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WESTERN CENTRAL ATLANTIC FISHERY COMMISSION (WECAFC)

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Review of the Biological Data, the Stocks Spatial Distribution and the Ecological Connectivity between the Areas Beyond National Jurisdiction and the Exclusive Economic Zones in the WECAFC region

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Acronyms and abbreviations

ABJN Area Beyond National Jurisdiction

AntC Antilles Current

ASFIS Aquatic Sciences and Fisheries Information System

B_{MSY} Spawning stock biomass (SSB) that results from fishing at FMSY for a long time

BRD Bycatch Reduction Device

CaribC Caribbean Current

CARICOM Caribbean Community

CFMC Caribbean Fishery Management Council

CI Confidence Interval

CITES Convention on International Trade in Endangered Species of Wild Fauna and Flora

CLME Caribbean Large Marine Ecosystem

CLME+ Caribbean and North Brazil Shelf Large Marine Ecosystems Project

CMM Conservation and Management Measures

CMS Connectivity Modeling System

COPPESAALC Commission for Small-Scale and Artisanal Fisheries and Aquaculture of Latin America and the Caribbean

CRFM Caribbean Regional Fisheries Mechanism

DANIDA Danish Government

DCRF Data Collection Reference Framework

dFAD drifting Fish-Aggregating Device

DOF Diario Oficial de la Federación

DWFN Distant Water Fishing Nations

EAF Ecosystem Approach to Fisheries

EEZ Exclusive Economic Zone

EN Endangered

ERA Ecological Risk Analysis

F Fishing mortality

FAD Fish-Aggregating Device

FAO Food and Agriculture Organization of the United Nations

FDSWG Fisheries Data and Statistics Working Group

FIRMS Fisheries and Resources Monitoring System

F_{MSY} Fishing mortality consistent with achieving Maximum Sustainable Yield (MSY)

GDP Gross domestic product

GEBCO The General Bathymetric Chart of the Oceans

GEF Global Environment Facility

GMFMC Gulf of Mexico Fishery Management Council

GMLME Gulf of Mexico Large Marine Ecosystem

GOM Gulf of Mexico

GS Gulf Stream

GYC Guyana Current

HCR Harvest Control Rule

IATTC Inter-American Tropical Tuna Commission

IBM Individual-Based Model

ICCAT International Commission for the Conservation of Atlantic Tunas

ICES International Council for the Exploration of the Sea

ICM Interim Coordination Mechanism

iDCRF interim Data Collection Reference Framework

IFREMER Institut Francais de Recherche pour l' Exploitation de la Mer

IUCN International Union for the Conservation of Nature

IUU Illegal, Unreported and Unregulated (Fishing)

IWG Interssesional Working Group (WECAFC)

LBSPR Length-Based Spawning Potential Ratio

LC Loop Current

LIME length-based Integrated Mixed Effects

LME Large Marine Ecosystem

LOA Length Overall

MCS Monitoring, Control and Surveillance

mFAD moored Fish Aggregating Devices

MISC Miscellaneous

MSC Marine Stewardship Council

MSE Management Strategy Evaluation

MSY Maximum Sustainable Yield

NAFO Northwest Atlantic Fisheries Organization

NBC North Brazil Current

NBCR North Brazil Current Ring

NBSLME North Brazil Shelf Large Marine Ecosystem

NE Northeast

NEC North Equatorial Current

NECC North Equatorial Counter Current

NGO Non-Governmental Organization

NOAA National Oceanic and Atmospheric Administration

NW Northwest

OBIS Ocean Biodiversity Information System

OSPESCA Central American Fisheries and Aquaculture Organization

PSA Productivity-Susceptibility Analysis

PSAT Pop-up satellite archival tag

RDB Regional Data Base

REBYC-II LAC Project on Sustainable Management of Bycatch in Latin America and Caribbean Trawl Fisheries

RFB Regional Fishery Body

RFMO Regional Fishery Management Organization

SAFMC South Atlantic Fishery Management Council

SAG Scientific Advisory Group (WECAFC)

SAGARPA Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación

SCRS Standing Committee on Research and Statistics (ICCAT)

SE Southeast

SEC South Equatorial Current

SEDAR South East Data, Assessment, and Review

SEUSALME South East USA Large Marine Ecosystem

SICA Sistema de la Integración Centroamericana

SIDP FAO Species Identification and Data Programme

SIDS Small-Island Developing States

SLC Subregional Office for the Caribbean (FAO)

SPR Spawning Potential Ratio

SS3 Stock Synthesis Model

SSB Spawning Stock Biomass

SSB_{MSY} Spawning stock biomass capable of producing Maximum Sustainable Yield

SSC Species Survival Commission (IUCN)

SSF Small Scale Fisheries

SSF_{MSST} Spawning Stock Fecundity at the minimum spawning stock threshold

SSF_{MSY} Spawning Stock Fecundity correspondent to MSY

SW Southwest

SWG Species Working Group (ICCAT)

TAC Total Allowable Catch

TED Turtle Excluding Device

TL Total length

UN United Nations

UNCLOS The United Nations Convention on the Law of the Sea

UNDP United Nations Development Programme

USGOM USA Gulf of Mexico

USSA USA south Atlantic

UWI University of the West Indies

VAOS Venezuela Artisanal Off-Shore

VMS Vessel Monitoring System

VPA Virtual Population Analysis

VPLOP Venezuelan pelagic longline observer program

VU Vulnerable

WECAFC Western Central Atlantic Fishery Commission

WGSAM Working Group on Stock Assessment Methods (ICCAT)

YOY Young of the year

EXECUTIVE SUMMARY

In the WECAFC 17th Session, the Commission endorsed the roadmap for progressing towards the Development of a Model for a Regional Fisheries Management Entity or Arrangement in the WECAFC region. The roadmap called for a Second Preparatory Meeting of the WECAFC Strategic Reorientation, in which an ad hoc Intersessional Working Group (IWG) was assigned to do the preliminary work to gather information, best practices, and options for the development of such an entity or arrangement. The review presented here was developed as a project in response to the needs of the IWG in its work of informed identification of key options and priorities. The objectives of the project included the revision of the data available and information gaps in the WECAFC region regarding: 1) Stock identification, distribution, structure, abundance estimates and other relevant information, for stocks occurring exclusively in EEZs, that are or may be transboundary/shared stocks and/or straddling stocks, as well as, stocks occurring in the high seas of the WECAFC region; 2) WECAFC fisheries mapping, 3) Fisheries and stocks managed by other organizations that overlap geographically with the WECAFC region; and 4) The ecological connectivity between ABNJ/high seas and EEZ/coastal waters.

The current review describes a group of selected species that are considered of significant importance to member countries in the WECAFC region, its classification into transboundary and straddling/highly migratory stocks, and their fisheries, including information on the state of exploitation of the selected species. It also considers the ecological connectivity between the high seas and the EEZs of coastal nations. Lastly, it highlights issues that need to be addressed to generate the sound scientific knowledge base in support of the strategic reorientation of the Commission.

The selection of the fish resources included in this review used as a starting point those that appear in Appendix 3.1 WECAFC Reference list of aquatic species presented in the WECAFC interim Data Collection Reference Framework (iDCRF Version 2021.0.7), which are WECAFC “Main” Species and “other Reference” Species. The resulting 69 species selected, included 65 species from the WECAFC Reference list and four species that did not appear in any of the WECAFC Reference lists but were included for this review based on their relative importance in the Region’s fisheries. Once the species were selected for this review, they were classified into transboundary and straddling species, accordingly, resulting in 38 transboundary and 31 straddling species.

This review provides information on the current fisheries for 38 transboundary and 31 straddling species caught by commercial and recreational fleets with a focus on the most recent FAO catch statistics from 2015 to 2019. It includes updated information on the distribution, life history, stock identification, and stock status of the species reviewed. It also provides updated spatial distribution of catches, catches by gear, and relative abundance of most straddling species and fishing areas for most transboundary species in newly developed maps.

This review show that shared fisheries in the WECAFC region involve fish that are caught in waters of more than one country and in the high seas. Of the 38 species classified as transboundary, the queen conch (*Aliger gigas*, formerly *Lobatus gigas*, *Strombus gigas*) is the only species that is not considered transboundary by current research in the region. Nonetheless, queen conch in the Caribbean should be considered a shared stock with transboundary issues. The rest of the species classified as transboundary show no relevant discrepancies. One characteristic is that several groups of species show clear relevance within and between the LMEs in the region. The spiny lobster is widely distributed and exploited across all LMEs in the region. The group of groundfish species is most intensively exploited in the NBSLME and parts of the southern coast of the CLME, except for the whitemouth croaker (*Micropogonias furnieri*) widely distributed in the coastal areas of the southern GMLME, CLME, and NBSLME.

Other transboundary species like shelf shrimps can be separated into two groups, those corresponding to the GMLME and SEUSALME, and those corresponding to the CLME and NBSLME, with a couple of species that are broadly distributed across all LMEs of the region (Redspotted shrimp, *Farfantepenaeus brasiliensis* and Atlantic seabob, *Xiphopenaeus kroyeri*). Although classified as transboundary species, in most cases these species are managed as stock units by individual countries across the region and not as shared stocks. The four pelagic fish species classified as transboundary are under the mandate of the only RFMO operating in the region (ICCAT). Seven elasmobranch species were classified as transboundary. The review showed that most of the shark catches come from multi-specific fisheries and SSF off the NBSLME and southern coasts of the CLME, except for Bonnethead shark (*Sphyrna tiburo*) that is more common in the GMLME. Most of the shark species are landed dressed at sea and grouped, this practice hinders proper identification and reporting of the catches. Also, there is a considerable number of small individuals landed, likely juveniles, in the NBSLME which may be an indication of the existence of nursery areas for some shark species. Therefore, the need for enhanced efforts in identifying which species may be using the area as nursing grounds becomes a critical issue in the conservation of shark species in the region.

Of the 31 species classified as straddling/highly migratory, two are not under the mandate of the only Regional Fishery Management Organization operating in the western central Atlantic (ICCAT), namely the Fourwing flyingfish (*Hirundichthys affinis*) and the Common dolphinfish (*Coryphaena hippurus*).

The present review showed that information on reported catches and fishing effort across the region's fisheries is unbalanced, incomplete and outdated. Regardless of the country's development status, the level of fishery data relevant to the WECAFC region is incomplete at least. The most notorious is the limited information on basic fishing effort data, i.e. fleet characteristics, number of vessels dedicated to an important fishery, number of fishers, gear type by fleet(s), among other issues. The review of the most recent reported catches (2015-2019) by countries showed two outstanding issues; the first, in species-specific reported catches there were discrepancies between those reported to FAO and those reported in other official databases (National or ICCAT) for the same species and year. The second, was the use of carry-over catch values over several years in some species-specific reported catches.

Basic information on fishing effort in least developed countries with large coastal areas and multiple fisheries is limited, aggregated and most of the time not up to date (with very few exceptions). In contrast, countries with small and limited coastal areas tend to be more organized. Nonetheless, in either case the fishing effort information is limited and unbalanced at best. It is recognized that the limited information on catch and effort data in the region is due to the absence of a regional Data Collection Reference Framework. However, efforts endorsed by the WECAFC are focused to establish the foundation for a comprehensive fisheries data and statistics collection in the WECAFC region, although it is recognized that is an ongoing process that may take years to put in place.

The review presented the different fishery regional bodies in the WECAFC region and noted that ICCAT is the only regional fishery management organization in which its mandate overlaps with almost all the straddling/highly migratory species considered in the current review. The literature review appears to indicate that most countries in the region are targeting or have interest in expanding their large pelagic fisheries towards tuna species and/or tuna-like species; therefore, it would be in the countries' best interest to get involved in the ICCAT process for reviewing the state of a resource that is under its mandate.

The ecological connectivity between the high seas and the region's EEZs is largely dominated upstream by the NBC and NBCR and by the NEC downstream which seem to have inferred influence in some of the straddling/highly migratory species exploited in the region. These two major currents are largely responsible for the connection of the straddling/highly migratory species (like tuna and tuna-like species) exploited in the region. However, for some transboundary species is less evident. However, without direct empirical evidence on this potential connectivity between the two distant ecosystems precludes any assertion that poor management around the boundary of either side of the ecosystems will result in the loss of catches downstream (i.e. within the WECAFC region). Nonetheless, the current review presented a recent published study revealing that the most vulnerable countries that depend the most on the spawning grounds of neighbor states are concentrated in the Caribbean islands; although the study did not specify the species that were responsible for that effect in the Caribbean region.

It is hoped that the review will serve as the basis for an actionable process for helping the decisions that will require the transformation process of WECAFC into a Regional Fisheries Management Entity or Arrangement in the region.

Future considerations are expressed in Appendix A as a way forward that may help in the transformation process of WECAFC. It addresses several issues like potential examples for regional mandate with bidding Conservation and Management Measures and ways to address deep-sea fishing in the areas beyond national jurisdiction of WECAFC.

1. INTRODUCTION

The Western Central Atlantic Fishery Commission (WECAFC) was established in 1973 by Resolution 4/61 of the FAO Council under Article VI (1) of the FAO Constitution. WECAFC is a Regional Fishery Body (RFB), which has the mandate to issue fishery management advice, which may be implemented by its members on a voluntary basis. Regional Fishery Bodies (RFBs) do not have the authority to issue binding advice for its members.

The WECAFC area covers nearly 15 million km^2 of marine area extending from Cape Hatteras in North Carolina, United States of America (35°N) to south of Cape Recife, Brazil (10°S). This area covers the southeast coast of the United States, the Gulf of Mexico, the Caribbean Sea and the northeast coast of South America. Approximately 51% of the mandate area is in areas beyond national jurisdiction (ABNJ) and around 81% corresponds to waters with depths greater than 400 m. Except for Northern Brazil, which is included in FAO Fishing Area 41, the rest of the management area corresponds to FAO Fishing Area 31.

The Commission during its 16th session agreed to launch a process to develop a Regional Fisheries Management Organization (RFMO) in the WECAFC area of competence and to collaborate in fisheries management and conservation in the Areas Beyond National Jurisdiction (ABNJ) of straddling stocks, deep-sea fish stocks and highly migratory species that are not under the mandate of ICCAT (International Commission for the Conservation of the Atlantic Tunas) (FAO WECAFC 2016). However, in the First Preparatory Meeting of the WECAFC for the Transformation into an RFMO a different approach to the reorientation process of WECAFC was recommended (FAO WECAFC 2020a). The approach considered that any possible structure of a new entity/arrangement would address core issues that need to consider: a) An advisory role in science, capacity building, technology transfer and Monitoring, Control and Surveillance (MCS), and b) Binding Conservation and Management Measures (CMM) decisions at the level of the ABJN with the possibility of retaining the option to include the Exclusive Economic Zones (EEZ) in order to maintain flexibility for certain stocks/species as it is done under the North Atlantic Fisheries Organization (NAFO) Convention. Other aspects to be included would be the fight against IUU fishing, and trade issues such as traceability and catch documentation schemes.

WECAFC Members concurred that there are limitations on the data collection in the region and that there is a clear need to obtain stock data and other relevant information to make adequate fisheries management decisions. They underlined that, when deciding on CMMs, not all species have to be managed and that priorities and procedures must be established to respect the sovereign rights of WECAFC Members. In addition, there is growing concern of Fishing by Distant Water Fishing Nations (DWFN) in a large area of the high seas of WECAFC that may be affecting the availability of fish (particularly straddling resources) in the EEZ of the member states of WECAFC.

WECAFC member countries noted that in the 1970s and 1980s without the necessary data and information, management of their shared fisheries would be impossible. Subsequently major investments by the countries with support from the Danish Government (DANIDA) capacity building projects and the FAO/Norway EEZ program contributed to the improvement of information on the fisheries and stocks status significantly (WECAFC/FDSWG/II-ext/2021/2). However, in the 1990s and first decade of 2000 less emphasis was given to fisheries statistics and to the need for sharing fisheries data and statistics between states, particularly for use in regional assessments. This resulted in increasing the significant existing gaps in basic fishery data that complicated management actions without information based on scientific evidence. The situation on the availability of credible and sufficient basic fisheries data for monitoring and stock evaluations had worsened. Fishery managers were faced with much less data for decisions on management and conservation purposes.

During the past decade (2010), several Commission meetings agreed on the need for improvements in basic information on fishery data and statistics, as well as the need to develop and implement agreed data sharing policies to support decision-making, noting that it was a strong impediment for robust and effective management of marine resources in the region (WECAFC/XVII/2019/15). Moving forward, the Commission endorsed a partnership with FAO Fisheries and Resources Monitoring System (FIRMS) to provide decision-makers with sufficient and reliable information to develop effective fisheries policies in accordance with the Code of Conduct for Responsible Fisheries.

The most recent Commission (17th) Session convened in 2019 in Miami, Florida (USA) (FAO WECAFC 2020b), members adopted two Recommendations that: 1) WECAFC endorses the structure and concept of developing a list of main species, including socio-economic data, 2) WECAFC endorses the Interim Data Collection Reference Framework (DCRF), as a foundation for fisheries data and statistics collection and collation to feed the needs of developing, monitoring, assessing and reviewing regional fisheries policies; promotes a WECAFC-CRFM-OSPESCA Regional Data Base (RDB); and strengthens the collaboration between the FDSWG and other WECAFC working groups to refine and keep updated the DCRF and associated data sharing polices.

The aim of the DCRF is to provide a path for achieving improved data collection in the entire region for informing regional and sub-regional management plans. As part of this purpose existed the need to support the Secretariat of WECAFC in implementing targeted actions of the 2019-2020 Workplan on improved regional fisheries governance, which among other actions included a comprehensive and detailed mapping of WECAFC fisheries and management practices for an informed strategic reorientation.

During the WECAFC 17th Session, the Commission also endorsed the roadmap for progressing towards the Development of a Model for a Regional Fisheries Management Entity or Arrangement in the WECAFC region. The outlined roadmap called for a Second Preparatory Meeting of the WECAFC

Strategic Reorientation. In advance for the Second Preparatory meeting, an *ad hoc* intersessional working group (IWG) was tasked to do the preliminary work to gather information, best practices, and options for the development of such an entity or arrangement. These tasks would facilitate activities and outputs to inform the Second Preparatory Meeting of the WECAFC Strategic Reorientation and would provide support to the WECAFC Secretariat, who was tasked with facilitating the work of the WECAFC *Ad hoc* Intersessional Working Group (IWG) and the Second Preparatory Meeting.

Subsequently, a project was established in response to the need to support the IWG in its work of informed identification of key options and priorities. The objectives of the project included the revision of the data available and information gaps in the WECAFC region regarding: 1) Stock identification, distribution, structure, abundance estimates and other relevant information, for stocks occurring exclusively in EEZs, that are or may be transboundary/shared stocks and or straddling stocks, as well as, stocks occurring in the high seas of WECAFC; 2) WECAFC fisheries mapping, 3) Fisheries and stocks managed by other organizations that overlap geographically with WECAFC, and 4) The ecological connectivity between ABNJ/high seas and EEZ/coastal waters.

This document describes a group of selected species that are considered of great importance to member countries in the WECAFC region, its classification into transboundary and straddling/highly migratory stocks, and their fisheries, including information on the state of exploitation of the selected species. It also considers the ecological connectivity between the high seas and the EEZs of coastal nations. Lastly, it highlights issues that need to be addressed to generate the sound scientific knowledge base in support of the strategic reorientation of the Commission.

2. GENERAL CONSIDERATIONS

In the First Preparatory Meeting of the Western Central Atlantic Fishery Commission for the Transformation into a RFMO held in Bridgetown, Barbados on 25 and 26 March 2019, WECAFC members concurred that there are limitations on the data collection in the region and that there is a clear need to obtain stock data and other relevant information to make adequate fisheries management decisions. They also agreed on several time specific approaches starting with the ABNJ where binding measures can be implemented, and including selected straddling and transboundary species, or highly migratory stocks within the EEZs without prejudice of the sovereign rights of WECAFC Members.

In preparation for the WECAFC *Ad hoc* IWG and the Second Preparatory Meeting of the WECAFC Strategic Reorientation, as a key intersessional process endorsed by the 17th biennial meeting of WECAFC Commission, it was agreed to establish the relevant information and scientific knowledge base in support of the deliberations of the Second Preparatory Meeting by reviewing the information on fish stocks and fisheries that occur exclusively in EEZs, that are transboundary and straddling stocks, as well as those occurring in the high seas of the WECAFC region, and the ecological connectivity between ABNJ/high seas and EEZ/coastal waters.

Species and stocks considered in this review.

Selection of the fish resources (in the large sense) to be included in this review used as a starting point those fish resources that appear in Appendix 3.1 WECAFC Reference list of aquatic species presented in the WECAFC iDCRF (iDCRF Version 2021.0.7), which are WECAFC “Main” Species and “other Reference” Species. Each of these two groups of species is further divided into several subgroups. Group 1 Species are those considered main reference species. These are key species of to the region and of specific interest to the WECAFC mandate for which States are strongly encouraged to statistical reporting. These key species are defined as follows and are supported on one or more primary subgroup bases (i.e. criteria for inclusion) and have specific reporting requirements under the iDCRF (Version 2021.0.7): a) Subgroup Basis 1: Species with fisheries management plans endorsed (Conch, lobster, flying fish) or under development (e.g. Conch, lobster and Flyingfish, North Brazil Shelf-Guianas Shrimp and Groundfish) (i.e. as in iDCRF Appendix 3.1a); b) Subgroup Basis 2: Species of interest to historical Working Groups of regional bodies (WECAFC, Caribbean Regional Fisheries Mechanism-CRFM, Central American Fisheries and Aquaculture Organization-OSPESCA, including through their ICM). These species would include those such as, small and/or coastal tunas, dolphinfish, Wahoo, reef and shelf species (e.g., shrimps, groupers, snappers, acoupas, etc.), recreational, and commercially targeted and threatened sharks, rays (i.e., as in iDCRF Appendix 3.1b); c) Subgroup Basis 3: Species in high seas (areas beyond national jurisdiction)/straddling/shared (i.e. as in Appendix 3.1c) and, not under mandate of another RFMO (i.e. as in iDCRF Appendix 3.2a); and d) Subgroup Basis 4. Species for WECAFC region originating from 1978 working party on fishery statistics and/or of interest for other reasons (e.g. of local interest including high commercial value, for biodiversity reasons, or for importance of impacts from due to climate changes) (i.e. as in iDCRF Appendix 3.1d). Group 2 Species are those “Other species” (Subgroup Basis 5) having reporting mandates to neighboring RFMO (e.g. ICCAT) including tuna and tuna like species (i.e. as in iDCRF Appendix 3.2a).

