are considered either stable or increasing, a status which has mainly been attributed to a combination of highly regulated management frameworks and/or the inclusion of additional conservation approaches, such as the establishment of marine protected areas and the expansion of fishing activity into new (further or deeper) grounds.

Theile's (2003, 2005) Queen Conch Significant Trade Review mentions that the stock should be considered depleted in several countries. In the absence of reliable estimates of the status of the queen conch populations, sound regional fisheries management should take into account the precautionary approach and be adaptive, both important criteria within an ecosystem-based management system.

According to Appeldoorn *et al*., (2011), applying an ecosystem-based approach to management necessitates measures based on the biology and ecology of queen conch. The most important of these characteristics is density, which is closely tied to reproductive potential, while other important characteristics include nursery areas, larval dispersal and population connectivity, habitat quality and anthropogenic impacts, as well as the particular vulnerability of queen conch to exploitation. In effect, the ecosystem-based approach recommends that queen conch management plans incorporate the following aspects: protection of nearshore habitats, juveniles and spawning adults; establishment of marine reserves in juvenile and adult specimen habitats; routine monitoring of the intensity and spatial distribution of the fishing activity, and, last but not least, the density and spatial distribution of queen conch populations.

Its biological vulnerability to overexploitation combined with the high international demand for queen conch products set the basis for the inclusion of this species in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).This Appendix strives to promote the conservation and sound management of listed species. CITES Appendix II includes species that are not necessarily threatened with extinction currently, but may become so unless trade is closely controlled. International trade in products of specimens of Appendix II-listed species may be authorized by the granting of an export permit or re-export certificate. Queen conch has been listed in Appendix II of CITES since 1992, but the majority of countries did not become party to the Convention until years after that. Compliance with the CITES listing provisions has generally been good, although some countries have been quicker to respond than others (MRAG, 2013).

In support of the CITES conservation approach, and considering the queen conch's relevant role in the marine environment, the species has been listed in Appendix III of the Specially Protected Areas and Wildlife (SPAW) protocol (2000) of the Cartagena Convention. The SPAW protocol allows harvesting of listed species but encourages Member States to:

> "adopt appropriate measures to ensure the protection and recovery of the species ….. and regulate [their] use … in order to ensure and maintain the populations at the highest possible levels" (UNEP 1990, Art. 11 (1c)).

APPENDIX 3: Summary of the Regional Queen Conch Fisheries Management and Conservation Plan: Measures

These fourteen management measures were considered the main measures for regional level intervention or harmonization, proposed by experts participating at the Second Meeting of the WECAFC/CFMC/OSPESCA/CRFM Working Group, held in Panama from 18 to 20 November 2014.

I. RECOMMENDED SHORT-TERM MANAGEMENT MEASURES

1. Harmonized and simplified categories of queen conch meat conversion factors

Justification: Because they represent meaningful biological and socio-economic phenomena and are usually more available than other forms of data, catch rates serve as the backbone of nearly every model used to assess fish stocks. However, even these data are typically incomplete and require estimations. In the queen conch fishery, the main commodity is the meat fillet or muscular foot of the gastropod. Though this preparation sounds standard, different fishing communities and processors have different levels of product presentation and efficiency in their cleaning methods. Differences in the processing of queen conch meat affect the estimation of its catch data in terms of overall yield and numbers of individuals. Therefore, uniform conversion factors need to be determined and applied to catch data so that: (1) More accurate and precise landing estimates can be generated, and (2) These can be compared across the region. Conversion factors exist only in some countries (Antigua and Barbuda, the Bahamas, Belize, the Dominican Republic, Jamaica, Honduras, Martinique, Mexico and Nicaragua), but they are necessary for all countries. A better and simplified definition of such factors, allowing for their use in the catch statistics and stock assessments, still needs to be addressed.