Of the 196 species that appear in the WECAFC Reference list of aquatic species presented in the iDCRF (Version 2021.0.7, Appendix 3.1), all nine species of the Group 1, Subgroup Basis 1 were selected (iDCRF Appendix 3.1a), a total of 17 species were selected from the Subgroup Basis 3 (iDCRF Appendix 3.1b), 17 species of the Subgroup Basis 4 (iDCRF Appendix 3.1d), and 22 species of the Group 2 Subgroup Basis 5 were also selected (iDCRF Appendix 3.2a). In addition, four species —one species of groundfish (*Nebris microps*, Smalleye croaker), one species of grouper (*Mycteroperca microlepis*, Gag grouper), and two elasmobranch species (*Sphyrna tiburo*, Bonnethead shark and *Pteroplatytrygon violacea*, Pelagic stingray)— that were not included in any of the iDCRF Reference lists of aquatic species were included in the present review, based on their relative importance in the Region’s fisheries. Therefore, the list of 69 selected species considered in this review is presented in **Table 2.1** (key regional species, ground fish, reef and slope species), **Table 2.2** (pelagic and oceanic species) and **Table 2.3** (sharks and rays).

Once the species of interest were selected (**Tables 2.1, 2.2, 2.3**), the next step was to define their shared nature within the WECAFC region. Shared stocks can be classified into three non-exclusive categories; transboundary stocks that cross the EEZs of two or more bordering coastal states; straddling stocks that cross neighboring EEZs and the adjacent high seas; and highly migratory stocks that cross non-neighboring EEZs and the high seas (like most tunas) (Munro *et al.* 2004). Noting that there is not a list for transboundary, nor straddling species, like the one for highly migratory species listed in Annex 1 of UNCLOS, the classification of transboundary stocks in the WECAFC region was based on the method developed by Palacios-Abrantes *et al.* (2019). The method relied on multiple data sources including occurrence, distribution models and catch data, and only considered a species to be present in a grid cell if all data sources showed positive occurrence. From the list of 633 exploited transboundary species worldwide identified by Palacios-Abrantes *et al.* (2019), matched species for the WECAFC region were identified and classified as transboundary species initially. Of the 69 species selected in **Tables 2.1**, **2.2** and **2.3**, 47 species matched the study. The remaining 22 were classified as transboundary following the study´s criteria (Palacios-Abrantes *et al.* 2019). The separation between transboundary and straddling stocks of the 69 species selected was based on regional knowledge of the species distribution, *e.i.*, in addition to the movement of the species fished between neighboring nations, the confirmed catches of the same species occurring in the high seas (ABNJ) gave the species the straddling stock classification. Therefore, within the WECAFC region all highly migratory species were also considered straddling species, and those species fished only between neighboring nations were considered transboundary. The classification resulted in 38 transboundary and 31 straddling species in the WECAFC region (**Tables 2.1, 2.2, 2.3**).

Noting that FAO only reports catch by countries in mayor fishing areas, various FAO information resources were used as sources of information on the biological characteristics and geographical distribution of the species. The review included the FAO species catalogues and other information products provided by the FAO Fish Finder (http://www.fao.org/fishery/fishfinder/en), previously known as Species Identification and Data Program (SIDP), FIRMS stocks and fishery fact sheets (http://firms.fao.org/firms/en) including those that appear in Appendix 3.3 in the WECAFC Data Collection Reference Framework (Version 2021.0.7). In addition, information provided by Regional and sub-regional organizations as well as the most recent published literature, the public media, and expert opinion were utilized to develop a comprehensive summary for the species of interest (or groups of species) in each section.

Data approach and issues.

This review builds on the most recent published review of the state of the fisheries resources of the WECAFC region and on recent information published by the Regional Fishery Management Organization with mandate over the region (i.e. ICCAT) as well as the Regional Fishery Bodies present in the region.

Fisheries mapping was developed, initially, from the information available in the geographical and spatial data from the ICCAT database, and FIRMS´s Tuna Atlas. Several sets of base maps were created to show EEZs areas, the ABNJ area, and the different Large Marine Ecosystems (LME) in the context of the WECAFC region.

The bathymetric data set, the GEBCO_2021 grid (GEBCO 2020), was used as a source to show the depth intervals (0-50 m, >50-100 m, >100-200 m) on the maps. In some cases, bathymetric data was also used to delineate the general distribution of some species based on their respective depth ranges. The polygons of the maritime areas (EEZ, FAO fishing areas, LME's) were downloaded from the MarineRegions.org web portal (www.marineregions.org). The geospatial analysis and the generated maps were designed using the QGIS 3.20.1 software (QGIS Development Team 2021) and the statistical programming language R version 4.0.5 (R Core Team 2021).

These group of maps served as base for the species (or group of species) general geographical distribution, the spatial distribution of catches, fishing gear, effort, catch areas, and sightings. Species geographical spatial distribution maps were created from several sources, including but not limited to, ICCAT (https://www.iccat.int/en/), IUCN red list (https://www.iucnredlist.org/), the OBIS platform (www.obis.org), the Sea Around Us (http://www.seaaroundus.org/) and Robertson and Van Tassell (2019).

Fishery maps that included spatial distribution of catches, fishing gear, and industrial longline effort were created from the most recent ICCAT data base (https://www.iccat.int/en/accesingdb.html) for all tuna, tuna-like species, and elasmobranchs that are oceanic, pelagic, and highly migratory under the

ICCAT mandate (ICCAT 2019, ICCAT Recommendation 19-01 MISC). For species outside the ICCAT data base, maps displaying fishing areas were based on the available spatial catch data information and from sightings (of few elasmobranch species) obtained from the review of the most recent published literature.

The data used to review the most recent catch statistics for the selected transboundary and straddling resources were obtained from the most recent FAO data set (FAO 2021) for 2015 through 2019 and extracted for FAO fishing area 31. Noting that the WECAFC region includes a portion of northern Brazil, and further noting that Brazil reports marine fishery catch data as FAO fishing area 41 without discriminating between the WECAFC portion. Only reported data for FAO fishing area 31 was used in the review for catch statistics. On limited occasions and for species under ICCAT's mandate, FAO catch statistics were replaced with the updated data and identified accordingly in the catch table.

The review of the importance of the selected transboundary and straddling resources for the countries in the WECAFC region was based on the species or species group rank value by order of importance. The most important countries representing >80% or >90% of the total accumulated catch for 2015-2019 were considered in the analyses. Noting that a comprehensive data base on fisheries and socio-economics is not available for the WECAFC region, the information presented is based on country fishery-specific data obtained from published resources. Therefore, the information is unbalanced across the region.

Table 2.1. List of key regional species, groundfish, reef and slope species selected for review in the WECAFC region.

Code	Scientific name/ English name	Area of occurrence	Palacios-Abrantes *et al.* 2020	Classification for this review
Key regional species				
SLC	*Panulirus argus*/ Caribbean spiny lobster	SEUSALME, GMLME, CLME, NBSLME	X	TRANSBDOUNDARY
COO	*Aliger gigas* (Lobatus, Strombus) / Queen conch	SEUSALME, GMLME, CLME, NBSLME	-	TRANSBDOUNDARY
Groundfish				
YNA	*Cynoscion acoupa*/ Acoupa weakfish	CLME, NBSLME	-	TRANSBDOUNDARY
YNJ	*Cynoscion jamaicensis* / Jamaica weakfish	CLME, NBSLME	-	TRANSBDOUNDARY
YNV	*Cynoscion virescens* / Green weakfish	CLME, NBSLME	-	TRANSBDOUNDARY
WKK	*Macrodon ancylodon*/ King weakfish	CLME, NBSLME	X	TRANSBDOUNDARY
CKM	*Micropogonias furnieri*/ Whitemouth croaker	GMLME, CLME, NBSLME	X	TRANSBDOUNDARY
NBM	*Nebris microps*/ Smalleye croaker	CLME, NBSLME	-	TRANSBDOUNDARY
		Reef and Slope species		
Groupers				
GPR	*Epinephelus morio*/ Red grouper	ALL WECAFC EEZ	X	TRANSBDOUNDARY
GPN	*Epinephelus striatus*/ Nassau grouper	SEUSALME, GMLME, CLME	X	TRANSBDOUNDARY
EEU	*Epinephelus guttatus*/ Red hind	SEUSALME, GMLME, CLME	X	TRANSBDOUNDARY
MAB	*Mycteroperca bonaci*/ Black grouper	ALL WECAFC EEZ	X	TRANSBDOUNDARY
MKM	*Mycteroperca microlepis*/ Gag grouper	GMLME, SEUSALME	-	TRANSBDOUNDARY
Snappers				
LJN	*Lutjanus analis*/ Mutton snapper	ALL WECAFC EEZ	-	TRANSBDOUNDARY
SNR	*Lutjanus campechanus*/ Northern red snapper	SEUSALME, GMLME, CLME	X	TRANSBDOUNDARY
LJI	*Lutjanus griseus*/ Gray snapper	ALL WECAFC EEZ	-	TRANSBDOUNDARY
SNC	*Lutjanus purpureus*/ Southern red snapper	CLME, NBSLME	X	TRANSBDOUNDARY
SNL	*Lutjanus synagris*/ Lane snapper	ALL WECAFC EEZ	X	TRANSBDOUNDARY
SNY	*Ocyurus chrysurus*/ Yellowtail snapper	ALL WECAFC EEZ	X	TRANSBDOUNDARY
Shelf Shrimps				
ABS	*Farfantepenaeuss aztecus*/ Northern brown shrimp	SEUSALME, GMLME	X	TRANSBDOUNDARY
APS	*Farfantepenaeuss duorarum*/ Northern pink shrimp	SEUSALME, GMLME, CLME	X	TRANSBDOUNDARY
PST	*Litopenaeus setiferus*/ Northern white shrimp	SEUSALME, GMLME	-	TRANSBDOUNDARY
PNU	*Farfantepenaeus subtilis*/ Southern brown shrimp	CLME, NBSLME	-	TRANSBDOUNDARY
SOP	*Farfantepenaeus notialis*/ Southern pink shrimp	CLME, NBSLME	X	TRANSBDOUNDARY
PNT	*Litopenaeus schmitti*/ Southern white shrimp	CLME, NBSLME	-	TRANSBDOUNDARY
PNB	*Farfantepenaeus brasiliensis*/ Redspotted shrimp	SEUSALME, GMLME, CLME, NBSLME	-	TRANSBDOUNDARY
BOB	*Xiphopenaeus kroyeri*/ Atlantic seabob	SEUSALME, GMLME, CLME, NBSLME	X	TRANSBDOUNDARY

Table 2.2. List of pelagic species (oceanic) selected for review in the WECAFC region.

Code	Scientific name/ English name	Area of occurrence	Palacios-Abrantes *et al.* 2020	This review
Pelagic species (oceanic)				
FFV	*Hirundichthys affinis*/ Flying Fish	CLME, HIGH SEAS	-	STRADDLING
BFT	*Thunnus thynnus*/ Northern Bluefin tuna	ALL WECAFC	X	STRADDLING
YFT	*Thunnus albacares*/ Yellowfin tuna	ALL WECAFC	X	STRADDLING
ALB	*Thunnus alalunga*/ Albacore	ALL WECAFC	X	STRADDLING
BET	*Thunnus obesus*/ Bigeye tuna	ALL WECAFC	X	STRADDLING
SKJ	*Katsuwonus pelamis*/ Skipjack tuna	ALL WECAFC	X	STRADDLING
BLF	*Thunnus atlanticus*/ Blackfin tuna	ALL WECAFC	X	STRADDLING
LTA	*Euthynnus alletteratus*/ Little tunny	ALL WECAFC	X	STRADDLING
BON	*Sarda sarda*/ Atlantic bonito	ALL WECAFC	X	STRADDLING
FRI	*Auxis thazard*/ Frigate tuna	ALL WECAFC	X	STRADDLING
BLT	*Auxis rochei*/ Bullet tuna	ALL WECAFC	X	STRADDLING
SWO	*Xiphias gladius*/ Swordfish	ALL WECAFC	X	STRADDLING
BUM	*Makaira nigricans*/ Blue Marlin	ALL WECAFC	X	STRADDLING
SAI	*Istiophorus albicans*/ Atlantic sailfish	ALL WECAFC	X	STRADDLING
WHM	*Tetrapturus albidus*/ Atlantic white marlin	ALL WECAFC	X	STRADDLING
SPF	*Tetrapturus pfluegeri*/ Longbill spearfish	ALL WECAFC	X	STRADDLING
RSP	*Tetrapturus georgii*/ Roundscale spearfish	ALL WECAFC	X	STRADDLING
WAH	*Acanthocybium solandri*/ Wahoo	ALL WECAFC	X	STRADDLING
DOL	*Coryphaena hippurus*/ Common dolphinfish	ALL WECAFC	X	STRADDLING
SSM	*Scomberomorus maculatus*/ Atlantic Spanish mackerel	GMLME, SEUSALME	X	STRADDLING
KGM	*Scomberomorus cavalla*/ King mackerel	ALL WECAFC	X	STRADDLING
CER	*Scomberomorus regalis*/ Cero	CLME	X	STRADDLING
BRS	*Scomberomorus brasiliensis*/ Serra Spanish mackerel	CLME, NBSLME	X	STRADDLING

Table 2.3. List of sharks and rays (threatened and not) selected for review in the WECAFC region.

Code	Scientific name/ English name	Area of occurrence	Palacios-Abrantes *et al.* 2020	This review
Sharks & Rays (Threatened and not)				
OCS	*Carcharhinus longimanus*/ Oceanic whitetip shark	ALL WECAFC	X	STRADDLING
RHN	*Rhincodon typus*/ Whale shark	ALL WECAFC	X	STRADDLING
FAL	*Carcharhinus falciformis*/ Silky Shark	ALL WECAFC	X	STRADDLING
BTH	*Alopias superciliosus*/ Bigeye thresher shark	ALL WECAFC	X	STRADDLING
SMA	*Isurus oxyrinchus*/ Shortfin mako	ALL WECAFC	X	STRADDLING
BSH	*Prionace glauca*/ Blue shark	ALL WECAFC	X	STRADDLING
SPL	*Sphyrna lewini*/ Scalloped hammerhead shark	SEUSALME, GMLME, CLME, NBSLME	X	STRADDLING
SPK	*Sphyrna mokarran*/ Great hammerhead	ALL WECAFC	X	STRADDLING
SPZ	*Sphyrna zygaena*/ Smooth hammerhead	SEUSALME, GMLME, CLME, NBSLME	X	STRADDLING
TIG	*Galeocerdo cuvier*/ Tiger shark	ALL WECAFC	X	STRADDLING
RMB	*Mobula birostris*/ Giant oceanic manta ray	ALL WECAFC	-	STRADDLING
PLS	*Pteroplatytrygon violacea*/ Pelagic stingray	ALL WECAFC	-	STRADDLING
CCL	*Carcharhinus limbatus*/ Blacktip shark	ALL WECAFC EEZ	-	TRANSBDOUNDARY
CCR	*Carcharhinus porosus*/ Smalltail shark	GMLME, CLME, NBSLME	-	TRANSBDOUNDARY
RHR	*Rhizoprionodon porosus*/ Caribbean sharpnose shark	SEUSALME, CLME, NBSLME	-	TRANSBDOUNDARY
RHL	*Rhizoprionodon lalandii*/ Brazilian sharpnose shark	CLME, NBSLME	-	TRANSBDOUNDARY
CTJ	*Mustelus higmani*/ Smalleyed smoothhound	CLME, NBSLME	-	TRANSBDOUNDARY
SPQ	*Sphyrna tudes*/ Smalleye hammerhead	CLME,NBSLME	-	TRANSBDOUNDARY
SPJ	*Sphyrna tiburo*/ Bonnethead shark	SEUSALME, GMLME, CLME, NBSLME	-	TRANSBDOUNDARY

3. TRANSBOUNDARY and SHARED STOCKS

Key regional species

Caribbean spiny lobster (*Panulirus argus*). This species is distributed in the subtropical and tropical western Atlantic from Bermuda and the east coast of the USA from North Carolina, to Rio de Janeiro, Brazil, including the Gulf of Mexico and the Caribbean Sea, from shallow waters to depths up to 100 m (Butler *et al.* 2011). It occupies various marine habitats, with seagrass beds, mangroves, coral reefs, and rocky substrates. The highest concentrations based on capture fisheries occur in the western Caribbean and Brazil (Figure 3.1). The species has a complex life cycle, with a 6–12 month planktonic larval period, with an important larval dispersal throughout the Caribbean. However, larvae are also retained in local gyres predominantly off Costa Rica and Panama, off Honduras and south of Cuba, and north of The Bahamas contributing to local recruitment (Kough *et al*. 2013, Segura-García et al. 2019). Subsequently, larvae migrate to coastal shallow nursery areas for 6 to 8 months. A recent stock structure has been proposed for the WECAFC region (Truelove *et al*. 2016, FAO 2019 a). The five-stock structure is represented by a Brazilian stock, eastern Caribbean stock, a western Caribbean stock, an Atlantic stock, and an undefined Gulf of Mexico stock (Figure 3.2). However, the United States has identified one stock for area of the northern Gulf of Mexico and the southeastern USA, and three stocks in USA territories (Puerto Rico, St. Thomas/St. John, and St. Croix). The different potential stocks within the WECAFC area highlights the need to definitively delimit each stock and to understand the interaction between them in terms of larval export and recruitment to the fishery.

Queen conch (*Aliger gigas*, formely *Lobatus gigas* and *Strombus*). This species has recently changed its scientific name to *Aliger gigas* (Maxwell *et al.* 2020). It is a large gastropod mollusk, endemic to the Caribbean and utilized across its range since pre-Columbian times (Antczak *et al.* 2013); it therefore has an important fishery and cultural significance. The queen conch occurs throughout the Caribbean Sea, the Gulf of Mexico, and around Bermuda (**Figure 3.3**). Different queen conch life stages occupy different habitats, which extend over a broad depth spectrum: larvae (veliger) can be found in surface waters and approach the sea floor when ready to settle; early juveniles can be found buried in coarse sandy habitats, near to reefs and seagrass beds, and adults prefer a variety of habitats, like sandy algal flats, gravel, hard bottom rubble, smooth hard coral, or beach rock bottoms (Prada *et al.* 2017). In general, queen conch moves 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 m), while mature and old individuals are found in deeper waters, as far down as mesophotic depths of up to 59 m (García-Sais *et al.* 2012). 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). A more recent study indicated that Queen conch form reproductive aggregations to spawn, usually in deeper waters (20–45 m) (Frenkiel *et al.* 2009). Reproduction may be greatly affected by low densities because of excessive fishing efforts, but 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 (Prada *et al.* 2017). Stock structure in the WECAFC region is unclear. Early genetic studies into stock structure indicated high levels of gene flow between several Caribbean northern islands (Mitton *et al.* 1989, Campton *et al.* 1992), other studies have concluded the existence of connectivity among distant locations throughout the region (Morales 2004). It seems that many of the life-history characteristics of queen conch vary over relatively small spatial scales, which may be the most troublesome for stock assessment.

The Fishery

Caribbean spiny lobster. Lobster tails is the main product of the Spiny lobster fishery. Tails are exported almost completely frozen, although recently in Nicaragua live or pre-cooked whole lobster are being exported to European and Asian markets with the correspondent added value and higher prices, and more investments in processing plants infrastructure (FAO 2019 a). This resource is one of the most valuable in the WECAFC region with an average annual landed catch of around 25 000 tonnes valued at about US$ 850 million dollars (2019 FAO estimated landed catch).

According to recent FAO landing statistics, the largest production of Caribbean spiny lobster is from The Bahamas fluctuating between 5 800 and 8 400 tonnes between 2017 and 2019, producing 23.71% of the accumulated landed catch in 2015-2019 in the WECAFC region (**Table 3.1**). Over 91% of the accumulated landed catch of Caribbean spiny lobster comes from seven countries in the WECAFC region (**Figure 3.4**), of which the top four, The Bahamas, Honduras, Nicaragua, and Cuba contribute with 76% of the accumulated catch for 2015-2019. The USA and Belize —that rank fifth and eighth respectively of the accumulated landed catch of Caribbean spiny lobster from 2015 to 2019— have no reported catches for 2019 whilst Panama reported 12 tonnes of lobster (*Panulirus spp.*) in 2019. This indicates that landed catch statistics of a valuable resource in the region like Caribbean spiny lobster are in critical need to be up to date. In addition, Brazil´s reported landed catch of Caribbean spiny lobster (*Panulirus argus + Panulirus laevicauda*) for the same period is around 7 000 tonnes, but is reported for FAO fishing area 41, although it is likely that a proportion of that amount is caught within the WECAFC region it is unclear the quantity caught in the region.

The main fishing effort for Caribbean spiny lobster is from free diving and traps; other diving methods include scuba diving and hookah. Other methods to catch lobster include “condos” or “casitas cubanas” and trammel-nets, although recently in some countries the use of nets has been banned. Most of the Caribbean spiny lobster fishery is artisanal throughout the region, but there are several countries that have an industrial fishery as well, among them are Brazil, Colombia, Honduras, Jamaica, Nicaragua, and Trinidad and Tobago (**Table 3.2**). In the artisanal fisheries about 15 000 vessels are involved, which are made of fiberglass or wood between 6 m to 11.5 m in length with the majority using outboard motors of 25-75 HP, and the number of fishers involved is estimated at about 60 000 (OSPESCA 2018). The industrial fishing for 2017 has an estimate of 620 active vessels of which 90% use traps/pots and 10%

diving. The steel or fiber glass hulled vessels are between 16 m and 24 m powered by diesel engines of 325-540 HP. The number of fishers participating in the industrial fishery are estimated at 8 000 with 40% fishing by diving and 60% with traps/pots (OSPESCA 2018). The catch level depends on the season in which the most productive time is in the first three months of the fishing season.