Implementation advice: All countries and territories should report their queen conch landings and imports/exports utilizing standardized definitions and stating the applied conversion factors. If available at the national level, those factors are preferable. In absence of national conversion factors, data should be expressed utilizing regional conversion factors which have been agreed upon. FAO has proposed the following regional conversion factors:

Processing grade	Processing definition	Conversion factor
Dirty meat	Animal without the shell	5.3
50% clean	Removal of the operculum (claw) and the visceral bag.	7.9
100% clean	Only the white meat remains	13.2

Countries should continue to collect weight data by processing grades to update and improve the proposed conversion factors.

2. Improvement of catch and effort monitoring programmes

Justification: Queen conch catch data are often poor or incomplete. In some cases electronic data are not organized with statistical rigour and/or represent only short time periods. In other cases, data only exist on paper and have not been converted to an electronic format. In some countries, processors provide reports with catch and effort information based on their purchases (e.g. Honduras, the Bahamas, Jamaica and Colombia). Even in these countries, local consumption is often not included in the catch statistics. Fishing effort is another key variable, particularly because most models use catch per unit effort as a measure of abundance. Effort is estimated with an even higher level of error than catch. The number of fishers increases regularly, but this information is not necessarily recorded or analysed in assessments. Additionally, the efficiency of effort often changes over time, which can make it difficult to interpret catch per unit effort data. For example, fishing efficiency is affected by changes in fishing techniques (often with increasing efficiency from learning), and fishing locations if these are not recorded and accounted for (vessels can maintain high catch per unit effort while sequentially depleting fishing grounds if they move to new grounds when previous ones are exhausted). To overcome such difficulties, managers will need to increase compliance among fishers and processors to be able to improve the way catch and effort data are being reported. A good example comes from the Bahamas, where processing facilities electronically report to the Department of Marine Resources the catch and effort of purchased landings, hopefully leading to more timely, complete and accurate reports. However, even these data have not been evaluated yet.

Implementation advice: Agree to form a regional advisory group that will carefully analyse catch and effort databases existing at subregional levels and propose strategies and applications for the improvement of data collection and processing, including optimizing possibilities for collaborative work and increasing compliance for reporting. Resulting strategies may need to include: (1) design of more effectively structured queen conch survey formats; (2) improving mechanisms to facilitate and increase fishers' reporting; (3) compiling, organizing and digitizing historical queen conch fishery data from analogue formats; (4) applying conversion factors and determining the degree of queen conch products used for local consumption; (5) interviewing experienced fishers and recreating a history of changes in typical fishing techniques and the likely effects on the efficiency of fishing effort; and (6) work on improving existing digital databases at the national and subregional level.

3. A synchronized regional closed season (1 June to 30 September)

Justification: Queen conch can potentially reproduce all year round, but high water temperature (28-29 °C) is associated with peaks in queen conch reproduction and gametogenesis. In general, the warmest months in the Caribbean are July through September, but due to recent water temperature increases, presumably as a consequence of global climate change, these warmer water temperatures – and thus peak spawning – may extend into October. A positive relationship between higher water temperature and reproduction is common in many fishable species, thus the establishment of a queen conch closed season may overlap with other stocks, negatively affecting fishers' income. A harmonized regional closed season would help reduce overall fishing mortality and contribute to the success of queen conch mating and spawning, thus supporting reproduction and population replenishment, while at the same time facilitating the monitoring and patrolling needed to counteract illegal fishing. Although most countries have a closed season at some time during the calendar

year, the maximum benefit of this approach is only achieved if the temporal limitation in fishing effort is exercised equally over broad areas, thus allowing for population resilience and connectivity.

Implementation advice: The adoption of a closed season at a regional or subregional level can be developed through existing mechanisms like CRFM, CFMC, OSPESCA, OLDEPESCA and WECAFC. It can be adjusted in response to variability in spatial/temporal patterns, once monitoring data become available. Special protocols should be in place in order to enforce this regulation. Fisheries managers can facilitate compliance through better communication and education within the communities and beyond. Biological studies on spawning season in the western central Caribbean, i.e. Cuba, Haiti and the Cayman Islands, provide a good indication of when queen conch are congregating to spawn and, therefore, most vulnerable to overfishing. Enforcement will be vastly improved if trading of queen conch during the closed season is limited to validated inventories (all kind of fishers, processors and traders), following the OSPESCA Resolution OSP 02 09. This regulation can be extended across the Wider Caribbean.