Noting the economically importance of Caribbean spiny lobster trade resource in the region and the way high producing countries are distributed spatially (**Figure 3.4**), science has demonstrated that most lobster fisheries are recruitment driven (Ehrhardt 2005, Kough *et al.* 2013). Therefore, understanding recruitment mechanisms as well as the environmental and ecological effects on recruitment dynamics are vital to the objectives of Ecosystem Approach to Fishery (EAF) management. A suggested approach for renewal rates of spiny lobster in the Caribbean is by calculating how many of the post-larvae arriving to each fishing area survive to become recruits to the fishery (Arteaga-Ríos *et al.* 2007, Caputi *et al.* 2014). Therefore, such an approach would require that each country in the region contributes to the enrichment of the common larval pool to assure the regional survival, by allowing every spiny lobster in every fishery to reach maturity and reproduce (Buesa 2018). Thus, the needed actions to achieve it would require enforcing minimum size limits, a permanent capture ban on berried females, and reproduction oriented closed seasons throughout the whole Caribbean region.

Queen conch. The white conch meat is the main product of the queen conch fishery. Total queen conch production is difficult to estimate because of incomplete and/or incomparable data across the region because the statistics of many fishing 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 region (Prada *et al.* 2017).

In the last 30 years, the overall harvest of conch has increased, largely driven by increasing demand and the expansion of the fishery into previously unexploited deeper waters. Concern over the apparent decline in conch populations in several Caribbean countries led to the inclusion of queen conch on Appendix II of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) in 1992; the overall declining trend in queen conch landings resulted in the application of the first CITES Significant Trade Review in 1995 to exports from Antigua and Barbuda, Barbados, Dominica, Saint Lucia, and Trinidad and Tobago; then under the second CITES Queen conch Significant Trade Review in 2003, a temporary moratorium was imposed on Dominican Republic, Haiti and Honduras (Thiele 2001, MRAG 2013, Prada *et al.* 2017).

According to the recent FAO landing statistics, the largest production of queen conch meat is from Nicaragua with over 11 000 tonnes between 2017 and 2019, producing 34.34% of the accumulated landed catch in 2015-2019 in the WECAFC region (**Table 3.3**). A group of major producers for the same period with average annual reported landings of over 3 000 tonnes include The Bahamas and Belize. Mexico, an important producer, has dropped below the 2 000 tonnes in recent years (2018-2019). Jamaica, a major producer in the last decade, has been reporting 3 750 tonnes since 2013 and 0 tonnes in 2019, which looks like a carry-over for several years. This group of five countries produce over 72% of the accumulated landed catch of queen conch meat in the region. A second group of countries with landings of more than 1 000 tonnes over the past five years includes Dominican Republic, Antigua and Barbuda, Turk and Caicos Islands and Puerto Rico. All the afore mentioned countries account for 90% of the accumulated total queen conch landings over the period 2015-2019; spatially major producers are off and around the Mesoamerican reef area, the Greater Antilles and northern areas (The Bahamas, Turk and Caicos Islands), in contrast with the eastern and southern areas of the Caribbean Sea (**Figure 3.5**). However, it has been noted that in general, it appears that there are anomalous trends in the historical reported landings and there appear to be indications that perhaps the inclusion of the shell may lead to critical mistakes in estimated catches of queen conch; thus, situations like this reinforces the urgency to apply more adequate conversion factors for better catch data estimates and understanding of real patterns (FAO 2020).

The main fishing gears for queen conch are free diving, SCUBA, and surface compressor (hookah) diving techniques. The queen conch fishing fleet in the Caribbean Community (CARICOM) countries consist of small canoes or dories of 7 m -10 m, powered by outboard engines or sail/oars and carrying 1-4 divers; larger vessels are also used involving more fishers and multi-day trips (MRAG 2013). In the offshore banks off Jamaica, industrial vessels made of steel-hull of up to 35m length and powered by inboard engines are used as 'mother' vessels (industrial vessels). These vessels can carry over 40 divers and operate for a week or longer. The vessels serve as a base for daily fishing trips where fishers use smaller dories with outboard engines or oars that carry 1-2 divers. Industrial fishing takes place in Dominican Republic, Jamaica, Honduras, and Nicaragua. The normal practice on industrial vessels is for the meat to be extracted from the conch and the meat is pre-processed and stored on ice or frozen. In the French Antilles queen conch is also captured by bottom gillnets and trammel nets (300−400 m long). An overview summary of the queen conch fishing effort for some countries in the WECAFC region that have conch fisheries reveals that The Bahamas, Belize and Haiti have an important number of fishers and small boats involved in the fishery in which the catch is taken by free diving over daily trips (**Table 3.4**). The rest of the small islands in the Caribbean, the number of fishers and boats involved in the fishery is small, with exception of the Turk and Caicos Islands where fishers' numbers are over 200.

The queen conch fishery provides income for approximately 20000 fishers, mostly artisanal; it is an important and traditional source of low-fat protein for the Caribbean population (Prada *et al.* 2017). 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 but there are no major studies to determine the benefits and specific reliance of local communities on artisanal queen conch fishery.

Queen conch is an important trade resource in the region and economically is highly variable across the region. White conch meat is the main product of the fishery, followed by the queen conch shell and pearls, and recently the opercula has entered the trade as exported product from Jamaica and

Nicaragua (Prada *et al.* 2017). The USA has been one of the major importers of queen conch products with over 2000 tonnes in 2018 (https://www.st.nmfs.noaa.gov/commercial-fisheries/foreign-trade/). The European Union has been an expanding market for this species.

State of the stocks

Caribbean spiny lobster. According to the 2018 FAO State of World Fisheries and Aquaculture Report, Caribbean spiny lobster stocks appear to be "maximally-sustainably fished" ("fully fished" in previous SOFIA editions) throughout most of its range based on historical landings through 2015 from Bahamas, Nicaragua, and Cuba (FAO 2018a) (**Table 3.5**). Stock assessments under the USA management, indicate that all three Caribbean stocks (St. Croix, St. Thomas/St. John, Puerto Rico) under their mandate are not overfished nor undergoing overfishing (SEDAR 2019), and the Gulf of Mexico (GOM)/southeast Atlantic stock is not subject to overfishing, but the population status is unknown (SEDAR 2005). Assessments presented at the first and second meetings of the Joint OSPESCA/WECAFC/CRFM/CFMC Working Group on Caribbean Spiny Lobster (FAO 2015, 2019a) indicate that the stocks appear to have improved compared with 2006, and that the status in individual countries is either fully fished/stable (Anguilla, Antigua and Barbuda, The Bahamas, Belize, Cuba, Mexico and Nicaragua), overfished (Brazil, Colombia, Jamaica, Grenada, Haiti, Saint Lucia) or unknown (Dominican Republic, Honduras, Martinique and Panama).

Queen conch. According to the 2018 FAO State of World Fisheries and Aquaculture Report, Caribbean queen conch stocks appear to be fully fished and/or overfished based on information from The Bahamas, Jamaica and Nicaragua (FAO 2018a) (**Table 3.5**). The status of many stocks within the region is unknown or at least highly uncertain (MRAG 2013). The USA Caribbean queen conch management review in 2007 indicated that the species was overfished and experiencing overfishing (SEDAR 2007). In 2019, queen conch became a candidate for the USA Endangered Species Act (ESA), thus initiating a status review for the species under the ESA (https://www.fisheries.noaa.gov/species/queen-conch-esa-candidate-species#conservation-management). Currently the USA considers the queen conch overfished, except for Puerto Rico and United States Virgin Islands, where it is not undergoing overfishing thanks to a rebuilding management plan. Belize indicated that its exploited queen conch stock is stable (http://firms.fao.org/firms/resource/13774/en). In Turk and Caicos it is uncertain (http://firms.fao.org/firms/resource/13772/en), in St. Lucia it is overfished and experiencing overfishing, and in Antigua it is likely overexploited (http://firms.fao.org/firms/resource/13107/en).

In the last meeting of the CFMC/OSPESCA/WECAFC/CRFM/CITES Working Group on Queen Conch (FAO 2020) several commitments were made to improve the sampling and assessments methods which included robust estimation of conversion factors that can be comparable among countries for more accurate and precise information, including white meat and shell. The importance of survey design(s) was highlighted by the WG as a method to obtain better estimates of population densities and stressed the need to develop guidelines for conch density survey protocols that could then be standardized across the region (with priority given to those countries already conducting surveys), that include information on the habitat type, depth, size/age classes (FAO 2020). Another important aspect was the commitment to determine the genomic connectivity across the Caribbean using new genetic techniques, initially in countries with common fishing grounds useful for understanding small-scale population structure needed for management.

The Ground fish resources

Acoupa weakfish (*Cynoscion acoupa*). In the WECAFC region, this species is most common in northeastern South America, and it is locally abundant in some areas there (Chao *et al.* 2021); in the region is distributed from Panamá to Lake Maracaibo (**Figure 3.6a**), then is not present in central Venezuela but it is present from the northeastern coastal areas of Venezuela through to the Gulf of Paria and south along the NBSLME to Brazil (Cervigón 2005). It is a demersal species that occurs along the coast mostly in shallow waters near estuaries at depths up to 30 m (Le Joncour *et al.* 2020). It is commonly found over mud or sandy mud bottoms near mouths of rivers, estuaries, and coastal lagoons. Juveniles and larvae shelter in mangrove swamps as nursery grounds (Barletta and Saint-Paul 2010, Rousseau *et al.* 2017). It forms spawning aggregations in estuaries in the spring and summer in Maracaibo Lake, Venezuela (Montaño and Morales 2013). It attains sexual maturity around 2 years of age and longevity is at least 15 years (de Espinosa 1972). The species stock structure in the region is poorly known. The available information based on genetic studies indicates that there is a single stock in northern Brazil (Oliveira *et al.* 2020). This species is likely fished by coastal communities throughout its distribution range but known fishing areas for this species are reported by commercial fisheries in the Gulf of Venezuela in the southern Caribbean, the Gulf of Paria and along the NBSLME (**Figure 3.6b)**.

Jamaica weakfish (*Cynoscion jamaicensis*). This species is distributed in the western Atlantic from the Gulf of Honduras along the coast of Central America through to the Gulf of Venezuela, is absent from central Venezuela (Cervigón 2005), but reappears from northeastern Venezuela to Brazil along the NBSLME (**Figure 3.7a**). In the Caribbean islands, is present in the coasts of the islands of Hispaniola and Puerto Rico. This species increases in abundance in the southern portion of its range, like the NBSLME area (Frédou and Villwock de Miranda 2015a). It is generally found over mud and sandy mud bottoms off the coastline between 5 m and 120 m depth. Nursery and feeding grounds are in river estuaries (Frédou and Villwock de Miranda 2015a). The species stock structure in the region is unknown. This species is likely fished by coastal communities throughout its distribution range but known fishing areas for this species are reported by commercial fisheries in the Gulf of Venezuela in the southern Caribbean, the Gulf of Paria and along the NBSLME (**Figure 3.7b**)

Green weakfish (*Cynoscion virescens*). This species is distributed in the western Atlantic along Central and South America's coast, from Laguna de Caratasca in Honduras to Tubarao, Brazil (**Figure 3.8a**), but is absent from the central coast of Venezuela (Cervigón 2005); it is common and abundant in the NBSLME area and common in Brazil (Hornby *et al.* 2015, Frédou and Villwock de Miranda 2015b). It is generally found over mud and sandy mud bottoms off the coastline between 6 m and 70 m of depth, especially near river mouths. Juveniles inhabit estuaries during summer and adults are also known to inhabit estuaries of all major rivers in the NBSLME area (Novoa 2000, Cervigón 2005). It is mostly demersal during the day and moves toward the surface at night. It feeds mainly on shrimps and occasionally on fish (Frédou and Villwock de Miranda 2015b). The species stock structure in the region is unknown. This species is likely fished by coastal communities throughout its distribution range but known fishing areas for this species are reported by commercial fisheries in the Gulf of Venezuela in the southern Caribbean, the Gulf of Paria and along the NBSLME (**Figure 3.8b**).

King weakfish *(Macrodon ancylodon)*. In the WECAFC region, this species has a spotty distribution in southern Central America and northwestern South America (**Figure 3.9a**). However, king weakfish has a continued distribution from the Gulf of Paria south to Brazil, along the NBSLME; where is common and abundant in river estuaries (Novoa 2000, Molinet *et al.* 2008, Harper *et al.* 2015). This species occurs over mud or sandy bottoms in coastal waters over depths of up to 60 m (Frédou *et al.* 2015). Juveniles inhabit estuaries and coastal lagoons. It feeds mainly on shrimps and small fish. Upon sexual maturation, it migrates to coastal areas and has restricted migratory habits in coastal and estuarine areas. It spawns near river mouths with larvae and juveniles entering estuaries for protection and feeding (Frédou *et al.* 2015). The stock structure in the region based on genetic studies is formed by broadly a tropical group (from Venezuela to Pernambuco-northeast Brazil) and by a subtropical group from São Paulo (southeast of Brazil) to Argentina (Santos *et al.* 2006). This species is likely fished by coastal communities throughout its distribution range but known fishing areas for this species are reported by commercial fisheries in the Gulf of Venezuela in the southern Caribbean, the Gulf of Paria and along the NBSLME (**Figure 3.9b**).

Whitemouth croaker (*Micropogonias furnieri*). The whitemouth croaker is the most broadly distributed croaker species in the WECAFC region (**Figure 3.10a**), from Veracruz in the Gulf of Mexico to northern Quintana Roo in the Yucatan Peninsula; is present in the Caribbean islands of Cuba, Jamaica, La Hispaniola, Puerto Rico to St. Croix; and along Central and South America, from southern Belize to Brazil (Aguilera *et al.* 2015). Whitemouth croakers are generally found over mud and sandy mud bottoms in coastal waters to about 120 m depth, is one of the dominant croaker species in the upper NBSLME area, the Gulf of Paria, as well as the northeastern shelf of Venezuela due to the seasonal influence of the Orinoco River flow into the Caribbean (Cervigón 2005, Molinet *et al.* 2008). Nursery and feeding grounds are in estuaries. It is dependent on estuaries during early juvenile stages. Spawning is between spring and summer and is concentrated in shallow coastal waters (Aguilera *et al.* 2015). The stock structure of the species in the WECAFC region is currently unknown. The available information indicates that there are three genetic stocks in the southwestern Atlantic from Pará State in Brazil through to Uruguay and Argentina (Vasconcellos *et al.* 2015). This species is likely fished by coastal communities throughout its distribution range but known fishing areas for this species are reported by commercial fisheries in the Gulf of Venezuela in the southern Caribbean, the Gulf of Paria and along the NBSLME (**Figure 3.10b**).

Smalleye croaker (*Nebris microps*). The geographical range distribution of the Smalleye croaker is from the Gulf of Urabá (Panamá-Colombia) to the Gulf of Venezuela in the southwestern Caribbean; and from northeastern Venezuela to the Gulf of Paria and along the NBSLME to Brazil (**Figure 3.11a**). The Smalleye croaker is widely distributed and common in many parts of its range, it inhabits coastal waters and estuaries, and its presence is reduced in waters with salinity over 30 ppm (Cervigón 2005). It is caught as bycatch and in mixed catch sciaenid fisheries throughout its range, but more common in French Guyana (Harper *et al.* 2015). This species is found over sandy mud bottoms in coastal waters to about 50 m depth (Aguilera and Haimovici 2020). It also enters estuaries, especially in the juvenile stages. This fish feeds mainly on shrimps and small crustaceans. The maximum reported size for this species is 50 cm total length but is common to 30 cm (Chao 2002). The species stock structure in the region is unknown. This species is likely fished by coastal communities throughout its distribution range but known fishing areas for this species are reported by commercial fisheries in the Gulf of Venezuela in the southern Caribbean, the Gulf of Paria and along the NBSLME (**Figure 3.11b**).

The Fishery

The groundfish shared fishery resources selected are all members of the family Sciaenidae (Croakers, drums, and other species). As a general characteristic of the members of this family, of which most of its members in the region are estuarine-dependent, they expand and contract their dispersion over the continental shelf associated to coastal lagoons and river estuaries depending on seasonal river flow into the sea/ocean and tides. In the areas where these species occur are mostly associated with shrimp species that are subjected in most cases to an intensive fishery. Most of the croaker species are caught as part of the bycatch of the shrimp fisheries and are mostly reported grouped with other marine fishes. On few occasions when an artisanal coastal fishery exists that targets brackish water species are likely reported grouped, i.e. as *Cynoscion* spp. (Weakfishes).

According to recent FAO landing statistics for the period of 2015-2019 for all groupings and species-specific reporting, eight countries report landings of croakers, drums and/or weakfishes but only one country reports species specific landings (**Table 3.7**). However, Venezuela´s species-specific reporting seems to experience a high level of carry-over values across the recent period in almost all reported species except for the whitemouth croaker. Nonetheless, the proportion between species shows that the whitemouth croaker is the most important species in the catches, followed by the Acoupa weakfish. The other three species —Jamaica, Green, and King weakfishes— have relatively similar proportional reported catches and represent about a third of the total species-specific Sciaenid landed catch from Venezuela.

The reported catches grouped under *Cynoscion* spp. (Weakfishes nei) show that Mexico accounts for 74.34% of the total accumulated catches for 2015-2019 in the region (**Table 3.7**), followed by French Guyana (13.62%) and Venezuela (11.27%). In the case of Venezuela, the difference between 2015 values and those of the following years (2016-2019) is likely due to the breakdown to the species level and reporting them separately from 2016-2019 as seen in the species-specific reported catches for Venezuela. In the case of Mexico, weakfish catches mostly *Cynoscion arenarius* (Sand weakfish), *C. nebulosus* (Spotted weakfish) and *C. nothus* (Silver seatrout) are likely part of the commercial bycatch of the Atlantic Spanish mackerel artisanal fisheries using set gillnets off Veracruz, and other Sciaenid species associated to the artisanal fisheries off the coastal estuaries in the same area for which the one of the more representative in the catches is the Whitemouth croaker (Beléndez *et al.* 2014, DOF 2018). In the case of French Guyana, the assumption would be that those weakfish reported catches are likely of Acoupa weakfish and Green weakfish based on the assessment information for the small-scale coastal fisheries (FAO 2019 b, Tagliarolo 2019). The other two countries reporting weakfish catches - Nicaragua and Dominican Republic- account for a small fraction of the total accumulated weakfish catch reported in the region. In Nicaragua, the weakfish catches are likely Acoupa and Jamaica weakfish from the artisanal coastal fisheries that operates off coastal lagoons and estuaries, and potentially from the industrial shrimp fisheries (CIPA 2008, INPESCA 2018). In the case of Dominican Republic, there is no specific information on weakfish catches nor fisheries that captures it; however, the possibility exists that it could likely be Jamaica weakfish associated to the shrimp fisheries north of the island (Herrera *et al.* 2011).

Another group of Sciaenid reported catches are the croakers and drums, which consists of a small number of countries with individual catches below 500 tonnes over the recent period (2015-2019); Colombia, Venezuela, and Guatemala account for 99.59% of the accumulated catch (**Table 3.7**). In Colombia, croaker catches could be a combination of the shared species selected in this section due to the geographical distribution of all of them, and the catches are likely associated to artisanal fisheries in Colombia´s major estuaries, like Ciénaga de Sta. Marta, utilizing set gillnets, as well as part of the retained bycatch of the shrimp fisheries (Rueda *et al.* 2011, Lindop *et al.* 2015a). In Venezuela, the reported catches are likely of other Sciaenid species not included with the commonly reported species, like *Larimus breviceps* (Shorthead drum) (Cervigón 2005, Molinet *et al.* 2008). As for Guatemala, there is no indication that the Sciaenids are part of the catches in their Caribbean fisheries (Lindop *et al.* 2015b); however, noting that there are trawl shrimp fisheries and that the geographic distribution of Jamaica weakfish and Whitemouth croaker extends to Guatemala, the possibility exists that these species may be part of the reported croaker catches by Guatemala.

The FAO statistics do not reflect the detailed catch levels of croakers, drums, and weakfishes for the countries whose fishing operations take place in the NBSLME and beyond. The group of countries catching this group of species directly or as part of the retained bycatch of their shrimp fisheries are, Guyana, Suriname and, to some extent French Guyana. They report their catches of Sciaenid species under the FAO group of Ostheicthyes (Marine fishes nei). However, in recent years there have been historical catch reconstruction of all the Sciaenid species reviewed in this section (Mohammed and Lindop 2015, MacDonald *et al.* 2015, Hornby *et al.* 2015, Harper *et al.* 2015), and some time series have been used in sub-regional assessments reflecting the level of importance of this group of species in the NBSLME, that requires more detailed attention due to the transboundary nature of the Sciaenid species exploited by all countries in the region (FAO 2019 b, FAO 2021).

In Trinidad where Sciaenid species (*e.g.* Acoupa, Jamaica, and King weakfish, and Whitemouth croaker), are either targeted by the artisanal multi-gear fleet using gears such as gillnets, fish pots, demersal handlines and demersal longlines or caught as bycatch in the trawl nets of the shrimp fishery (Mohammed *et al.* 2011, Mohammed and Lindop 2015). The artisanal multi-gear fleet, which targets soft-bottom fish like, croakers, drums and weakfishes, operates mainly off the west and south coasts of Trinidad, and the shrimp trawlers operate mainly in the Gulf of Paria. Generally, boats in the artisanal fishery called “pirogues” are wooden, fiberglass or fiberglass-coated open boats of 7-9 m in length, powered with one or two outboard engines usually between 45-75 HP.

In Guyana, until 1980’s the entire artisanal catch of finfish and shrimp was absorbed into the fresh fish market and consumed domestically. However, since then, artisanal fishers have exported certain valuable fish such as Acoupa weakfish among other species (MacDonald *et al.* 2015). Several Sciaenids, like weakfishes (*Macrodon ancylodon*, *Cynoscion acoupa and Cynoscion virescens)* and croakers *(Micropogonias furnieri*, and *Nebris microps)* are part of the retained catch of the large-scale commercial Atlantic seabob fishery; trawlers configured to catch Atlantic seabob target finfish when the shrimp is not in abundance. However, most of Guyana’s fishing effort occurs in the relatively shallow waters of the continental shelf, where 60% of the artisanal boats use gillnets within coastal waters. The artisanal fleet consists of 1 147 boats equipped with different types of gillnets (Chinese seine, Pin seine, Gillnet-nylon and polyethylene, anchor seine, circle seine), which are likely the ones used to catch Sciaeneids (Drugan 2019). Artisanal boats are made of wood of 6-18 m, powered by sail, outboard, or inboard engines; the size of the boats defines the type of the gear and the target species.

In Suriname, the fishing fleet can be divided into the industrial trawl and the artisanal fleets. The industrial fleet can be subdivided into shrimp targeted and finfish targeted fisheries. Under the industrial fishery categorization there is a demersal bottom trawl fishery with a maximum number of 47 licenses, these vessels are typically around 20 m (max length 32 m) long with an engine of 500 HP (Smith and Burkhardt 2017). Fishing trips typically last four to eight days and fishing takes mostly during daytime, fishing areas are from a depth of 32 m and maximum days at sea per vessel is limited to 170 (Ministry of Agriculture, Animal Husbandry and Fisheries 2021 a). There are a series of management measures adopted recently that include limits on mesh sizes and inclusion of bycatch reduction device (BRD). The Sciaenid catch consists primarily of Jamaica weakfish, followed by Green weakfish and Whitemouth croaker. While King weakfish is the primary species of the retained catch of the Atlantic seabob fishery, followed by Green weakfish and Smalleye croaker; and Jamaican weakfish is the main retained bycatch species of the shrimp fishery (Meeremans *et al.* 2017). The artisanal fleet is more diverse and operates with different gears but is dominated by drift-gillnet. The coastal drift-gillnet fishery operates from two types of boats known as Guyana type boats, open Guyana type boats, 8-14 m long (recently limited to 330 licenses), powered by 25-50 HP (max of 75 HP) outboard engines and closed decked Guyana type boat 15 m long with 155 HP (max) diesel inboard engines (Hornby *et al.* 2015). These vessels are responsible for the catch of large demersal fish like the Sciaenids. The drift gillnet fleet targets Acoupa and Green weakfish, operating from the coast to depths of 16 m, using gillnets of 2 000 m (max of 3 000-4 000m) in length with 20 cm mesh. Boats (10 licenses) using pin seine and bank fishing, target Smalleye croaker and Acoupa weakfish operating from the coast up to 16 m, using nets of 2000 m in length with 5 cm mesh. Boats (max length of 10m) in estuaries using driftnets (75 licenses) of 500 m in length with 12.7 cm mesh operating at depths between 5-9 m target King weakfish and Smalleye croaker (Ministry of Agriculture, Animal Husbandry and Fisheries 2021 a).

In French Guyana, the target species for the coastal small-scale fishery is Acoupa weakfish, although Green weakfish are also caught. There is also an important bycatch of Sciaenids from the shrimp fishery, that consists of King weakfish as the most important and Smalleye croaker (Harper *et al.* 2015) but is not known if its retained.

In Venezuela, the coastal artisanal fishery uses handlines to catch a variety of species, including Whitemouth croaker and Jamaica weakfish off the northeastern coasts, with relative abundance estimates of 21 kg/day and up to 38 kg/day respectively (Arocha *et al.* 2006). The artisanal multi-gear fleet in the Gulf of Paria, much like the one in Trinidad, targets soft-bottom fish like, croakers, drums and weakfishes among other species, operates mainly off the west coasts and central area of the Gulf of Paria. Generally, boats in the artisanal fishery called “peñeros” are wooden, open of 7-9 m in length, powered with one or two outboard engines usually between 45-75 HP. The fishery targeting Sciaenids uses drift gillnets of 1 000-2 800 m long, although bottom longlines and handlines are used to catch Acoupa and Green weakfish (Novoa 2000, Arocha *et al.* 2006); while King weakfish is usually caught with gillnets. The approximate number of boats operating in the area where croakers, drums and weakfishes are caught is around 3000 registered “peñeros” in 2016. In recent years, due to the ban of the bottom trawl fishery in Venezuela, a new industrial fleet was developed, the multiple-gear fishing fleet (aka, “Polivalente Costa Afuera”) (Laurent *et al.* 2020). The fleet consists of transformed shrimp trawlers of 15-29 m in length with engines between 300 and 1 140 HP, and storage between 8 and 115 tonnes. The estimated number of vessels operating in the area is about 50; with an average crew of eight fishers and trip duration about 25 days at sea. The main area of operations of this fleet is along the NBSLME between the Orinoco delta and the Essequibo river, in which the main species caught are several species of catfishes, although Acoupa and Green weakfish were an important part of the catches representing over 10% of the total catch over several years (2015-2018), the gears by which Sciaenids were caught included bottom longline as the primary gear, followed by shark longline and traps.

State of the stocks

Acoupa weakfish (*Cynoscion acoupa*), Whitemouth croaker (*Micropogonias furnieri*), Jamaica weakfish (*C. jamaicensis*), and Green weakfish (*Cynoscion virescens*), are commonly caught off the NBSLME fisheries with trawls and gillnets. Recent assessments indicate that all species are at high risk of suffering overexploitation and the biomass is at high risk to fall below the limit reference point, with a potential of suffering recruitment overfishing in green weakfish, at least in some parts of the area (CLME 2013). Recent work on green weakfish using Length Based Indicators (LBI) suggests sustainable fishing, but the use of inappropriate LBI values (e.g. Linfinity) warns caution (McManus 2018). In Guyana, the stock assessment for green weakfish suggested that fishing mortality is at a level consistent with producing MSY catches, based on body length information (Santos *et al.* 2018), and the Productivity and Susceptibility Analysis (PSA) suggested that fisheries pose a high risk to stock status (Drugan 2019). In French Guyana, Acuopa weakfish stock assessment showed that despite the high uncertainty of model outputs (Depletion Based Stock Reduction Analysis and Bayesian biomass dynamics model), the stock appeared to be overexploited partly due to the high levels of illegal fishing pressure in the area (Tagliarolo 2019, FAO 2021).

The available stock assessment information and the PSA conducted on King weakfish (*Macrodon ancylodon*) (Drugan 2019) indicated that there is no clear quantitative evidence that the stock is healthy or unhealthy, the stock is subject to high fishing pressure from multiple fisheries on juveniles as well as adults and is likely at least fully exploited if not overexploited.

Smalleye croaker (*Nebris microps*) stock assessment in Guyana suggested that fishing mortality is at a level consistent with producing MSY catches. However, the PSA for Smalleye croaker suggests that fisheries pose a high risk to stock status (Drugan 2019).

The Reef and Slope resources

The Groupers

<u>Red grouper (*Epinephelus morio*)</u>. Red grouper is distributed in the western Atlantic from North Carolina, south along the USA Atlantic, in the Gulf of Mexico from the Florida Keys north to Alabama, in the Flower Garden Banks, and from Veracruz, Mexico to northwestern Cuba, throughout the Caribbean Sea and along South America, but with a gap in large river mouths (**Figure 3.12a**) (Brule *et al.* 2018). Its depth range is from 5 m to 300 m. Adults occur over sandy or mud bottom in offshore continental shelves from 50 m to 300 m, larger juveniles are found in crevices and under ledges on rocky reefs from 5 to 25 m, and smaller juveniles can occur on shallow seagrass beds and inshore reefs. There is no indication that this species aggregates to spawn, but it can be caught in large numbers during the spawning season. The known spawning season is between late winter and early spring in different areas in the GOM and USA Atlantic (Brule *et al.* 2018). In the Gulf of Mexico, genetic analyses

suggested the existence of a single stock, but not ruling out the possibility of several reproductively distinct stocks, supported by distribution discontinuity and life-history traits (Zatcoff *et al.* 2004). However, for USA/Mexico management purposes there are three recognized stock units: the USA South Atlantic unit, the USA GOM unit and the Mexican GOM unit. Most important reported fishing areas are off the Yucatan Peninsula, around the Florida Peninsula, off Colombia and the NBSLME (**Figure 3.12b**).

Nassau grouper (*Epinephelus striatus*). Nassau grouper is naturally abundant in areas with large shelf habitat (**Figure 3.13a**), such as The Bahamas, Belize, Cuba, and other islands of the Greater Antilles, and less abundant in areas such as continental South America (e.g. Colombia and Venezuela) (Sadovy *et al.* 2018). This species prefers clear water with high relief coral reefs or rocky substrate. It occurs to a depth of at least 140 m, but individuals have been recorded to regularly descend to depths of 255 m during the spawning season. This species exhibits highly synchronized seasonal migrations to specific sites, typically located on outer reef drop-offs, where hundreds to tens of thousands of individuals aggregate to spawn (Sadovy *et al.* 2018). Genetic studies show evidence that there is strong genetic differentiation among Nassau Grouper subpopulations in the Caribbean region (Jackson *et al.* 2014), the genetic barriers proposed separates The Bahamas and eastern Caribbean, central Caribbean, and Mesoamerican Reef/Belize. Presently fishing areas for Nassau grouper were only recorded off the Colombian coast (**Figure 3.13b**).

Red hind (*Epinephelus guttatus*). This species is distributed in the western Atlantic from North Carolina south along the USA, Bermuda, the Bahamas, throughout the Gulf of Mexico and Caribbean Sea (**Figure 3.14a**). It is one of the most common species of *Epinephelus* in the West Indies, but it is not highly valued in the market as compared to other groupers (Brule 2018). This species inhabits coral reefs and rocky bottoms. Females rest on or close to the bottom, while males are territorial with a group of up to five females. This species forms spawning aggregations and spawning occurs almost exclusively within the aggregation period. It spawns from December to April in the Caribbean, from May to July in Bermuda and from January to April on the Campeche Bank in the southern Gulf of Mexico (Tuz-Sulub *et al.* 2006, Caballero-Arango 2013, Tuz-Sulub and Brulé 2015). There are at least six known spawning aggregation sites in Puerto Rico. Most important reported fishing areas are off the Yucatan Peninsula, in several spots in the northern and eastern Gulf of Mexico, southeastern USA, and off Colombia (**Figure 3.14b**).

Gag grouper (*Mycteroperca microlepis*). Gag grouper is distributed in the western Atlantic from North Carolina south along the USA, Bermuda, throughout the Gulf of Mexico except Cuba (**Figure 3.15a**) (Koenig *et al.* 2018). This reef-associated species is usually found offshore on rocky bottoms and occasionally inshore on rocky or grassy bottoms. Overall, the species prefers habitats characterized by maximum structural complexity, at depths between 70 m -100 m. It spawns exclusively on shelf-edge reefs, preferably on rocky ridges next to drop-offs; in December and January, females form pre-spawning aggregations in shallower areas prior to migrating to the spawning aggregation sites in deeper water, while males remain near spawning sites in deep water year-round. Primary spawning season seems to be between winter and spring (Koenig *et al.* 2018). The stock structure information for the species is centered in the northern WECAFC region, is unclear regarding continuity between the Gulf of Mexico and USA Atlantic coast distribution of the species (Chapman *et al.* 1999). However, for USA management purposes the recognized stock units are for the USA GOM and USA southeastern Atlantic. Most important reported fishing areas are off the northern Yucatan Peninsula, in several spots in the northern and eastern Gulf of Mexico, and the southeastern USA (**Figure 3.15b**).

Black grouper (*Mycteroperca bonaci*). This species is distributed in the western Atlantic from Cape Canaveral, Florida south along the USA, Bermuda, the Bahamas, in the Gulf of Mexico from the Florida Keys north to Alabama, the Flower Garden Banks and surrounding area, and from southern Texas south along Mexico to Cuba, throughout the Caribbean Sea and the northern part of the NBSLME (**Figure 3.16a**) (Padovani-Ferreira *et al.* 2018). Is considered a solitarily species and known to form spawning aggregations in the Gulf of Mexico and Caribbean Sea. Spawning occurs during winter and early spring months from November to May but varies by areas. Juveniles settle in shallow sandy-rocky patch reefs and sometimes occur in estuaries, seagrass, and oyster rubble habitat. The stock structure in the USA consists of two stocks, one for the USA GOM and another for the USA South Atlantic and USA Caribbean (Puerto Rico and Virgin Islands) (SEDAR 2010). In the rest of the region, the stock structure of the species is limited (González-Salas *et al.* 2020). Most important reported fishing areas are off the Yucatan Peninsula, around the Florida Peninsula, off Colombia and the NBSLME (**Figure 3.16b**).

The Snappers

Northern red snapper (*Lutjanus campechanus*). Red snapper is generally found at 10 m to 180 m in the Gulf of Mexico and along the eastern coasts of North America, Central America, and northern South America (**Figure 3.17a**) (Anderson *et al.* 2015). Red snapper feed on fish, shrimp, crab, worms, cephalopods and some phyto and zooplankton. Spawning season varies with location, but in most cases occurs nearly year-round. The spawning season off the southeastern United States extends from May to October, peaking in July through September. On Campeche Bank, it spawns between April-October (Anderson *et al.* 2015). The stock structure information is limited to the northern WECAFC region. It appears not to show significant genetic variation between the specimens of northern Gulf of Mexico and those of southern Gulf of Mexico, but is believed they are unlikely to be part of the same population (Gold and Richardson, 1998). The species is managed as separate stock units by the USA and Mexican fishing authorities (SEDAR 2017a, DOF 2018). Fishing areas are likely distributed across its distribution range but known areas are commonly found off the Mexican coasts in the Gulf of Mexico and the southern USA (**Figure 3.17b**).

Gray snapper (*Lutjanus griseus*). The species occurs in tropical, subtropical, and warm temperate waters from Bermuda to Brazil, and throughout the Gulf of Mexico and Caribbean Sea (**Figure 3.18a**), is a common snapper and can be highly abundant throughout its range. Gray snapper as juveniles, settle nearshore in estuaries, seagrass beds or shallow reefs, and gradually move offshore as they grow larger; adults are generally located nearshore or offshore on hard-bottom and coral habitats (Lindeman *et al.* 2016 a). It spawns offshore in groups, showing simple migratory spawning (Domeier and Colin 1997). Spawning occurs primarily in the summer months, between May and September in in association with the lunar cycle. The stock structure of gray snapper in the northern part of the region consists of at least four genetically distinct stocks, one in the southern GOM and northwestern Caribbean, one in the northwestern GOM, another in the northeastern GOM, and the other in the southeastern USA (Gold *et al.* 2009, Rosado-Nic *et al.* 2020). In the southern part of the region, several subpopulations like those that exists in the Greater Antilles (Cuba in particular) and the southern Caribbean (e.g. Venezuela) are likely to exist but none have been defined (Lindeman *et al.* 2016 a). Known fishing areas are recorded for the Gulf of Mexico, southern USA, off Colombia, and the NBSLME area (**Figure 3.18b**).

<u>Mutton snapper (*Lutjanus analis*)</u>. Mutton snapper is distributed from Cape Hatteras, North Carolina south along the USA coast, the Bahamas, in the Gulf of Mexico from the Florida Keys north to Tampa, off the Mississippi Delta region, and from Texas (Corpus Christi) south along Mexico to Cuba, throughout the Caribbean Sea, and along South America (**Figure 3.19a**) (Lindeman *et al.* 2016 b). It occurs over reef, seagrass, and rubble bottoms, in continental shelf areas as well as in clear waters around islands. Large adults are usually found among rocks and coral while juveniles occur over sandy and seagrass (*Thalassia testudinum*) habitats. Spawning aggregations are documented from Belize; in Cuba, spawning aggregations occur on several shelf regions between May and August in depths of 20 m-40 m (Lindeman *et al.* 2016a). An important spawning aggregation site at Dry Tortugas, Florida has been subject to management attention. The stock structure in the region is not completely clear. A study supports a single stock hypothesis for specimens from the Florida Keys, Puerto Rico, and the United States Virgin Islands (Carson *et al.* 2011). It is likely that there may be other subpopulations in the southern WECAFC region due to the life history of the species. Known fishing areas are recorded for the Mexican Gulf of Mexico, southern USA, off Colombia, and the NBSLME area (**Figure 3.19b**).

<u>Yellowtail snapper (*Ocyurus chrysurus*)</u>. The species is widely distributed and abundant in the tropical and subtropical portions of the region, despite its wide range, yellowtail snapper is most abundant in the Bahamas and throughout the Caribbean (**Figure 3.20a**) (Lindeman *et al.* 2016c). The species inhabits clear coastal waters, mostly around hardbottom and coral reefs; it usually occurs above the bottom, and frequently in aggregations. Adults can be very abundant in reef areas, and it is fished throughout its geographical distribution. Young individuals are found in shallow vegetation and on shallow hardbottom; adults move to shallow coral reef areas (Nagelkerken *et al.* 2000). Spawning can occur throughout the year, with peaks at different times in different areas (Smith 1997). In Cuban waters, peak spawning is during April with another less intensive peak in September (Claro *et al.* 2001). The stock structure of Yellowtail snapper is not clearly understood, but populations from southeastern USA waters are believed to belong to a single stock; populations from Brazil and Belize are significantly different (da Silva *et al.* 2015). However, the genetic linkages between the Gulf of Mexico and the

Caribbean remain unknown. Known fishing areas are recorded for the Mexican Gulf of Mexico, southern USA, off Colombia, and the NBSLME area (**Figure 3.20b**).

Southern red snapper (*Lutjanus purpureus*). This species is distributed in the tropical western Atlantic Ocean throughout most of the Caribbean Sea from Cuba southward to northeastern Brazil (**Figure 3.21a**). It is most abundant on the continental shelf off Honduras and in the Brazil-Guianas Shelf; less common around the Antilles where it is confined to deeper water. Southern red snapper inhabits rocky areas between about 30 and 160 m depth, most commonly in depths between 70 m and 120 m. Adults feed mainly on fishes, shrimps, crabs, and cephalopods. Spawning occurs mainly during spring and summer (Allen 1985). The stock structure of the species in the region is not totally understood. A distinct population of southern red snapper exists in Brazil (Gomes *et al.* 2012), but there is not sufficient information available in the Caribbean region. Known fishing areas are recorded off Colombia, and the NBSLME area (**Figure 3.21b**).

Lane snapper (*Lutjanus synagris*). This western Atlantic species is distributed from North Carolina south along the USA coast, Bermuda, the Bahamas, throughout the Gulf of Mexico and Caribbean Sea, and along the South American coast to Santa Catarina, Brazil (**Figure 3.22a**) (Lindeman *et al.* 2016d). This species is found in a variety of habitats, often around coral and rocky reefs and on vegetated sandy areas. This species is found in turbid as well as clear waters. Its maximum depth is 400 m, but the species is typically in much shallower waters over continental and insular shelves. Early life stages can be found among a variety of structural habitat types including settlers in seagrasses and near shore over hard bottom. There are multi-species spawning aggregations off the coast of Cuba that include this species, with the largest production on the southwest coast of the island (Lindeman *et al.* 2016d). The available studies on stock structure show the existence of at least three subpopulations in the northern WECAFC region: one in the western GOM, one in the eastern GOM, and one in the northern Caribbean (Puerto Rico) (Karlsson *et al.* 2009, Gold *et al.* 2011). It is likely that there may be other subpopulations in the southern WECAFC region due to the life-history of most lutjanids, where juvenile and adults are relatively sedentary, preferring inshore, soft or sandy-bottom habitats or nearshore hard-bottom habitats (Sierra and Fujiwara 2021). Fishing areas for lane snapper, like most snappers reviewed are recorded for the Mexican Gulf of Mexico, southern USA, off Colombia, and the NBSLME area (**Figure 3.22b**).

The Fishery

The reef and slope shared fishery resources selected are all members of the families Serranidae (Groupers) and Lutjanidae (Snappers). A characteristic of several members of these families, they reproduce in mass spawning aggregations that form for brief periods at specific times and places each year. These aggregations will attract the biggest fish and are highly predictable making them highly susceptible to overfishing. There are several examples of declining populations of grouper and snappers in the WECAFC region that have been subject to overfishing due to intensive fishing on spawning aggregations, like in the case of Nassau grouper, gag grouper, mutton snapper, among others.

Groupers and snappers in the WECAFC region are valuable to multiple countries and stakeholders whether for food, livelihoods from fish sales, and dive tourism. These species provide considerable income in the region; therefore, declines in population abundance from uncontrolled aggregation-fishing can affect communities and stakeholders in many different economic sectors. Of particular concern are the negative impacts to small-scale and artisanal fisheries that depend heavily on reef fishes.

According to recent FAO landing statistics for the period of 2015-2019, few countries report species-specific, the majority is at the family level or at the genus level for both groups (Groupers and Snappers). For groupers, Mexico is responsible for most of the accumulated reported catch under Serranidae (Grouper, seabasses nei) with 96.24% of the total accumulated catch in the period reviewed as well as for the total of *Mycteroperca* spp. (Brazilian groupers nei) which in México are called “negrillo” and “abadejo” (**Table 3.8**). In Mexico, the main target species is “*mero o cherna americana*”, *Epinephelus morio* (red grouper) and is fished by three types of fleets: artisanal; artisanal mid-range; and another foreign (Cuba) that is called “Flota cubana”, described as a mother ship with six boats each fishing with bottom longline gear of up to 350 hook each (DOF 2018). The other two fleets have limits on the number of hooks allowed, and 4 200 artisanal boats were in operation by 2014. In the artisanal, the bottom longline is limited to 750 m and maximum of 250 hooks; while the artisanal mid-range, can use up to four bottom longlines with 500 hooks each or one bottom longline with 2000 hooks. The main fishing grounds are concentrated in the Campeche Bank, off the state of Yucatan (Monroy-García *et al.* 2014). In Mexico, the “Mero, Negrillo, and Abadejo” (red grouper and Brazilian grouper nei) fishery has several management regulations on minimum size, gear limitations, an annual seasonal closure, and area limitation (DOF 2018). However, there are 10 other grouper species that are considered target (five *Epinephelus* spp. and five *Mycteroperca* spp.) but are not disaggregated by species in any of the fleets. It is possible that “negrillo” (Black grouper, *Mycteroperca bonaci*) and “abadejo” (Gag grouper, *Mycteroperca microlepis*) are reported as Brazilian groupers nei (*Mycteroperca* spp. *)* (Monroy-García *et al.* 2014).