4. Non-Detriment Finding (NDF) for export of queen conch meat and its by-products

Justification: Any country wanting to export queen conch in any form, is required under CITES (in accordance with Article IV) to prepare and update an NDF, demonstrating that the level of export will not be detrimental to the queen conch stocks of the country concerned and that the product is obtained in accordance with the prevailing laws of that country. Thus, in order to export queen conch, a country must develop and demonstrate sustainable management and ongoing monitoring of the stock.

Implementation advice: It is recommended that the queen conch range states in the region develop mutually agreed, standardized NDF guidelines to be considered as a minimum standard for complying with the export NDF requirement. A proposal for NDF guidelines was presented and supported by the Regional Queen Conch Group in the 2014 meeting.

5. Licensing of all queen conch fishers, processors and exporters

Justification: Only through national licensing will it be possible for managers to get an idea of the number of people involved in the fishery and ensure their compliance with reporting and management measures to further proper management and conservation of the resource. In this manner, licensing will support efforts for data and information collection and enforcement. It will also allow the fisheries authorities to communicate management measures to the fishers more effectively. In the fight against illegal, unreported an unregulated (IUU) fishing, the use of licences is essential in identifying legal versus illegal fishing activities.

Implementation advice: Information on national licensing programmes should be shared at the regional level to promote queen conch conservation. This information should be in a format acceptable to all countries.

6. Adoption of stricter regulations on autonomous diving techniques

Justification: Diving for queen conch has implications for the safety of fishers. Data from Honduras report that the country has 19–25 accidents per annum in the queen conch fishery. There is ample anecdotal evidence of an even greater number of diving-

related accidents in the region. Lack of training, improper equipment, poor maintenance and work under strenuous physiological conditions all contribute to these accidents.

Implementation advice: Several measures are proposed: a) require dive certification and training (oxygen provider, emergency first response, etc.) for all queen conch fishers as a condition for licensing; b) require training in diving equipment and maintenance; c) require annual equipment safety inspections of queen conch fishers who scuba dive; d) display a dive flag on the dive site; and e) require scuba divers to dive with a buddy.

7. Organized patrolling

Justification: As with any open water marine fisheries, the enormous size of the maritime space of the region represents a challenge. IUU fishing is a serious problem and regional cooperation in coordinated patrolling is greatly needed, all the more because many countries in the region lack the resources to enforce their maritime space.

Implementation advice: To address this issue, bilateral and multilateral agreements should be put in place between range states, possibly by subregion. This protocol should include, inter alia, linkages between enforcement/coast-guard, customs, fisheries and port authorities, and relevant fisherfolk groups. .

8. Extended use of satellite-based VMS systems for boats with a length exceeding 10 metres.

Justification: Caribbean fisheries are increasingly relying on satellite-based vessel monitoring systems (VMS), because the technology facilitates rescue responses to emergencies at sea and the identification of potential illegal fishing activities, while at the same time providing data to analyse a fishery's spatial/temporal patterns. However, the technology is expensive (although costs are coming down rapidly) and demands technical assistance. At the same time, regional coordination is a requisite to be effective in terms of exchange of this information which has to be compatible and as such may require certain adjustments in the way the data are obtained and processed.

Implementation advice: Queen conch range states should implement a satellite-based VMS system for fisheries management. The region should explore ways to integrate these systems. Development and implementation of satellite-based VMS systems should be linked to MCS (Monitoring, Control & Surveillance).

9. Continuous education and outreach programmes for stakeholders.

Justification: Despite the cultural and economic importance of the queen conch fishery, there are few and isolated activities being developed to increase public awareness about it, and the related environmental and conservation issues around marine resources in general. As a result, progress in fisheries management, compliance and implementation of co-management strategies remains low.