The Dominican Republic and Venezuela are the two countries that report most of the total accumulated catches of *Epinephelus* spp. (Grouper nei) with 81.8%, each with 68.75% (Dominica Republic) and 13.05% (Venezuela) for 2015-2019 (**Table 3.8**). In Dominican Republic, the fishery for groupers (*Epinephelus* spp.) is the same as the one for snappers (Lutjanidae) for which the country reports 26.36% of the total accumulated catches for 2015-2019, the second after Mexico (**Table 3.9**). In both cases, the fishery (for Groupers and Snappers) is operated by small-scale (artisanal) fleets that target species in the border of the platform (shelf edge) and the offshore ocean banks of Dominican Republic, La Navidad and La Plata, as well as other small banks in the north of the island (Herrera *et al.* 2011). The fishing grounds for the coastal artisanal fleet are in the southwest part of the island where the shelf drop is close to the coast, off Barahona and Pedernales, and in the northeastern part of the island off Samaná Peninsula. Fishing depths are between 100-500 m. There are mainly two types of vessels that harvest fish species off Dominican Republic: "*Yola"*, a flat wooden boat sometimes recovered with fiberglass, 5-7 m long and powered by a 5-25 HP outboard engine; and "*Bote* or *Panga"*, a modest-sized fiber glass boat with a high bow, narrow waterline beam, and a flotation bulge along the gunwale, or top edge of the hull. These are powered with different size outboard engines (15-40 HP) depending on the length of the "*bote*" (5 m - 7 m) (Gentner *et al.* 2018). The fishing gears used are hand-line, longline, and traps. It is likely that fishing in the offshore banks will be undertaken by an artisanal mid-range fleet capable of fishing operations offshore with holding facilities onboard noting the fishing grounds are 90 miles offshore. The published information indicates that the main groupers/snappers caught are Yellowedge grouper (*Hyporthodus flavolimbatus*) and Queen snapper (*Etelis oculatus*); however, the multispecific reef fleet operating in the southwest and use traps also catch Nassau grouper (Herrera *et al.* 2011).

In Venezuela, the fishery is operated by small-scale (artisanal) fleets that target grouper and snapper species in the border of the platform (shelf edge), on hard bottoms, and in the reefs of the Venezuelan Islands. There are three small-scale (artisanal) fisheries that target this group of species: i) the artisanal coastal fleet, that uses small wood/fiberglass vessels (≤10 m, 75 HP outboard engine) with a crew of 2-3 fishers, and operates off the Venezuelan Caribbean coasts and Islands; ii) the mid-range fleet, that consists of mid-size wood vessels (10-14 m) with inboard engine and a crew of 5-7 fishers, and which operates off the Venezuelan Caribbean coasts and Islands as well; and iii) the long-range artisanal fleet, with larger size wood vessels (14-24 m), and which operates in the waters of the NBSLME (off Guyana and Suriname) with a crew of 10-15 fishers (Mendoza 2015). When targeting grouper and snapper, the mid- and long-range fleets are known as the "*pargo-mero*" artisanal fleet, most of which are based in Margarita Island. The preferred gears for the artisanal coastal fleet are handlines, traps, and bottom gillnets. In the mid- and long-range artisanal fleets, the use of hand-line and bottom longline are the norm for these fleets. Most of the grouper catch is from the northeastern part of Venezuela including the catch from the NBSLME (73% in the 1990s), followed by the northwestern area (17%) off La Guajira, and 10% of the catches were from the central area including the offshore reef islands (Los Roques, Las Aves) (Novoa *et al.* 1998). The grouper catch is not disaggregated but records indicate that the most common species in the catches are red hind (*Epinephelus guttatus*), and Nassau grouper (*Epinephelus striatus*) commonly caught in the Venezuelan reef islands; the Yellowedge grouper (*Hyporthodus flavolimbatus*) is the main species caught by the long-range artisanal fleet fishing in along the NBSLME (off Guyana and Suriname) as well as some catches of Snowy grouper (*Hyporthodus niveatus*); red grouper (*Epinephelus morio*), Atlantic goliath grouper (*Epinephelus itajara*), and Rock hind (*Epinephelus adscensionis*) are caught by the coastal and mid-range artisanal fleets along the Venezuelan coasts and shelf islands (Novoa *et al.* 1998, Mendoza and Lárez 2004, Cervigón and Ramírez 2012).

The FAO statistics for snappers follow a similar pattern as in groupers above: most of the reports by country is at the family level and at the genus level. For snappers, three countries are responsible for most of the accumulated reported catch under Lutjanidae (Snappers, jobfishes nei) with 81.61% of the total catch in the period reviewed (**Table 3.9**). Mexico reports 42.85% of the total catch of snappers, coming from the "*Huachinango and Pargo*" fishery, which has 13 snapper species as target, including the northern red snapper (*Lutjanus campechanus*) —the main target— and other common like the mutton snapper, grey snapper, lane snapper, and yellowtail snapper particularly in the area off Yucatán state (DOF 2018). Unlike the grouper fishery, the snapper fishery is more of a multispecific artisanal coastal fleet that operates along the Mexican coasts, using boats with outboard engines and a crew of 3-4 fishers using handline gear. The artisanal mid-range grouper-directed fleet with line gear called "*bicicletas*" —which consist of a series of hooks along a single line drop line— catches snappers as well.

The next two countries with important snapper catches are Dominican Republic with 26.36% and Venezuela with 12.40% of the Lutjanidae (Snappers, jobfishes nei). In both countries, the fishery operations are the same as with the grouper fishery described before. However, Dominican Republic also has a multispecies reef fishery that takes place on the coral reefs along the entire country's coasts up to 30 m of depth. This fishery catches several snapper species using traps in addition to handline gear in which the most frequent species caught were Mutton snapper, Grey snapper, Lane snapper, and Yellowtail snapper. It is noted that the only snapper species reported to FAO by Dominican Republic is Southern red snapper for which 13.33% of the total accumulated of the species is reported by Dominican Republic (**Tables 3.9, 3.10**); however, there are no known reports of this species in Dominican Republic (https://biogeodb.stri.si.edu/caribbean/en/thefishes/species/3691). In Venezuela, the snapper species reported grouped are from catches reported by the coastal artisanal fleet that operates along the Venezuelan coasts using mostly traps, handline, and gillnets. In contrast with the mid- and long range artisanal fisheries that separate by species because of the difference in price for those species reported by Venezuela to FAO statistics (*e.g*. Mutton snapper, Southern red snapper, Lane snapper, and Yellowtail snapper).

There are five countries that report *Lutjanus* spp. (Snapper nei), The Bahamas, British Virgin Islands and Nicaragua account for 87.83% of the total accumulated catches for 2015-2019 (**Table 3.9**). The Bahamas accounts for 48.13% of the snapper nei catches, is from the small-scale commercial (artisanal) sector that primarily targets demersal species and do disaggregate the snapper catches which come from the grouper fishery in which both group of species are caught using spears, scale fish traps, hook and line or nets. Aggregating devices are sometimes used to attract snappers and grunts. Deepwater grouper and snapper species are caught using scale fish traps in strings lowered down the drop-off from shallow to deep water, ranging in depths from 24 – 244 m (Moultrie *et al.* 2016). Nicaragua accounts for 29.27% of the reported snapper catches are also from the artisanal finfish fishery which consists of about 2440 boats of different sizes (8-11 m), with inboard (23 HP) and outboard (75 HP) engines, as well as sails. However, about 48% of the boats are powered. The gears commonly used are gillnets and hand lines (CIPA 2008, Haas *et al.* 2015). The British Virgin Islands account for 10.44% of the total snapper catches coming from the small-scale (commercial) fishery. The main fishing gear used by the artisanal fishers is the fish trap, with others including handline gear and fishing nets. The finfish landed are snappers and groupers among other reef-associated species (FAO 2004). Most fishers market their own catch at various places within the territory usually at or near landing sites, with an appreciable number of fishers selling their catch directly to the hotels and restaurants and a small number to the local companies.

At the species level for groupers, Red grouper (*Epinephelus morio*) is mainly reported by the USA with 94.51% of the total accumulated catch for 2015-2019; for Nassau grouper (*Epinephelus striatus*) the total recent catch is reported by three countries, The Bahamas (66.24%), Colombia (17.51%), and Cuba (16.25%) (**Table 3.8**); Bahamas and Cuba artisanal fisheries have traditionally targeted this species, for Colombia would appear to be from occasional landings from its artisanal fisheries operating in reef areas of San Andres Island and the Chocó-Darién reef system where the species are known to occur (Bolaños-Cubillos *et al.* 2015, Escobar-Sierra *et al.* 2021). For Red hind (*Epinephelus guttatus*), most of the recent catch (91.14%) is reported by three island nations, Grenada, St. Vincent and the Grenadines, and Bermuda (**Table 3.8**); in Grenada and St. Vincent, red hind is a common species landed by the demersal fisheries over shallow reef areas using most likely bottom longline gear (Mohammed and Lindop 2015, Harvey 2018). Bermuda catches of red hind and Black grouper (*Mycteroperca bonaci*) are from line fishing which is a common fishing practice among the artisanal fishers and trolling with lures to catch black grouper in the shallower parts of the reef platform (Luckhurst and Trott 2009, 2015). For the Gag grouper (*Mycteroperca microlepis*), the total recent catch is reported by the USA, fishers mainly use vertical hook-and-line gear to harvest gag, and some also use longlines and spears, the species also makes up a large part of the recreational catch in the USA south Atlantic and GOM (SEDAR 2014a, 2016a, 2021a,b).

For the snappers at the species level, in the northern area of WECAFC region, Northern red snapper (*Lutjanus campechanus*) is only reported by Mexico (66.06%) and the USA (33.94%), and Grey snapper (*Lutjanus griseus*) most of the total accumulated catch (97.78%) for 2015-2019 are reported by Mexico (80.99%) and the USA (16.79%) (**Table 3.9**).

In the Caribbean and NBSLME, most of the total accumulated catches of Mutton snapper (*L. analis*) that account for 95.3% are reported by Venezuela (55.07%), the USA (30.61%), and Colombia (9.62%) (**Table 3.9**); for Lane snapper (*Lutjanus synagris*) most of the accumulated catches are reported by Cuba (55.89%), Venezuela (25.78%), and Mexico (10.85%) (**Table 3.10**). The Yellowtail snapper (*Ocyurus chrysurus*) a common snapper across the WECAFC region and abundant in the Caribbean is broadly reported, but most of the total accumulated catches for the recent period are from Mexico (46.54%), USA (18.07%), and Nicaragua (17.87%) (**Table 3.10**). It is noteworthy to indicate that in Mexico and Nicaragua, the snapper fishery ("*Huachinango and Pargo*" in Mexico and "*Escamas*" in Nicaragua) targets multiple snapper species that are aggregated most of the time, but for some species like "*pargo cola amarilla*" (*Ocyurus chrysurus*) in Nicaragua, where this is the main snapper species (61.1%) in the "*Escamas*" fishery is disaggregated among other finfish species (INAPESCA 2018). Most of the Southern red snapper catch for the recent period is reported by Guyana (46.36%) and Venezuela (21.08%) from the NBSLME and from Cuba (16.76%) and Dominican Republic (13.33%) from the Caribbean islands (**Table 3.10**). In Guyana, the Southern red snapper fishery is caught by three fleets; the red snapper line fleet, the red snapper trap fleet and an incidental line fishery for shark carried out by the trap boats, all of which are mixed fisheries targeting a variety of species. Recently, Guyana is encouraging handline gear for the Red snapper fishery (Government of Guyana Ministry of Agriculture 2019). Venezuela's catches of southern red snapper mostly come from its mid- and long range "*pargo-mero*" artisanal fleets that have operated in the southeastern Caribbean and in the NBSLME off French Guyana and Suriname (Mendoza and Lárez 2004, FAO 2019b).

State of the stocks

The Groupers

Red grouper. The stock status is different in three areas: Northern GOM, Mexico and USA South Atlantic. No structural partitions. The northern Gulf of Mexico stock is not overfished, and overfishing is not occurring (SEDAR 2019b). The Mexican stock unit is "in deterioration" for years, based on the stock assessment results, reduction of the CPUE values in the commercial fleet and the lower abundance indices obtained in the joined surveys undertaken by Mexico-Cuba (DOF 2014). The USA south Atlantic stock is overfished, and overfishing is occurring (**Table 3.6)** (SEDAR 2017b, Carpenter *et al.* 2015).

Nassau grouper. There are no recent assessments, mostly because of the declining trends in the landings and its classification as a threatened species under the USA Endangered Species Act. It is considered to be overfished in the United States Caribbean region (https://www.fisheries.noaa.gov/species/nassau-grouper#overview), as well as in Cuba (Baisre 2018). It is also listed as endangered on the IUCN red list (Sadovy *et al.* 2018). Overfishing has been a major threat to this species, particularly heavy fishing on spawning aggregations.

Red hind. The most recent stock assessment conducted for this species in the USA Caribbean indicates several key data gaps, but concluded that the stock has, on average, a 32.5%–60% risk of experiencing overfishing and therefore is being exploited unsustainably (SEDAR 2014b).

Gag grouper. The most recent assessment for the USA South Atlantic Gag grouper stock found that the stock is not subject overfishing and is not overfished (SEDAR 2021a). In the USA Gulf of Mexico, the most recent stock assessment for the species indicated that the stock is not overfished (2016 stock assessment) and is not subject to overfishing based on 2019 catch data (SEDAR 2021b). Management measures implemented in 2009 have allowed the stock to rebuild.

Black grouper. The stock status for the species in USA waters based on the most recent stock assessments, the Gulf of Mexico/USA South Atlantic stock is not overfished (SEDAR 2010) and is not subject to overfishing based on 2019 catch data. In the USA Caribbean, Black grouper is part of the Caribbean groupers complex and is not assessed so the overfished status is unknown, but the groupers complex is not subject to overfishing based on 2019 catch data. In Mexico, reported landings of the species are lumped with other grouper species (SAGARPA 2012), and the Mexican grouper fishery is considered to be in an overall state of decline. In Cuba, black grouper declined by more than 50% in mangroves and the reef slope (Baisre 2018). In the rest of the region, the stock status of the species remains unknown.

The Snappers

Northern red snapper. The GOM stock had been severely overfished and undergoing overfishing since the late 1980s. However, the most recent assessment indicated that red snapper is still overfished but is no longer undergoing overfishing (SEDAR 2018b). The latest stock assessment for USA southeastern stock indicated that the stock remains overfished, and that overfishing is occurring (SEDAR 2017a), though at a lower rate than in 2009. This assessment estimates that, since 2010, the stock has been increasing at a modest rate. In Mexico, the species is fished at maximum sustainable level at Tabasco, but in the rest of the fishing areas catches have diminished, with the species likely overexploited (DOF 2018) (**Table 3.6**).

Mutton snapper. The Puerto Rican and the United States Virgin Islands Mutton snapper population is not overfished and is not undergoing overfishing (SEDAR 2007b). The most recent assessment for the GOM and USA southeastern Atlantic stock indicated that is not overfished and overfishing is not occurring (O'Hop *et al.* 2015). Noting that this species has documented spawning aggregations, in 1992, the USA Gulf of Mexico Fishery Management Council imposed a two-month spawning season closure (May and June) in the area off Dry Tortugas, Florida (Lindeman *et al.* 2016a). In Cuba, mutton snapper is considered to be overfished due to intensive fishing during the spawning aggregation of the species; approximately 35%–40% of the annual catch of mutton snapper were obtained during spawning aggregations between May and June (Claro *et al.* 2009, Baisre 2018).

Grey snapper. In the Gulf of Mexico, the stock has been experiencing overfishing since 1976 (with few exceptions) and is currently undergoing overfishing (SEDAR 2018b); while the USA South Atlantic stock is not experiencing overfishing but its overfished condition is unknown. In Cuba, where this species forms abundant spawning aggregations (June through August), the stock has declined (Claro *et al.* 2009). In Puerto Rico, Gray snapper was considered overfished (with overfishing still occurring) (Ault *et al.* 2008). The stock status in Venezuela, where the species is common and fished by many shallow water gears, is not known.

Yellowtail snapper. Based on recent USA stock assessment, this species is not overfished in USA waters and is not experiencing overfishing (SEDAR 2020a). However, it is considered to be overfished in Cuba and in Brazil. In Cuba, landings declined more than 50% since 1995. Brazil has the largest landings of this species worldwide, a trend that began in the 1980s (Lindeman *et al.* 2016c).

Southern red snapper. The stock assessment carried out in Guyana and French Guyana suggested that the stock was overfished and undergoing overfishing; while the stock status from assessments in Brazil and Suriname indicated that the stock was not overfished nor undergoing overfishing (FAO 2021).

Lane snapper. Stock status in the USA GOM indicates that the stock is not undergoing overfishing, but it is not clear if it is overfished (SEDAR 2016b). In other localized areas of the region (Honduras) where a small-scale fishery targets the species, the assessment suggested that the stock is experiencing overfishing (Sierra and Fujiwara 2021). In Cuba, lane snapper is considered to be overfished due to intensive fishing during spawning aggregations in which 60%-70% of the annual catches were fished in 10-21 days during peak spawning (Claro *et al.* 2009, Baisre 2018). Older assessment conducted in several countries fishing in the NBSLME fisheries concluded from the preliminary results that the stock in that area might be overfished (CRFM 2006). From a yield per recruit perspective, the fishery then appears to be operating near the optimum, but this assumes that future recruitment will continue at current levels. The current stock status in the southern WECAFC region is not known.

The Shelf Shrimp resources

The shared shrimp species of interest in this section are those considered to be the main target species of the soft-bottom fisheries in the region. The resulting selection included three northern species, three southern species and two regional species.

Northern brown shrimp (*Farfantepenaeus aztecus*). Northern brown shrimp is distributed along the Atlantic coast of USA from Massachusetts to Texas; east coast of Mexico from Tamaulipas to Campeche (**Figure 3.23**) (Holthuis 1980). Inhabits depths of 4 m to 160 m, and its highest densities are between 27 m and 54 m over muddy bottoms, often with sand, clay, or broken shells. The adults are marine, the juveniles estuarine and marine. Peak spawning is in spring and summer, with newly hatched shrimp entering estuaries in February and March to settle in their nursery habitat (https://www.fisheries.noaa.gov/species/brown-shrimp). The population structure of the species is not clear but there are indications that the Northern Gulf of Mexico and Northwest Atlantic distributions may constitute a single contiguous population (McMillen-Jackson and Bert 2003) that is currently assessed and managed independently in the USA region. In Mexico is caught in the estuaries of Tamaulipas and Veracruz (DOF 2012). It is unclear if the population caught in Mexico is part of the same population in the northern GOM and the USA southeast Atlantic.

Northern pink shrimp (*Farfantepenaeus duorarum*). Northern pink shrimp is distributed from southern Chesapeake Bay and Bermuda to the Florida Keys and around the coast of the Gulf of Mexico to Quintana Roo (**Figure 3.24**) (Holthuis 1980). They are most abundant in the Tortugas area and in the Gulf of Campeche. It inhabits depths of 2 m to 70 m over muddy bottoms sometimes with sand or clay. Adults are marine, and juveniles estuarine. Off North Carolina, they spawn in May through July (https://www.fisheries.noaa.gov/species/pink-shrimp). In Florida they spawn multiple times, peaking from April through July when the water is warmest. Newly hatched shrimp travel to their estuarine nursery habitats in late spring and early summer, propelled by shoreward currents. Like Northern brown shrimp, the population structure of this species is not clear but there are indications that the northern GOM and the USA southeast Atlantic distributions may constitute a single contiguous population (McMillen-Jackson and Bert 2003) that are currently assessed and managed independently in the USA region. Pink shrimp is caught along with Brown and White shrimp throughout the area.

Northern white shrimp (*Litopenaeus setiferus*). Northern white shrimp is distributed from southern Chesapeake Bay to the Florida Keys and around the coast of the Gulf of Mexico to the Yucatan south of Cabo Catoche, Mexico (**Figure 3.25**) (Holthuis 1980). They are most abundant off southwestern Florida and the southeastern Gulf of Campeche. It inhabits depths of 2 m to 90 m over muddy bottoms sometimes with sand or clay. Adults are marine, and juveniles estuarine. White shrimp spawn when offshore ocean bottom water temperatures increase, generally from May through September in North Carolina and South Carolina, and from March through September in the Gulf of Mexico. (https://www.fisheries.noaa.gov/species/white-shrimp). Newly hatched shrimp travel to their estuarine nursery habitats in April and early May. The population structure of this species is formed by a population from the USA Atlantic coast and another from the GOM based on some evidence of genetic separation (Ball and Chapman 2003).

Southern brown shrimp (*Farfantepenaeus subtilis*). Southern brown shrimp is distributed from the Greater Antilles in the Caribbean Sea and south of Yucatan, Mexico along Central America and the northern coast of South America to northern Brazil (**Figure 3.23**). The biology and ecology of this species is like its northern counterpart, most of its biological traits are adapted to its distribution and habitat. This species inhabits depths of 1 m to 190 m, over bottom mud, often with sand, or broken shells. The adults are marine, the juveniles estuarine and marine. They are omnivorous, and feed on worms, algae, microscopic animals, and various types of organic debris (Holthuis 1980). Stock structure in the WECAFC region has not been addressed.

Southern pink shrimp (*Farfantepenaeus notialis*). Southern pink shrimp in the western Atlantic is distributed from the Greater Antilles in the Caribbean Sea and south of Yucatan, Mexico along Central America and the northern coast of South America to southern Brazil-Rio de Janeiro (**Figure 3.24**). This species usually inhabits depths of 3 m to 50 m, over bottom mud, often with sand, and sandy patches among rocks. The adults are marine, and the juveniles estuarine. Off northern Colombia, spawning occurs all year, but peaks were observed between October - December and April-June (Páramo *et al.* 2014); in Guatemala peak spawning was observed from January to June (de León 2016). Stock structure in the WECAFC region has not been addressed, most countries that fish for this species in the region considers it as a single stock unit in their jurisdictional waters.

Redspotted shrimp (*Farfantepenaeus brasiliensis*). Spotted shrimp is distributed along the Atlantic coast of USA from North Carolina to Rio Grande do Sul in Brazil, including Bermuda and the southern Gulf of Mexico and the Caribbean Sea (**Figure 3.26**). However, its highest densities seem to occur in the NBSLME area. It inhabits depths of 3 m to 365 m, and its highest densities are between 45 m and 65 m over bottom mud or sand. The adults are marine, the juveniles estuarine and marine (Holthuis 1980). Stock structure in the WECAFC region has not been addressed, most countries that fish for this species in the region considers it as a single stock unit in their jurisdictional waters.

Southern white shrimp (*Litopenaeus schmitti*). Its geographical distribution in the WECAFC region is from Greater Antilles from Cuba to Virgin Islands and from Belize through to the northern coast of South America and the NBSLME (**Figure 3.25**). The species common habitat is bottom soft mud or silt, sometimes with sand, at depths from 2 m to 47 m, is most abundant between 15 m and 30 m. Juveniles found in estuarine areas, and the adults are marine (Holthuis 1980). In Guatemala, a high number of spawning females were present from July to October (de León 2016). Stock structure in the WECAFC region has not been addressed, most countries that fish for this species in the region considers it as a single stock unit in their jurisdictional waters.

Atlantic seabob (*Xiphopenaeus kroyeri*). Atlantic seabob is distributed from North Carolina, United States of America to Santa Catarina in Brazil, including the Gulf of Mexico and the Caribbean Sea (**Figure 3.27**). However, its highest densities seem to occur in the NBSLME area. It inhabits depths of 1 m to 70 m, but its highest densities are in depths less than 30 m over bottom mud or sand. It is a marine and brackish species, most abundant near river estuaries. Nursing areas are estuarine or inshore waters, adults spawn in marine waters (Holthuis 1980). A recent genetic study on the population structure of Atlantic seabob in the NBSLME indicated that only one single population is present there, although there is no conclusive evidence that Atlantic seabob from Trinidad and Tobago and Colombia were part of the same population (Kerkhove *et al.* 2019, FAO 2021). The possibility that Atlantic seabob from the northern part of the WECAFC region is the same population is plausible (Gusmão *et al.* 2006).

The Fishery

The shared shrimp resources of the region are members of the Penaeid family, which are short-lived species, having a life span of about 1–2 years. This family contains some of the most valuable commercial species of shrimps. Their life cycle is spent between estuaries, coastal lagoons, river deltas, and offshore waters; where larvae and post larvae migrate to nursery grounds in estuaries and other wetlands, and during the juvenile stage, they migrate to offshore waters and attain sexual maturity. In the region, the shared shrimp resources are fished across their life cycles' distribution range, in estuaries, coastal lagoons, river deltas, and offshore waters by a variety of coastal artisanal and subsistence fisheries and by industrial fisheries in offshore waters.

Shrimp fishery statistics reported to FAO are species-specific for the Atlantic seabob and the northern shrimp resources fished by Cuba, Mexico, and the USA; while the shrimp resources fished in the Caribbean LME and the NBSLME are reported grouped as *Penaeus* spp. (Penaeus shrimp nei), except for Southern white shrimp in recent years.

The total accumulated catch for the period of 2015-2019 of Northern brown shrimp and Northern white shrimp are reported by the USA and Mexico, in which most of the catch of both species is attributed to the USA (72.65% for Northern brown shrimp, 97.29% for Northern white shrimp), while Mexico landed the remaining portion of the reported catch (**Table 3.11**). For Northern pink shrimp, the USA is responsible for over half of the total accumulated catch for the same period, while Mexico landed about a third of the total accumulated catch, and Cuba landed the rest (9.01%) of the total reported catch of Northern pink shrimp in the region.

Almost all the Northern brown shrimp and Northern white shrimp harvested in the USA come from the GOM, mainly from Texas and Louisiana (https://www.fisheries.noaa.gov/species/); while over half of the Northern pink shrimp harvested in the USA come from the west coast of Florida. Northern brown shrimp is the most important species in the USA GOM shrimp fishery, with most catches made from June through October (GMFMC 2017). The fishery operates at about 70 m and is highly dependent on environmental factors such as temperature and salinity. Whereas in the southeastern USA it occurs in commercial quantities in areas where water depth is as great as 110 m, but Northern brown shrimp and Northern white shrimp are most abundant in areas less than 55 m deep (SAFMC 2004).

Northern white shrimps are found in nearshore waters to about 36 m from Texas through Alabama, where most of the catch is fished from August through December, in addition to a small spring and summer fishery (GMFMC 2017). In the southeastern USA, the Northern white shrimp is more common off South Carolina, Georgia and northeast Florida. Northern white shrimps are generally concentrated on the continental shelf where water depths are 27 m or less (SAFMC 2004).

Northern pink shrimps are fished off all GOM states but are most abundant off Florida's west coast, particularly in the Dry Tortugas grounds off the Florida Keys. Most landings occur from October through May and Pink shrimp are caught in water depths 55 m (GMFMC 2017). In the northern and western GOM states, Northern pink shrimp are sometimes mistakenly counted as Northern brown shrimp. Northern pink shrimps are of major commercial significance only in North Carolina and the Florida Keys on the Atlantic side, in areas where the highest abundance occur is at water depths of 11-37 m, although in some area they may be abundant at water depths of 65 m (SAFMC 2004).

In the USA GOM shrimp fishery, as of 2016, there were 1 440 valid or renewable federal GOM shrimp permits. There has been a moratorium on the issuance of new GOM shrimp permits since 2007. Permits are fully transferrable, and renewal of the permit is contingent upon compliance with reporting requirements. For state commercial shrimping licenses, there are approximately 9500, more than half of which are licensed through Louisiana (GMFMC 2017). Therefore, it is likely that there are less than 9 500 vessels fishing commercially for shrimps in state waters of the GOM.

The harvesting sector is composed of two types of fleets: 1) A small vessel fleet that is predominantly active in inshore and state offshore waters, and diverse with respect to gear and other operating characteristics; and 2) A large vessel fleet predominantly active in offshore waters, particularly the EEZ, and almost always using otter trawl gear with various modifications (including escapement devices like TEDs and BRDs). More than half of the vessels fall into a size range from 17 to 23 m across both fleets (GMFMC 2017). The small vessel fleet operating in inshore and state offshore waters use various types of gears including cast nets, haul seines, stationary butterfly nets, wing nets, skimmer nets, traps, and beam trawls.

A recreational shrimp trawl fishery occurs seasonally inside state waters. However, not all states have a permitting system for recreational shrimping in state waters, and not all states track the amount of bait shrimp landed (GMFMC 2017).

The USA GOM Penaeid shrimp fishery is subject to several cooperative management regulations that include simultaneous closure in both state and federal waters off the coast of Texas, the Tortugas Shrimp Sanctuary, and seasonally closed zones for the shrimp and stone crab fisheries off the coast of Florida (GMFMC 2017).

In the USA south Atlantic shrimp fishery, each state has its own regulatory gear restrictions. The commercial fishing area for Penaeid shrimp (Northern white, brown and pink) species in the Atlantic side is mainly concentrated from Florida to North Carolina. There is another fishery off the Florida Keys where the main target is pink shrimp (SAFMC 2004). In North Carolina, the important shrimping areas are off major rivers deltas and off the southern coast. The most important fishing area in Florida is the northeastern part of the state. In Georgia, shrimping takes place along the entire coast. In South Carolina, the most important shrimping areas are from Georgetown (Winyah Bay) south. Commercial shrimp catches in all four states are taken from internal waters, state waters out to three miles and from the EEZ. Most of the shrimp in these states are caught using otter trawl gear with its modifications. However, in Biscayne Bay, Florida, shrimps are harvested with wing nets. A wing net is a net in the form of an elongated bag kept open by a rigid frame that is attached to either side of a vessel and is not towed behind a vessel or dragged along the bottom. This is a top water fishery and shrimp are harvested as they leave the bay.

Recreational shrimp harvest in the USA Atlantic side occurs almost exclusively in state waters and is comprised mostly of Penaeid shrimp (white, brown and pink) species. A variety of gear types are employed for recreational food shrimp activities and recreational shrimping for bait. Recreational fishermen catch brown shrimp seasonally and almost always in state waters where regulations vary between states. In addition, there is a commercial bait shrimp fishery in the Atlantic side where Florida has the largest operation of the area (SAFMC 2004).

In Mexico, most of the shrimp catch consists of Northern brown shrimp that is caught off the coast from south of the Rio Bravo in Tamaulipas south to Rio Coatzacoalcos in Veracruz in depths of 9 m - 109 m by the artisanal and industrial fleets (DOF 2012). The industrial fleet of about 722 vessels uses the bottom trawl gear with escapement devices like those used in the USA Penaeid shrimp fishery (http://www.fao.org/fishery/facp/MEX/en). Other fishing areas include the Campeche Sound off Tabasco and Campeche, and the Mexican side of the Caribbean in Quintana Roo (Wakida-Kusunoki *et al.* 2006). In the area of the Campeche Sound, most of the shrimp catch consists of Northern pink shrimp. While the shrimp fishery in the Mexican side of the Caribbean consists of mainly of Redspotted shrimp. The artisanal fishery in the coastal lagoons like Laguna Madre in Tamaulipas uses set gillnet called "charangas", where a total of 3064 nets where operating in 2001 of a total of 2540 licensed nets (Ramírez 2003, Fernández and Escartín 2003).

The shrimp fishery off Campeche sound consists of two fleets: 1) An artisanal fleet that targets juveniles of Northern pink shrimp in coastal areas; and 2) An industrial vessel fleet active in offshore waters and using otter trawl gear with various modifications (including escapement devices like TEDs and BRDs), the main interest of this fleet is Northern white shrimp, although high proportions of northern brown and Northern pink shrimps were also caught. However, shift in fleet operations (day vs night fishing) can reverse the proportion of species caught (Wakida-Kusunoki *et al.* 2006).

The Mexican Penaeid shrimp fishery is subject to several management regulations, which include spatial and seasonal closures, and no take areas. For the industrial fleets fishing in Mexican waters there is a seasonal closure from May to September. Spatial closures for the industrial shrimp fleet occur from Campeche to the limits with Belize of a no take zone between 0 miles and 15 miles. For the artisanal fleets operating in estuaries, coastal lagoons, seasonal closures are from May-July and from May-September depending in the area, and there is a permanent closure in Términos and Campeche lagoons (CONAPESCA 2018).

The shrimp fishery in Cuba operates off the southeastern coasts of the island, from Cienfuegos to Manzanillo. The shrimp fleet comprises of 30 vessels that use otter trawl gear with its escapement devices (http://www.fao.org/fishery/facp/CUB/es). Most of the shrimp catch is of Northern pink shrimp (about 98%), the rest is of Southern white shrimp (Pérez 2016). The fleet fishes from depths of 5-15 m and up to 50 m depending on the fishing area. Fishing operations can last between 10 and 20 days at sea, but the shrimp catch is transshipped daily to the local plant in the island (Pérez Marrero 2016). Seasonal closure from July to October is used as a management action.

Most of the total accumulated catch (95.99%) in the region for the period of 2015-2019 of the *Penaeus* shrimp catch is attributed to eight countries (**Table 3.11**). Mexico is the major producer of *Penaeus* shrimps with 36.25%, followed by Nicaragua and Honduras with a combined reported catch of 27.43%. The rest of the five countries with important *Penaeus* shrimp catches (32.31%) share most of the shrimp resources along the Atlantic northern coast of South America where important estuaries and river deltas are the major grounds for the southern *Penaeus* shrimp species. In Central America, the majority of the shared *Penaeus* shrimp species are caught off the shelf of Honduras and Nicaragua with artisanal and industrial fleets, while the rest are likely caught by small-scale coastal fleets in estuaries of Guatemala and Costa Rica. In these last two countries, the estimated catch from Guatemala is made of the Northern brown and Northern pink shrimp (most likely to be Southern brown and Southern pink shrimps based on the geographical distribution of the species) and the Southern white shrimp (Lindop *et al.* 2015b); whereas the small catch from Costa Rica is confusing because the country does not report Caribbean shrimp landings in the official web site (https://www.incopesca.go.cr/publicaciones/estadiscticas/historico.aspx). In Nicaragua, the main *Penaeus* shrimp species caught by the artisanal and industrial fleets are the Southern pink and the Southern white shrimp, and possibly Southern brown and Redspotted shrimps are also caught but in smaller quantities (CIPA 2008). Artisanal fleet operating in coastal lagoons normally catch Southern white shrimp with cast nets. The number of operating industrial shrimp vessels in 2017 was 14, all of which operate with bottom trawl gear with escapement devices (INPESCA 2018). In Honduras, the species breakdown is like that of Guatemala (Funes *et al.* 2015). In Dominican Republic, artisanal and subsistence fisheries catch of Southern white shrimp and likely Southern pink shrimp in the northeastern part of the island. Most of the shrimp catches are made of Southern white shrimp (85-95%), the main gears used are gillnets and cast nets (Herrera *et al.* 2011).

From Colombia and along the northern coast of South America and the NBSLME the *Penaeus* shrimp species caught are southern *Penaeus* spp. In Colombia, most of the *Penaeus* shrimp species caught are Southern pink shrimp, Redspotted shrimp, Southern brown shrimp, and Southern white shrimp. The shrimp fishery off Colombia in the Caribbean is operated by what is called a shallow water fleet, with vessels operating in the area south of Cartagena, mainly between the Gulf of Urabá and the Gulf of Morrosquillo, and another area north of Colombia (La Guajira) (Bustos *et al.* 2012). In 2004, there were 53 vessels dedicated to *Penaeus* shrimp fishing, 30 were from Colombia, the rest were foreign flagged. The fleet's vessels are "Florida type" of 13-25 m with 165-520 HP engines, each vessel operates using otter trawl gear with escapement devices for turtles, fishing operations take place during the night at depths between 21 and 81 m (Zúñiga *et al.* 2006).

In Venezuela, *Penaeus* shrimp species are caught in three main areas: 1) in the west, shrimp fisheries take place in the Gulf of Venezuela and in Lake Maracaibo; 2) in the northeastern shelf shrimps are caught off the coastal Lagoons of Tacarigua, Unare-Píritu and around Margarita Island (mostly in the southern area); and 3) in the Gulf of Paria and northern Orinoco River delta (Marcano *et al.* 2001, Alió *et al.* 2010). Before the ban on industrial trawling fleet in Venezuela in 2009 that landed an important proportion of the *Penaeus* shrimp species in the country, the species composition by fishing areas was the following: 1) In the west, in the Gulf of Venezuela all southern *Penaeus* shrimp species were caught but 50% of the catch was of Southern brown shrimp, while in Lake Maracaibo it was mostly Southern white shrimp along with some catches of juveniles of the other species; 2) In the northeastern shelf, off the coastal lagoons southern Southern white and Redspotted shrimps were the most common in the landed catches, while around Margarita Island Southern brown, Southern pink, and Redspotted shrimps were most common; 3) In the Gulf of Paria, the most common species caught were Southern white, Southern brown, and Redspotted shrimps but off the Orinoco River delta Southern white shrimp was the most caught by the shrimp fisheries (Novoa 2000, Marcano *et al.* 2001, Alió *et al.* 2010).

In recent years, after the disappearance of the trawling fleet, the Venezuelan shrimp fishery is operated by the artisanal fleets in the different shrimping areas of country. Venezuela´s major *Penaeus* shrimp reported catches for the period 2015-2019 are split between *Penaeus* shrimp nei in 2015 and Southern white shrimp from 2016-2019 (**Table 3.11**). A plausible explanation is, since the take-over of the *Penaeus* shrimp fishery by the artisanal fleets in which most of the operations are within estuaries, coastal lagoons, and river deltas, the predominant shrimp catch is of Southern white shrimp, while the low catches of *Penaeus* shrimp nei are combination of all other species depending on the location of the fishing operations, like in the artisanal operations in the southern area of Margarita island, where the main species caught is the Southern pink shrimp versus the Gulf of Paria/Orinoco River delta, where Southern brown shrimp makes almost half of the *Penaeus* shrimp catch (Novoa 2000, Ferreira and Medley 2006, Marval *et al.* 2015). The artisanal fleets operate with 7-10 m wood or fiber glass boats powered by one or two outboard 48-75 HP engines; in the eastern part of the Gulf of Venezuela fishing operations are with drift gillnets called "tendedor derivante", while in the northeastern shelf coastal areas and in the Gulf of Paria the gear used is a single small otter trawl type net called "red arrastre chica" with escapement and bottom net modifications (Alió *et al.* 2010, Díaz *et al.* 2014). In addition, in the case of Lake Maracaibo and in the southern Gulf of Paria and northern Orinoco River delta, the predominant fishing gear is a type of beach purse seine called "mandinga or jala pa'tierra", with a mesh size ranging 1-2 cm, while cast nets are used in the coastal lagoons of Tacarigua, Unare-Píritu; and bottom set nets and "suripera" type net used in the area of the Gulf of Venezuela (Novoa 2000, Alió *et al.* 2010, Díaz *et al.* 2014).

There is no information on the total number of artisanal boats operating in the Venezuelan shrimp fisheries; however, the number of permits authorized by the National Fishery Administration for the small otter trawl fishery is 359, of which 162 are for the shrimping grounds off the coastal lagoons of

Tacarigua, Unare-Píritu, 122 are for the southern area of Margarita Island, 75 are for area of the Orinoco River delta (Gaceta Oficial de Venezuela 2016). There is no information available on the number of beach purse seine called "mandinga or jala pa'tierra" that target shrimp commercially across Venezuela. Nonetheless, the Venezuelan *Penaeus* shrimp fishery is subject to several management regulations which include seasonal closures that vary for the different shrimping grounds, in the northeastern and Atlantic shelf areas two seasonal closures are imposed and each has a duration of 45 days (Gaceta Oficial de Venezuela 2016), while the two seasonal closures in the western shrimping grounds have a duration of 10 days each. However, the seasonal closures appear to be directed towards Southern white shrimp and Atlantic seabob (González 2021).

Trinidad and Tobago report close to 10% of the *Penaeus* shrimp accumulated catches in the recent period, which is made of all the Southern shrimp species selected in this review (**Table 3.11**). The shrimp fishing grounds are in the western and southern coasts of Trinidad. There are three types of fleets targeting shrimps: 1) the artisanal type II fleet with 103 boats of 8-12 m that use inboard engine and fish in the Gulf of Paria, its main shrimp catch is of Southern brown shrimp; 2) the semi-industrial type III with eight boats of 10-12 m that use inboard engines operating single stern net and fish in the Gulf of Paria close to shore, its main shrimp catch is also of Southern brown shrimp; and 3) the industrial Type IV double rigged trawl with 36 vessels of 17-22 m (Gulf of Mexico type) and fish in the north, west and south of Trinidad, main shrimp catch is of Southern brown and Southern pink shrimp (FAO 2017, Ferreira 2019).

Guyana catches 6.1% of the total accumulated *Penaeus* shrimp catches during 2015-2019 (**Table 3.11**). The industrial prawn trawl fleet is the fleet that targets all the southern *Penaeus* shrimp species (Southern brown, Southern pink, Southern white and Redspotted shrimps). The industrial prawn fleet is made of 12 active vessels (of 24 licenses available) using otter trawl gear with various modifications (including escapement devices like TEDs and BRDs) (Government of Guyana Ministry of Agriculture 2019). The fishing area is beyond 27 m in depth. In addition, about 10% of *Penaeus* shrimp catches are landed as bycatch of the Atlantic seabob fishery, which includes only Southern brown and Southern pink shrimps.

French Guyana´s *Penaeus* shrimp catches during 2015-2019 is 5.8 % of the total accumulated catches for the time series reviewed (**Table 3.11**). The area most exploited is between the 30 m and 90 m isobaths, due to regulation that bans shrimp trawling within 30 m of the coast. The main shrimp species exploited on the continental shelf is Southern pink shrimp, representing close to 95% of the total *Penaeus* shrimp landings. The other species landed is the Redspotted shrimp, which is not separated in the landings (FAO 2017). All the vessels are Florida-style shrimp trawlers, each using two trawls at the same time with escapement devices. The number of licenses in 2010 was 49. However, during this time, the number of active shrimp trawlers was less than the number of licenses (Sanz *et al.* 2017).

Suriname catches the smallest proportion of *Penaeus* shrimps in the area (4.78%) for the period of 2015-2019 (**Table 3.11**). The fleet, like other areas, is the Florida-style shrimp trawlers using otter trawls with escapement devices. Licensing limits the number of vessels to 20 with a maximum length of 28 m, and maximum engine power to 500 HP. The fishing area of operations is limited from a depth of 32 m (Ministry of Agriculture, Animal Husbandry and Fisheries 2021a).

The northern part of Brazil is part of the WECAFC region, but no reports are available for FAO fishing area 31, as all Brazil´s catch within the WECAFC region is reported as FAO fishing area 41. The information available is from national scientists as it appears in reports to WECAFC meetings. The shrimp fishery in northern Brazil is one of the most important fisheries in the country. The main fishing area is located between the mouth of the Parnaiba River and the border of French Guyana, along the coast of the States of Maranhão, Pará and Amapá. Fishers use artisanal, small-scale and industrial vessels, outfitted with trawls (puca-de-arrastro or guizo), cast nets (tarrafa) and fixed traps (zangaria). The main species caught are Southern brown, and Southern white shrimps, as well as Atlantic seabob. The small-scale fishery is concentrated in the Maranhão area, operating in coastal waters with small, motorized trawlers (8 m to 13 m) commonly used to catch Southern white shrimps and Atlantic seabob. The industrial shrimp trawlers are the Florida type, from 17 m to 23 m, powered by 325 to 425 HP engines and operate otter trawls with escapement devices. The total number of shrimp trawlers in 2012 was 70 (of limit of 110 licenses in 2019). Trip duration are 40 to 50 days at sea and daily trawl operations last 5-6 hours. The area of operation of the industrial shrimp fleet is limited to 40 m - 80 m in depth (FAO 2017, Negreiros 2019). The Brazilian *Penaeus* shrimp fishery is subject to several management regulations which include seasonal closures and no take areas, as well as depth limitations to trawling operations (artisanal and industrial).