Implementation advice: Develop education and outreach programmes which aim to: a) convince decision-makers of the importance of data collection, scientific analysis, research, training, and capacity building to manage a shared living marine resource; b) explain to inspectors/enumerators the purpose and use of the data collected and why they need to be accurate; c) increase awareness among fishers and processors of the queen conch ecology, its role in the ecosystem and the impact of fishing, as well as the market demand for the sustainability of the stock; and d) teach school children and the general public about the need for environmental protection and conservation of marine resources.

II. RECOMMENDED MIDDLE-TERM MANAGEMENT MEASURES

10. National level queen conch conservation and management plans

Justification: In order to effectively implement this Regional Queen Conch Fisheries Management and Conservation Plan, fisheries authorities, queen conch fishers and other relevant stakeholders must develop national plans for ministerial endorsement, as well as related regulations that will enable the implementation and enforcement of the Plan.

Implementation advice: National plans are required to guide queen conch fisheries towards sustainability, to generate findings for certain measures and to communicate joint goals, measures and efforts to all stakeholders in the sector. The use of an Ecosystem Approach to Fisheries is essential to create buy-in and ownership for the Plan and ensure implementation after the planning phase. National management plans will follow guidelines given in the Regional Queen Conch Fisheries Management and Conservation Plan.

11. Traceability of queen conch throughout the value chain

Justification: Export markets and consumers increasingly demand traceability of food products throughout the supply chain. Moreover, traceability (including catch certification) plays an important role in the joint efforts to reduce IUU fishing of queen conch. While traceability is often considered extra work and a hassle by primary producers, it is already required by export markets and is increasingly demanded by the tourist industry (domestically and across the Caribbean). Traceability has the advantage that legal and illegal fishing practices can be distinguished, and it allows legally harvested products to fetch higher prices. In contrast, the market opportunities for illegal queen conch products will be reduced. Traceability provides additional benefits in terms of supporting hygienic handling of the product, quality and food safety. Introduction of standard catch certification forms is preferred, to facilitate trade in queen conch as well as other marine species. The adoption of the EU catch certificate format, as presented in Appendix II of EC REGULATION 1005/2008 "To Prevent, Deter And Eliminate Illegal, Unreported And Unregulated (IUU) Fishing", would facilitate trade and traceability using a best-practice approach.

Implementation advice: Agree to develop a traceability system following existing international guidelines and protocols, such as the application of the EC catch certification, which is already being used by various countries.

12. Develop collaborative arrangements needed to generate habitat maps at the scale needed for better fisheries management

Justification: Few queen conch fishing grounds have had their habitats or bathymetry mapped to a useful scale. Development of these kinds of maps demands special resources, technology and funding. The lack of proper maps has limited the consideration and application of spatially defined fisheries management measures. Mapping efforts should begin at the national level and can be scaled through regional cooperation mechanisms.

Implementation advice: Work collaboratively to join human, technical and financial resources that result in better habitat mapping, including studies of deeper water areas where most queen conch fishing is currently taken place.

13. Adoption of subregional mechanisms to evaluate the fishery potential of queen conch using fishery dependent and independent factors

Justification: Determining reliable indices of stock abundance is challenging for queen conch because of the complex biology of the species, including highly variable rates of growth, natural mortality and recruitment, which may be density and habitat-dependent. Progress can be made through regionally defined priorities in research and monitoring, time series data for more sophisticated stock assessments, and further studies of the species' role in the ecosystem, climate change effects, genetic connectivity and other issues related to an ecosystem-based management approach. Better biological and ecological data is a prerequisite for more informative stock assessment models.

Examples of these mechanisms are the development of underwater visual censuses as a way to estimate queen conch densities and size distributions, and ultimately to estimate population abundance and biomass for the determination of sustainably harvestable biomass. Surveys also provide a way to study queen conch demography and reproductive output between fished and unexploited sites, even if fishery-dependent data are available. At present, several countries rely on surveys to define their catch quotas (Jamaica, Belize, Honduras, Nicaragua and Colombia). However, different countries apply different survey methods. The most effective surveys rely on habitat maps, nautical charts, trained divers, safe diving protocols and proper working platforms. Towed underwater video systems allow for rapid coverage in the field but require additional time for post-processing. Regardless of the methodological details, surveys need to be designed using a sound statistical basis for both data collection and analysis, and thus require statistical expertise. Sampling of deeper habitats (30–50 m) may require special underwater video systems or specialized diving techniques. Surveys necessitate training and sufficient funding so that they can be repeated at periodic intervals.

Implementation advice: Agree to create a regional advisory group under the Queen Conch Working Group to analyse existing survey protocols and adopt the most convenient subregional efforts. Look for mechanisms for international cooperation in conducting queen conch surveys, including the formation of teams integrated by scientists, managers and fishers. This group can advise on the selection of priorities in research and monitoring subregionally, enhancing the collaborative mechanisms already in place.

III. RECOMMENDED LONG-TERM MANAGEMENT MEASURES

14. Progressive inclusion of co-management strategies

Justification: Decisions regarding fisheries in general, and the queen conch fishery in particular, are being taken by high-level government officials, often with insufficient involvement from stakeholders. Fishers understand problems in the fishery and are usually eager to express their concerns and recommendations. However, these inputs can go unheard as a result of the low levels of fishers' organization and empowerment. Fisheries co-management in the Caribbean largely remains at the pre-implementation phase.

Implementation advice: Agree to define a proper legal framework for the promotion of co-management in fisheries and work with the local communities to increase their willingness to participate.

APPENDIX 4: TABLE OF WIDER CARIBBEAN COUNTRIES WITH QUEEN CONCH FISHERIES AND RESPECTIVE REGIONAL AND SUBREGIONAL ORGANIZATIONS THEY HAVE ASCRIBED TO

Regional Organization	Country / Territory
WECAFC / CRFM / OECS	Antigua and Barbuda
WECAFC / CRFM	Bahamas
WECAFC / CRFM / OECS	Barbados
WECAFC / CRFM / OSPESCA / OLDEPESCA	Belize
WECAFC / CARICOM	Cayman Islands
WECAFC /OLDEPESCA	Colombia
WECAFC /OLDEPESCA	Cuba
WECAFC / CRFM / OSPESCA	Dominican Republic
WECAFC /	France (Martinique)
WECAFC /	France (Guadeloupe)
WECAFC / CRFM / OECS	Grenada
WECAFC / OSPESCA	Guatemala
WECAFC / CRFM	Haiti
WECAFC / OSPESCA / OLDEPESCA	Honduras
WECAFC / CRFM	Jamaica
WECAFC / OSPESCA / OLDEPESCA	Nicaragua
WECAFC / CARICOM	Turks and Caicos Islands
WECAFC / CRFM / OECS	Saint Kitts and Nevis
WECAFC / CRFM / OECS	Saint Lucia
WECAFC / CRFM / OECS	Saint Vincent and The Grenadines
WECAFC / CFMC	US Puerto Rico
WECAFC / CFMC	US Virgin Islands

The overall objective of this 10-year Regional Queen Conch Fishery Management and Conservation Plan is to guide the implementation of a set of identified management measures that can be applied at the regional or sub-regional level for the sustainability of queen conch populations and for the maintenance of a healthy fishery and livelihood of the people involved in the fishery. The ecosystem approach forms the basis of this Regional Queen Conch Fishery Management and Conservation Plan, enhancing partnerships and collaboration throughout the Wider Caribbean region to improve the long-term governance of queen conch fisheries across the This regional plan has been adopted by the 16th session of WECAFC, Guadeloupe, France, 20–24 June 2016, and the 17th meeting of the Conference of the Parties to CITES, Johannesburg, South Africa, 24 September – 5 October 2016.

ISBN 978-92-5-109931-5 ISSN 2070-7010

9 789251 099315

I7818EN/1/09.17