The Atlantic seabob fishery is important in the NBSLME area, most of the accumulated catch for 2015-2019 is from Guyana and Suriname, close to 94% is landed by these two countries (**Table 3.11**). In both countries, the Atlantic seabob fisheries are MSC certified. Mexico catches a noticeable proportion of the Atlantic seabob in the region, most of it is taken by artisanal fisheries in coastal lagoon and estuaries. Whilst the Atlantic seabob fishery in Guyana and Suriname is operated by artisanal and industrial fleets. Both countries have specific fishery management plans that limits the Atlantic seabob fishing operations. In Guyana, the Guyana Atlantic seabob fisheries operate in a habitat extending from the coastal lagoons and river mouths out to depths of about 30 m. The shallow water areas are reserved for the artisanal fisheries, and the industrial trawl fishery is restricted to a zone extending from the 14 m to the 32 m isobath. The industrial seabob trawl fleet currently comprises 81 operational vessels (Government of Guyana Ministry of Agriculture 2019).

In Suriname, the Atlantic seabob industry uses ‘twin-rig’ shrimp trawlers which land the shrimp on ice to processing companies; while artisanal fishers catch Atlantic seabob in the river mouths using ‘Chinese seines’ (Ministry of Agriculture, Animal Husbandry and Fisheries 2021b). Industrial vessels are equipped with the standard twin-rig method (two trawls on either side of the vessel) with escapement devices, and maximum engine power is limited to 500 HP. Below the 18 m isobath is closed for Atlantic seabob fisheries. The number of available licenses is limited to 26. Effort limitation in the fishery is monitored under a Harvest Control Rule (HCR).

State of the stocks

Northern brown shrimp. The current stock status of in the USA GOM is not overfished nor undergoing overfishing (Hart 2016a); for the stock in the USA southeastern Atlantic, the status is that it is not overfished, and overfishing is not occurring (NOAA 2013). The stock status of the species managed by Mexico is currently unknown, in 2010 decade it was fully exploited with no signs of recovery of the catches (DOF 2012) (**Table 3.6**).

Northern pink shrimp. According to the latest stock assessment, the USA managed stocks are not overfished nor undergoing overfishing (Hart 2017). The stock status of the species managed by Mexico is currently unknown, in 2010 decade it was overexploited with no signs of recovery of the catches (DOF 2012).

Northern white shrimp. According to the latest stock assessment, the USA managed stocks are not overfished nor undergoing overfishing (Hart 2016b, NOAA 2013). Like the Northern pink shrimp managed by Mexico, the stock status for Northern white shrimp is currently unknown, but in 2010 decade it was fully exploited with no signs of recovery of the catches (DOF 2012).

Southern brown shrimp. In French Guyana is the main targeted species caught by shrimp trawlers. The most recent stock assessment *F. subtilis* indicated that all models used agree that the stock is at historically low levels and probably below management target. The current Total Allowable Catch (TAC) and number of licenses are not effective since they potentially allow for overexploitation of the stock (FAO 2021).

The rest of the shrimp species the most recent available stock status is from the “Case Study on Shared Stocks of the Shrimp and Groundfish Fishery of the Guianas-Brazil Shelf” (UNGF/INT/001/OPS)” (CLME 2013). For Southern pink shrimp in Trinidad & Tobago and Guyana stock status and exploitation was at medium risk of the stock being overfished and experiencing overfishing. For the Redspotted shrimp in Guyana and Suriname stock status and exploitation was at low risk of the stock being overfished and experiencing overfishing in Suriname with data up to 2012; for Guyana was at high risk that overfishing was occurring and stock status was likely overfished. In Trinidad and Venezuela for all shrimp species combined, the risk of the stock being overfished and experiencing overfishing was at medium levels considering the uncertainty.

Atlantic seabob. The most recent stock status is available from FAO/FIRMS that summarizes the results from the Guyana and Suriname fisheries, which indicated that stock is not overfished, and overfishing is not occurring (CRFM 2019) (http://firms.fao.org/firms/resource/13249/en). Based on the stock assessment and HCR parameters, the results for both fisheries indicate that the performance is reasonable with low probability (<5%) of the stock being below 50% SSB_{MSY}. Catches are measured as a relative loss of opportunity, so for Suriname around 14% of monthly catches are less than 50% of the MSY level compared to 8% for Guyana (CRFM 2019).

The pelagic resources

In the WECAFC region, one the most economical valuable resources within the large pelagic fish species include four *Scomberomorus* species, King mackerel (*Scomberomorus cavalla*), Atlantic Spanish mackerel (*Scomberomorus maculatus*), Serra Spanish mackerel (*Scomberomorus brasiliensis*), Cero (*Scomberomorus regalis*).

The four mackerel species are epipelagic, neritic, often found in outer reef areas, and in estuaries, with characteristics specific to each species. The King mackerel and to some extent Cero, are more oceanodromous and common in outer reef areas that move in small groups or as single individuals. Whereas Atlantic Spanish and Serra Spanish mackerel that are more coastal and often found entering estuaries and moving in schools across their distribution range. All species display seasonal migrations within the distribution range in the region (Strum 1978, Strum *et al.* 1984, Clardy *et al.* 2008, Collette *et al.* 2011a, b, c, d). Although, there are some resident populations of King mackerel in the northern Gulf of Mexico and northeastern Brazil (Strum and Salter 1989). King mackerel is widely distributed across the region (**Figure 3.28a**), while the most important fishing areas are in the Gulf of Mexico, southeastern USA in the northern WECAFC region, and in the southern part are in the NBSLME and northeastern Venezuela (**Figure 3.28b**). In contrast, Atlantic Spanish mackerel is distributed from the northern limit of the WECAFC region through to the Yucatan Peninsula and northern Cuba, while Serra Spanish mackerel is distributed along the Caribbean shelf through to northeastern Brazil (**Figure 3.29a**). Fishing areas for Atlantic Spanish mackerel are mostly in the Gulf of Mexico and southeastern USA, while for Serra Spanish mackerel are in the NBSLME and northeastern Venezuela (**Figure 3.29b**). Cero is mostly limited to the islands across the Caribbean Sea (**Figure 3.30**). Spawning occurs seasonally for King, Atlantic Spanish, and Serra Spanish mackerels within their distribution range; for King mackerel it occurs in the Gulf of Mexico, Caribbean Sea, and northeastern Brazil; while for Atlantic Spanish mackerel it takes place in the northern Gulf of Mexico and the southeastern USA (Collete *et al.* 2011a, 2011d). Spawning of the Serra Spanish mackerel takes place over a protracted season in estuaries (Strum 1974).

The stock structure for King mackerel in the northern WECAFC region appears to display four stock units based on tagging efforts, however, there are no genetic differences between the two Gulf of Mexico populations therefore the species is managed by the USA as two migratory stocks: Gulf of Mexico and the southeastern USA coast (Gold *et al.* 2002). Other potential stock unit is located off northeastern Venezuela —where an important fishery exists since 1950— and Trinidad through Suriname

(Marcano *et al.* 1998, Hogarth and Martin 2006). Finally, the most southern stock unit in the region is in northern Brazil (Nobrega and Lessa 2009). Stock structure for Serra Spanish mackerel consists of three stock units: two in the southeastern Caribbean Sea (Gold *et al.* 2010) and one in northeastern Brazil (Nobrega and Lessa 2009). For Atlantic Spanish mackerel, the stock structure comprises a single intermingling genetic stock (Buonaccorsi *et al.* 2001). There is no information on the Cero stock structure.

The Fishery

As these resources are part of the ICCAT's species group and several ICCAT member countries have important directed fisheries, most of the reported catch is species specific.

King mackerel. Recent FAO statistics indicates that 99.75% of the accumulated catch of King mackerel for the period of 2015-2019 landed by six countries in the WECAFC region (**Table 3.12**). Mexico accounts for over 63% of the accumulated catch followed by the USA with over 19% of the total accumulated catch in the region. Venezuela that accounts for over 7% of the accumulated catch draws attention on the last three years of the period with similar catch numbers. Noting that the fishery for King mackerel is one of the most important large pelagic fish resources for the mid and long-range artisanal fleet in northeastern Venezuela (Marcano *et al.* 1998, Mendoza 2015), the possibility exists that those number reflect carry-over of previous years due to incomplete reporting in recent years. A potential similar problem may exist in the numbers observed from Trinidad and Tobago, noting that the reported catch remains the same for the last four years of the period and reports 1 tonne for 2015. Recognizing that the combined catch from these two countries can account for 11% or more of the total accumulated catch in the region, efforts should be made to reconcile the estimated catch for the recent period.

Serra Spanish and *Atlantic Spanish mackerel*. Most of the recent catches (98.69%) for Serra Spanish mackerel are shared by the three countries: Venezuela, Trinidad and Tobago, and Guyana (**Table 3.12**). Based on the available information reported to FAO, Venezuela accounts for almost half of the accumulated catch for 2015-2019, while the other half is shared by Trinidad and Tobago and Guyana. A small fraction of the accumulated catch is reported by Colombia in the last year of the series. This species represents an important large coastal pelagic shared resource for these countries, and it seems that the same potential reporting problem as in King mackerel in the case of Venezuela and Trinidad is repeated, that is, carry-over of catches for several years potentially masking the actual removals of Serra Spanish mackerel in the region. In the case of the Atlantic Spanish mackerel, the species is shared by two countries, the Mexico and USA (**Table 3.12**). Mexico is responsible for most of the accumulated catch (86.63%) for the period of 2015-2019, the rest is by the USA. However, Grenada has reported some catches of Atlantic Spanish mackerel for the same period but is likely due to species misidentification because the geographical distribution of the species is limited to the GOM and the USA (**Figure 3.29**).

Cero. Venezuela and Dominican Republic account for most of the recent accumulated catches (94.51%) in the region; the rest is shared by Puerto Rico and the USA (**Table 3.12**). The reported catch values from Venezuela seem to be carry-over estimates as for the previous species. This species is common in the Venezuelan offshore islands, particularly around Los Roques Archipelago (Cervigón 2005); it is commonly fished by the local SSF and landing information is not reported to the mainland on a timely basis often leading to generate estimates based on previous reports, hence the catch carry-over for this species.

There are several countries that do not report species-specific catches for this group of pelagic species, instead they are reported as *Scomberomorus* spp. or Seerfishes nei. Within this group, three countries account for most of the accumulated catch (94.82%) for 2015-2019, which include Colombia, Cuba, and Nicaragua (**Table 3.13**). The rest of the catch is shared by several small Caribbean islands, French Guyana and France. It is not clear what are catches reported as France, noting that Martinique and Guadalupe and French Guyana are French over-seas departments.

In the WECAFC region there are four countries that have directed fisheries towards this group of species, in the northern part of the region, the USA has directed commercial fisheries and recreational fisheries for King and Atlantic Spanish mackerel, while Mexico has directed commercial fisheries for King and Atlantic Spanish mackerels. In the southern part of the region, Venezuela and Trinidad and Tobago have directed commercial fisheries for King and Serra Spanish mackerels. The rest of the countries in the region catch this group of species as part of their seasonal multi-species fisheries for large pelagic fishes using a variety of handline gear that includes hook and line, and trolling, and gillnets. Apart from the USA, this group of species are caught by the countries artisanal fisheries for which some countries have specific on gear configuration, particularly those that use gillnets (Guyana, Mexico, Trinidad and Tobago).

In Mexico, King mackerel, Atlantic Spanish mackerels and Cero are fished with bottom gillnet over depths of 10-40 m and by trolling; gillnets are 300 m long with a 3.5-4 inch mesh size (Fernández *et al.* 2011, DOF 2018). In Trinidad, Serra Spanish mackerel —the most important mackerel species landed— and King mackerel are targeted by the artisanal multigear fleets operating off all Trinidad and Tobago´s coasts using gillnets (340 m long) (Fernández *et al.* 2011) and pelagic handlines methods that include "a-la-vive" (fishing with live bait), switchering (hand-line with baited hooks deployed while vessel is stationary), and trolling/towing (4-6 lines are towed from bamboo outriggers off vessel) (Arocha 2019). In Tobago, King mackerel is mostly caught by trolling (Mohammed and Lindop 2015).

In Venezuela, King mackerel is caught throughout the year in the northeast by trolling using live bait (Round sardinella, *Sardinella aurita*) (Marcano *et al.* 1998). Both mackerel species are also caught by Venezuela's offshore artisanal fleet operating off the NBSLME, although most of the catch from that area consists of Serra Spanish mackerel. Cero is mostly caught with handline gear around the Venezuelan offshore islands, mainly off Los Roques Archipelago. In the USA, King mackerel commercial landings are grouped into three gear categories: handline, gillnet, and other; handline, which includes hook and line, electric/hydraulic bandit reels; and trolling, the dominant gear. Gillnet landings prior to mid-1980s accounted for more than half of the landings since the gillnet landings have accounted for 10-20% of the landings. Small catches of King mackerel are also reported from the shrimp trawl fishery in the GOM. Also, King mackerel represent an important recreational fishery resource in the southeastern USA and GOM, mainly Florida (SEDAR 2014c). For Atlantic Spanish mackerel, USA commercial fishers use cast nets, gillnets, and hook-and-line gear to harvest the species; however, cast nets accounts for most of the landings. There is also an important recreational fishery (SEDAR 2013a).

In Dominican Republic, most of their catch of King mackerel and Cero are associated to moored Fish Aggregating Devices (mFADs) fisheries using hand-line gear by trolling around the mFAD and by live bait fishing. Each boat carries two fishers and each handle two hooked lines; dead bait (sardine or similar) is used to catch live bait (small jacks) that will then be used to catch large pelagic fishes when fishing on the mFADs (Arocha 2019). In Guyana, the artisanal fleet consists of 1147 boats, of which 15 are equipped with different types of gillnets (Chinese seine/fyke net, Pin seine, Gillnet-nylon, and polyethylene), mackerel species (King and Serra Spanish) are mostly caught by the nylon and polyethylene gillnets boats that account for 45% of the Guyana's catch by gear types (MacDonald *et al.* 2015, Arocha 2019).

State of the stocks.

King mackerel, Atlantic Spanish mackerel, Serra-Spanish mackerel, and Cero. An Ecological Risk Analysis (ERA) for the small tuna caught by longline and purse seine fisheries in the Atlantic which included all four *Scomberomorus* species was conducted in 2016 (ICCAT 2017). The assessment found that King and Atlantic Spanish mackerel were two of top three stocks estimated as the most vulnerable species caught in the region, with high risk to overfishing. The assessment found that for Serra-Spanish mackerel from the stock off north-northeastern Brazil was at 'moderate' risk (there are three levels of risk: high, moderate, and low) although it was indicated the data quality score for the estimation was 'moderate' (Frédou *et al.* 2017). In the case of Cero, assessment results indicated that was at low risk of overfishing (**Table 3.5**).

For the stock units of King and Atlantic Spanish mackerel under USA management, according to the most recent stock assessments (SEDAR 2013a, 2014c, d), all stocks in the Atlantic (Gulf of Mexico and Southeastern USA) are not overfished and are not subject to overfishing. The stock status assessment for the potential King mackerel southern Caribbean stock unit (off Venezuela, Trinidad, and Guyana) conducted in 2006, reviewed and updated in 2007 remained inconclusive (CRFM 2006, 2007). The updated assessment concluded that it is not known whether the stock is overfished or not, thus the current exploitation level may be sustainable, but may not be the level desired by management. Therefore, the precautionary approach suggested to managers was that current (2007) levels of fishing effort should not be increased and participation at CRFM assessment meetings of scientists from other countries that collect information on the same stock should be encouraged, with the aim of contributing with additional assessment data which would significantly reduce the uncertainty in the evaluation of the stock status.

For the two potential stocks of Serra-Spanish mackerel (Trinidad and Tobago and Venezuela), only Trinidad and Tobago carried out a stock assessment in 1991 and categorized this species as fully exploited (Henry and Martin 1992). The more recent assessment (Martin and Nowlis 2004) indicated that this species' biomass was below maximum sustainable yield (MSY), and that F was above FMSY. However, this most recent stock assessment was based on two different models with some conflicting results. In general, there was uncertainty in these results, and the recommendation for the Trinidad stock unit was to continue fishing at current levels. However, based on historical catches, the stocks were categorized as overfished in 2012 (WECAFC 2018).

The elasmobranch resources

There is limited information available on the status of elasmobranch stocks in the WECAFC area. Historically, these species where not deemed economically important in most countries of the region and there was little incentive to collect data on population sizes or other demographics. However, there is consensus that sharks and rays in the region exhibited a strong decline in the past decades (FAO 2018b).

The transboundary elasmobranch resources considered in this section are those species that fall into the group of coastal sharks which include four requiem sharks (*Carcharhinidae*), two hammerhead sharks (*Sphyrnidae*), and one houndshark (*Triakidae*). Most requiem sharks included in this review are shelf or slope dwellers, mostly littoral and semi pelagic with variations depending on the species.

Blacktip shark (*Carcharhinus limbatus*). The Blacktip shark is cosmopolitan in tropical to subtropical coastal, shelf, and island waters (**Figure 3.31**). In the Atlantic during their seasonal migration, they range from Massachusetts to Brazil, but their center of abundance is in the Gulf of Mexico and Caribbean Sea. The Blacktip shark inhabits inshore and offshore waters but is not a truly pelagic species. They are often seen nearshore around river mouths, bays, mangrove swamps, and in estuaries, though they do not penetrate far into freshwater (Burgess and Branstetter 2009). Neonates and juveniles are common in several distinct areas in the southern Caribbean, like the Gulf of Venezuela, Los Roques Archipelago, and in near shore areas of Trinidad (Tavares 2008, Shing 2006, Tavares and Sánchez 2012). This species commonly occurs in loose aggregations, it uses coastal bays and estuaries throughout the southeastern US, distinct areas of the southern Caribbean, and the NBSLME as nursery grounds (Castro 1996, F. Arocha direct observation). The Blacktip shark is targeted by several commercial and artisanal fisheries in the region, by the longline fishery in the northern part of the region and by semi-industrial multi-gear fleets off the NBSLME. The meat is used for fish meal or sold in local markets for human consumption. The fins are sold to Asian markets and the hides are used for leather.

Smalltail shark (*Carcharhinus porosus*). The Smalltail shark is distributed in the western Atlantic Ocean from the northern Gulf of Mexico to southern Brazil but is absent from the Caribbean Islands (**Figure 3.32**). Common in waters over continental shelves, the Smalltail shark prefers muddy bottoms in estuarine habitats (Feitosa et al. 2020). It swims along the bottom to depths of 118 feet (36 m). The Smalltail shark is primarily caught as incidental bycatch in the gillnets of artisanal fisheries. The flesh is marketed fresh for human consumption while the fins are valuable for use in shark fin soup. This shark is also processed into fishmeal and the oil is extracted from the liver.

Caribbean sharpnose shark (*Rhizoprionodon porosus*). The Caribbean sharpnose shark is a small (<110 cm total length) coastal shark that has a limited distribution in the WECAFC region found from the Bahamas, Caribbean Islands, and Quintana Roo, Mexico, to the south into northeastern Brazil and beyond (**Figure 3.33**) (Carlson *et al.* 2021). It inhabits continental and insular shelves from close inshore to a depth of 500 m (Ebert *et al.* 2013). It is targeted and taken as bycatch in gillnet, longline and commercial trawl fisheries, which are intense and inadequately managed in key parts of its range. Population structure is not defined for the Caribbean area, but there seem to be two genetically distinct populations between northeastern Brazil and the south (Mendonça *et al.* 2011).

Brazilian sharpnose shark (*Rhizoprionodon lalandii*). The Brazilian sharpnose shark is another small (<80 cm total length) shark that has a limited in distribution in the WECAFC region found from north of South America in the Caribbean Sea, including Panama and the southern Caribbean islands to the south to northeastern Brazil and beyond (**Figure 3.34**) (Pollom *et al.* 2020b). It inhabits over sand and mud on the inshore continental shelf at depths of 3 m – 149 m (Ebert *et al.* 2013, García 2017). It is captured in intensive artisanal gillnet fisheries throughout most of its geographic range and is consumed and sold locally. This species is subjected to intense exploitation in Colombia (García *et al.* 2007). In Venezuela, this shark is still among the most captured in artisanal fisheries (Tagliafico *et al.* 2015), but it has likely declined due to the absence of management and increasing demand.

Bonnethead shark (*Sphyrna tiburo*). The Bonnethead shark is a small sized shark (maximum of 150 cm) that occurs over continental and insular shelves from the intertidal zone down to 90 m across the WECAFC region (**Figure 3.35**). They normally occur in small schools of up to 15 individuals. However, during migration events, they are seen in large groups. During pupping season, females congregate in shallow waters, where they give birth (Lombardi-Carlson *et al.* 2003). It has a remarkably high rate of population growth that makes this species one of the most productive shark species (Cortés 2002). In the region, this species has been identified as a complex of two geographically discrete species: the northwest and western central Atlantic (USA, Bahamas, and Mexico), and the Caribbean Sea and southwest Atlantic (Belize south to Brazil) (Pollom *et al.* 2020c). In the United States, highly significant genetic differences were observed among Bonnethead shark from the Atlantic coast of Florida, Gulf coast of Florida, and southwestern Gulf of Mexico (Escatel-Luna *et al.* 2015). The species' population in the northern part of the region is relatively stable due to management actions (SEDAR 2013b).

However, in other areas where fisheries for this species exists and management measures are absent, the uncertainty in levels of harvest and its sustainability is likely that abundance of Bonnethead sharks is low.

Smalleye hammerhead shark (*Sphyrna tudes*). The Smalleye hammerhead is a medium-sized (to 150 cm total length) shark that occurs in the subtropical waters off the east coast of South America from Colombia to Uruguay (**Figure 3.36**). There is almost no data from the southern Caribbean Sea. The Orinoco delta (NBSLME) seem to have a large population, where it is thought to be the dominant species of hammerhead sharks, as well as in the waters of northeastern Trinidad where is caught by small-scale fisheries (Shing 2006). It inhabits inshore waters over the continental shelf at depths of 5-80 m. It is captured in intense and largely unmanaged commercial and artisanal fisheries throughout its range using beach seines, gillnets, longlines, and trawls throughout its geographic range (Pollom *et al.* 2020a).

Smalleye smoothhound (*Mustelus higmani*). The Smalleye smoothhound is a small (to 64 cm total length) houndshark that occurs from Colombia to southern Brazil (**Figure 3.37**) and inhabits mud, sand, and shell debris on the continental shelves and upper slopes from close inshore to 130 m depth (Pollom *et al.* 2020d). It is captured in commercial trawl fisheries and in commercial and artisanal driftnets, gillnets and longlines. Artisanal fisheries are intense across much of coastal Atlantic South America, and there are largely unmanaged commercial trawl and longline fisheries in many areas (Tavares *et al.* 2009). This species is rare in Caribbean Colombia but there are no baseline data. In Venezuela, this species is targeted in intensive fisheries, and there were already reported declines in abundance around Los Roques Archipelago in the 1990s (Tavares 2005).

The Fishery

Shark fisheries most likely pre-date recorded history in the region and is likely that every part of these resources has been used for some purpose. In some countries in the region shark meat is an important food consumed fresh or salted (FAO 2018b). In many communities across the region with Asian ties, fins of sharks are traded and exported. Shark cartilage and other products are increasingly sought for medicinal purposes. Few fisheries use the whole shark however: some use only the meat, others only use the fins, or liver for oil, or cartilage for pills, or jaws/teeth for tourism. In most of the cases where only a portion is used, the rest is discarded, which makes species identification of the catch difficult.

The fishery for elasmobranch species in this section can be directed and taken as the commercial part of the bycatch from other costal fisheries. In a recent survey in the WECAFC region, six countries reported directed fishery for sharks (Antigua, Barbados, Belize, Cuba, Panama and USA), none of those countries provided information on the number of fishers involved in the sharks fishery (FAO 2018b). In countries where directed fisheries exist, the types of fisheries described are diverse, most elasmobranch catches are taken by SSF fisheries using drift and bottom gillnets, pelagic and bottom longline (rigged with specific leaders and hooks for sharks), harpoons, and bottom trawls. In addition, a sport fishery for large coastal sharks exists in the USA, although is mostly limited to one shark per vessel/trip (SEDAR 2006).

Most of the elasmobranch catches in the region are reported in several groupings, Elasmobranchii (Sharks, rays, skates, etc. nei), Sphyrnidae (Hammerhead sharks, etc. nei), Rajiformes (Rays, stingrays, mantas nei), generic like *Sphyrna* spp., *Mustelus* spp., and transboundary specific like Blacktip shark, Smalltail shark, Caribbean sharpnose shark, and Smalleyed hammerhead shark. Most of the shark species caught by SSF in the region are likely reported under the Elasmobranchii group as well as shark species caught as bycatch by the pelagic longline tuna fisheries that do not fall under a specific management action of a regional management fisheries organization (i.e. ICCAT). Most of the Elasmobranchii reported catches in recent years are attributed to seven countries in the region, of which Mexico is responsible for 61.54% of the accumulated during 2015-2019 (**Table 3.14**). The rest of the countries (6) with important shark catches vary between 2.4% and 8.5% of the accumulated reported catches. In the case of Mexico with the largest accumulated catch in recent years, most of its shark catches are from the SSF using bottom gill nets and pelagic longlines, and it targets a variety of requiem and hammerhead sharks, among them Blacktip shark, Smalltail shark, and Bonnethead shark (*Sphyrna tiburo*) among other (SAGARPA 2012). Although the Atlantic sharpnose shark (*Rhizoprionodon terranovae*) has been known to represent close to 50% of the shark catches in the 1990s (Castillo-Géniz 2001), but it is unknown if it still represents a similar proportion of the shark catch in recent time. In the case of the reported catches from Venezuela, those are likely requiem sharks and coastal hammerhead sharks landed dressed in communities where species identification is unavailable. It seems likely that the same occurs in Nicaragua and Trinidad and Tobago. Cuba's shark catch seems to be of small coastal and large requiem sharks (FAO 2018b).

In the case of hammerhead sharks, Mexico reports them separately and is responsible for most of the hammerhead sharks in the region with 82% of the total accumulated catch for 2015-2019 (**Table 3.14**), which consists mostly of Bonnethead shark, and to a lesser extent the Scalloped hammerhead (DOF 2012). The Bonnethead shark is caught as target and bycatch in coastal gillnet and longline fisheries and as bycatch in shrimp fisheries (Pollom *et al.* 2020c). In the Western Central Atlantic, Bonnethead shark is captured in primarily in gillnets, demersal trawls and recreationally on hook and line. There is a directed fishery in Quintana Roo (Mexico) where the species is the third most important catch. It is present in landings in Belize, Cuba and Panama. In the southern Caribbean through to Brazil artisanal fisheries are intense across much of coastal areas, and there are largely unmanaged commercial trawl and longline fisheries in many areas. In Venezuela, although not specified in the catches, commercial and artisanal fisheries are intense, lack management, and have exhibited peaks in catches followed by declines, indicative of sequential overfishing (Mendoza 2015). In Trinidad, the Smalleye hammerhead is the second most important shark species followed by the Bonnethead hammerhead in the inshore artisanal fisheries (Shing 2006). Groundfish fisheries on the Brazil-Guyanas shelf were already fully exploited by 2000; these fisheries are multi-gear, multi-species, and multinational, with vessels crossing national maritime borders (Booth *et al.* 2001, Tavares 2005). Therefore, most coastal sharks are likely to be heavily exploited.

Among the requiem sharks, one of the most common species landed across the region for which catch specific landings exist is the Blacktip shark (**Table 3.15**). Most of the accumulated reported catch for 2015-2019 are reported by three countries, of which two (USA and Venezuela) account for 97.84% of the total reported catch, and the remaining fraction is reported by Trinidad and Tobago. In the USA, commercial bottom longline and gillnets are used to catch southeast Atlantic Blacktip sharks; recreational fishermen typically use rod-and-reel gear. In the southern Caribbean along the Venezuelan coast and offshore islands, Blacktip sharks are caught by artisanal fisheries off the northwestern coasts of Venezuela and in Los Roques archipelago (off central Venezuela). However, research in these areas indicated that the catch consisted of juvenile specimens (average size of 90 cm TL) and noted that few adults (> 150 cm TL) are seen in the landings of Blacktip sharks in the Venezuela Caribbean ports; although small quantities were caught as bycatch in the tuna longline fishery operating in the Caribbean (Tavares 2005, Tavares 2008, Tavares and Sánchez 2012). In Trinidad, the inshore artisanal fishery that catch most of the sharks (60%) is the gill net fishery for King and Serra Spanish mackerels. The inshore artisanal catch and beach seine catches of Blacktip sharks comprise both neonates and adults depending on the fishing location (distance from shore) at different times, which suggests that pups may stay in nearshore waters; the semi-industrial longline fishery also catches adult specimens (Shing 2006). In the area of NBSLME, Blacktip sharks are caught by the SSF, semi-industrial and industrial fleets that use trawl nets and gillnets, pelagic and bottom longline. Venezuelan industrial operations with drift-gillnets in the mid 1990 off the French Guyana targeting sharks were catching larger Blacktip sharks (>100 cm TL) (Tavares 2005).

The catches of the other three requiem sharks (Smalltail, Caribbean sharpnose and Brazilian sharpnose sharks) are only reported by Venezuela, which accounts for more than 90% of the accumulated catch in each species, and Colombia (**Table 3.15**). The artisanal fisheries in northeastern Venezuela land an important amount of the Caribbean and Brazilian sharpnose shark catch; while an important part of the shark catch from artisanal fisheries in northwestern Venezuela is of Caribbean sharpnose shark (Tavares *et al.* 2010, Tavares and Sánchez 2012). There are few reports for Smalltail sharks, confirmed reports come from the pelagic longline fishery targeting tunas operating in the Caribbean (Tavares 2005), although it is possible that coastal fisheries land Smalltail sharks, but it may be misidentified in the reports. In Trinidad, the Smalltail shark is the most common in the landings of sharks representing about 30% of the landed sharks followed by the Brazilian sharpnose shark (Shing 2006), catches of the Caribbean sharpnose sharks are also part of the shark landings in Trinidad.

Catches of Smalleye smoothhound sharks are reported as *Mustelus* spp. (Smoothhound nei), almost all the recent catch (99.60%) is reported from Venezuela and Trinidad and Tobago (**Table 3.15**). In northeastern Venezuela, the Smalleye smoothhound shark is one the most common landed species by the artisanal coastal fisheries that can reach up to 40%of the sharks landed catch (Tavares *et al.* 2010, Márquez *et al.* 2019). Landings from Trinidad are likely from the same fisheries and using the same gears as described for the other requiem sharks (Shing 2006).

State of the stocks

Blacktip shark. Stock status for the Blacktip shark exists only from the USA where it is managed as two stock units, the USA Gulf of Mexico (USGOM) and the USA south Atlantic (USSA). The USGOM stock assessment used a State Space Age-Structured Production Model, the benchmarks included estimates of spawning stock fecundity, fishing mortality and abundance for year 2016 (SSF_{2016}, F_{2016}, N_{2016}), reference points based on MSY (SSF_{MSY}, F_{MSY}), SSF at the minimum spawning stock threshold (SSF_{MSST}), status relative to SSF_{MSY} and/or SSF_{MSST}, and F_{MSY} levels. All model runs indicated that the stock was not overfished (SSF_{2016}/SSF_{MSY}=2.68) and overfishing (F_{2016}/F_{MSY}=0.024) was not occurring (SEDAR 2018a). For the USSA, the base model configuration (Stock Synthesis model) predicted that the stock was not overfished (SSF_{2018} > MSST) and that the stock was not experiencing overfishing ($F_{2018} > F_{MSY}$) in the terminal year of the assessment (SEDAR 2020).

Bonnethead shark. In the USA there has been and still is some directed commercial fishing for Bonnethead sharks, and they are also frequently caught in recreational fisheries, catches of this species are dominated by bycatch in the Gulf of Mexico shrimp trawl fishery. Based on the benchmarks for the MSY reference points for Bonnethead sharks in the USA the base model estimated that the stock was not overfished, and overfishing was not occurring, but that it had been near or even in an overfished condition several years between 1996 and 2003 (SEDAR 2013b).

Other than the stock assessments and data review conducted by the USA for the Blacktip shark and the Bonnethead shark above, there is no other information on the stock status of the region's transboundary sharks selected for this review. Noting that waters between Venezuela and northern Brazil is considered the global center of abundance for Smalltail shark, as of 2004 the total biomass decreased in 85% in northern Brazil (Feitosa *et al.* 2020); therefore, it is likely that this species is overfished. The only reference available for an estimation of the conservation status of the region's transboundary sharks selected is the information published by the IUCN's Shark Specialist Group for the IUCN Red list assessments for sharks (Kyne *et al.* 2012). The conservation status assessments published in the IUCN's web site (https://www.iucnredlist.org/) for the region's transboundary sharks selected are from 2019, with exception for Blacktip shark in which the assessment dates to 2005 and reviewed in 2009 (Burgess and Branstetter 2009). The subpopulation of the northwest Atlantic was estimated as vulnerable (VU) with no indication on population trend. For the rest of the species all population trends are decreasing but their conservation status varies from vulnerable to critically endangered depending on the species (**Table 3.16**).

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TABLES: TRANSBOUNDARY AND SHARED STOCKS

Table 3.1. Caribbean spiny lobster (*Panulirus argus*) catch (t) by country during the period 2015-2019.

Group: Key regional species. Species: *Panulirus argus*. - Caribbean spiny lobster. Species code: SLC								
Country	**2015**	**2016**	**2017**	**2018**	**2019**	**Rank**	**%**	**%cum**
Bahamas	6526	8482	7709	5824	6225.72	1	23.71	
Honduras	6156	6100	6100	6100	6100	2	20.84	44.56
Nicaragua	6473	5567	5031	4335	4074.9	3	17.38	61.94
Cuba	4035	4634	4147	4540	3278.4	4	14.07	76.01
United States of America	2690	2453	1743	2813	0	5	6.62	82.63
Dominican Republic	1282	1562	1677	2024	1905	6	5.76	88.39
Mexico	780	822	866	921	807	7	2.86	91.25
Belize	855	774	774	0	0	8	1.64	92.89
Jamaica	350	323	484	239	229	9	1.11	94.00
Antigua and Barbuda	277	277	277	277	277	10	0.94	94.94
Haiti	250	250	250	250	250	11	0.85	95.80
Anguilla	207	290	205	205	205	12	0.76	96.56
Venezuela, Bolivarian Republic of	635	103	105	105	105	13	0.72	97.27
Turks and Caicos Islands	218	260	218	154	129	14	0.67	97.94
Puerto Rico	192	118	69	129	147.54	15	0.45	98.39
Bonaire/S.Eustatius/Saba	125	88	93	95	95	16	0.34	98.73
Colombia	3	30	150	20	200.75	17	0.28	99.00
United States Virgin Islands	57	69	70	44	44	18	0.19	99.20
Saint Vincent and the Grenadines	56	30	54	63	49	19	0.17	99.37
British Virgin Islands	40	40	40	40	40	20	0.14	99.50
Martinique	34	35	35	35	35	21	0.12	99.62
Bermuda	35	30	26	24	37	22	0.10	99.73
Grenada	30	30	30	30	30	23	0.10	99.83
Saint Kitts and Nevis	22	18	30	37	25	24	0.09	99.92
Trinidad and Tobago	21	21	21	21	21.32	25	0.07	99.99
Costa Rica	9	4	0	0	0	26	0.01	100.00

Table 3.2. Caribbean spiny lobster (*Panulirus argus*) effort by country.

Country	Fishery		EFFORT					
			Diving			GEAR		
	Artisanal	Industrial	Free	Scuba	Hookah	Condos	Traps	TramelNet
Anguilla	X		X			X	X	
Antigua and Barbuda	X		X				X	
Bahamas	X		X			X	X	
Barbados	NO FISHING							
Belize	X		X			X	X	
Bermuda	X		X				X	
Brazil	X	X	X	X		X	X	X
Colombia	X	X	X				X	
Costa Rica	X		X					X
Cuba	X		X			X	X	
Curaçao	X		X					
Dominica	X		X				X	
Dominican Republic	X		X	X	X	X	X	
European Union (Martinique)	X		X					
Grenada	X		X				X	
Guatemala	X		X		X			X
Guyana	NO FISHING							
Haiti	X		X			X	X	
Honduras	X	X	X	X	X		X	
Jamaica	X	X	X	X		X	X	X
Mexico	X		X	X	X	X	X	X
Montserrat	NO FISHING							
Netherlands (Saba I.)	X							
Nicaragua	X	X	X	X	X		X	
Panama	X							
Saint Kitts and Nevis	X		X				X	
Saint Lucia	X						X	X
Saint Vincent and the Grenadines	X		X				X	
Suriname	NO FISHING							
Trinidad and Tobago	X	X	X			X	X	
Turk and Caicos Islands	X		X			X		
United States of America	X		X	X	X	X	X	
Venezuela	X		X				X	X

Table 3.3. Stromboid conchs (*Strombus* spp.) catch (t) by country during the period 2015-2019.

Group: Key regional species. Species: *Strombus* spp. - Stromboid conchs nei. Species code: --								
Country	**2015**	**2016**	**2017**	**2018**	**2019**	**Rank**	**%**	**%cum**
Nicaragua	11161	9260	11020	12395	11651.3	1	34.34	
Bahamas	4045	2696	3289	4027	3068.59	2	10.60	44.93
Belize	2349	2776	3032	4082	4288	3	10.23	55.16
Jamaica	3750	3750	3750	3750	0	4	9.28	64.44
Mexico	4342	1132	4820	1268	1699	5	8.21	72.65
Dominican Republic	1447	1634	1755	1691	1710	6	5.10	77.75
Antigua and Barbuda	1583	1583	1583	1583	1583	7	4.90	82.64
Turks and Caicos Islands	1257	1493	1857	2047	765	8	4.59	87.24
Puerto Rico	1188	1069	944	1085	812.46	9	3.16	90.39
Honduras	842	800	800	800	450	10	2.28	92.68
Saint Kitts and Nevis	537	648	561	529	340	11	1.62	94.29
Cuba	525	477	405	475	482.1	12	1.46	95.76
Saint Lucia	514	488	525	398	365.22	13	1.42	97.17
Saint Vincent and the Grenadines	267	330	213	310	285	14	0.87	98.04
Haiti	200	200	200	50	50	15	0.43	98.48
United States Virgin Islands	94	196	121	91	92.4	16	0.37	98.84
Guadeloupe	100	115	115	115	115	17	0.35	99.19
Colombia	0	0	118.5	0	387.1	18	0.31	99.50
Anguilla	100	42	80	80	80	19	0.24	99.74
Curaçao	26	26	26	26	26	20	0.08	99.82
Grenada	26	26	26	26	26	21	0.08	99.90
Sint Maarten	13	13	13	13	13	22	0.04	99.94
Bonaire/S.Eustatius/Saba	15	11	10	6	10	23	0.03	99.97
British Virgin Islands	5	5	5	5	5	24	0.02	99.99
Martinique	2	2	2	2	2	25	0.01	100.00
Venezuela, Bolivarian Republic of	0	2	2	2	2	26	0.005	100.00

Table 3.4. Summary overview of the queen conch fishing effort in several countries of the WECAFC region (Source: Prada *et al.* 2017).

	No. Fishers	No. small boats	No. industrial vessels	Free diving only	Compressor	Average trip (days)
Dominican Republic, Honduras, Jamaica, Nicaragua	> 1000	70-247	82	-	Yes	Over 10 days industrial Daily small boats
Bahamas, Belize, Haiti	> 1000	300-4000	-	Yes	Only Bahamas	Up to a Week
Antigua and Barbuda, Barbados, Cayman Islands, Colombia, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Turks and Caicos Islands	≤ 100	< 100	-	-	-	Daily

Table 3.5. Transboundary stocks status in the WECAFC region: Key species, Groundfish, Large pelagics.

	FIRMS & This review (after 2010)		FAO categorization	Reference year	OTHER SOURCES		ICCAT			
Common name, Species name	**Abundance Level**	**Exploitation rate**	WECAFC/SAG/IX/2018/3		USA SEDAR	Year	**Stock unit**	**Assessment year**	**Overfished**	**Overfishing**
Key regional species										
Caribbean spiny lobster, *Panulirus argus*	See text	See text	F	2015	U	2019	NA	NA	NA	NA
Queen conch, *Aliger gigas*	See text	See text	F/O	2016	O	2007	NA	NA	NA	NA
Ground fish										
Acoupa weakfish, *Cynoscion acoupa*	See text	See text	-	-	-	-	NA	NA	NA	NA
Jamaica weakfish, *Cynoscion jamaicensis*	See text	See text	-	-	-	-	NA	NA	NA	NA
Green weakfish, *Cynoscion virescens*	See text	See text	-	-	-	-	NA	NA	NA	NA
King weakfish, *Macrodon ancylodon*	See text	See text	-	-	-	-	NA	NA	NA	NA
Whitemouth croaker, *Micropogonias furnieri*	See text	See text	-	-	-	-	NA	NA	NA	NA
Smalleye croaker, *Nebris microps*	See text	See text	-	-	-	-	NA	NA	NA	NA
Large pelagics										
King mackerel, *Scomberomorus cavalla*	-	-	F	2012	GOM-F SE- F	2014	NW Atlantic	2016	-	Vulnerability: High*
Atlantic Spanish mackerel, *Scomberomorus maculatus*	-	-	F	2016	GOM-F SE- F	2013	NW Atlantic	2016	-	Vulnerability: High*
Serra Spanish mackerel, *Scomberomorus brasiliensis*	-	-	O	2012	-	-	NW Atlantic	2016	-	Vulnerability: Moderate*
Cero, *Scomberomorus regalis*	-	-	?	-	-	-	NW Atlantic	2016	-	Vulnerability: Low*

F: fully exploited; O: overexploited; U: non-fully exploited. *ICCAT. 2017.

Table 3.6. Transboundary stocks status in the WECAFC region: Reef and Slope, Shelf shrimps.

	FIRMS & This review (after 2010)		FAO categorization	Reference year	OTHER SOURCES		ICCAT			
Common name, Species name	**Abundance Level**	**Exploitation rate**	WECAFC/SAG/IX/2018/3		USA SEDAR	Year	**Stock unit**	**Assessment year**	**Overfished**	**Overfishing**
Reef and Slope species										
Groupers										
Red grouper, *Epinephelus morio*	-	-	USGOM - O USSE - F MEX - O	2015 2013 2015	GOM-F SE- O	2019 2017	NA	NA	NA	NA
Nassau grouper, *Epinephelus striatus*	-	-	BAH - O Cuba - O	2016 2016	Threatnd ESA	2016	NA	NA	NA	NA
Red hind, *Epinephelus guttatus*	-	-	-	-	USCAR-O	2014	NA	NA	NA	NA
Gag grouper, *Mycteroperca microlepis*	-	-	USGOM - F USSE - F	2015 2012	GOM-F SE - F	2021 2021	NA	NA	NA	NA
Black grouper, *Mycteroperca bonaci*	-	See text (Mexico)	-	-	F	2010	NA	NA	NA	NA
Snappers										
Northern red snapper, *Lutjanus campechanus*	-	See text (Mexico)	USGOM - F USSE - O MEX - O	2016 2014 2016	GOM-F SE- O	2018 2017	NA	NA	NA	NA
Mutton snapper, *Lutjanus analis*	-	-	USGOM - F	2013	USCAR-F GOM-F SE-F	2007 2015 2015	NA	NA	NA	NA
Gray snapper, *Lutjanus griseus*	-	-	USGOM - F	2015	GOM-O USCAR-O	2018 2008	NA	NA	NA	NA
Yellowtail snapper, *Ocyurus chrisurus*	-	See text (Cuba,Brazil)	-	-	USCAR-F GOM-F SE-F	2020				
Southern red snapper, *Lutjanus purpureus*	-	See text (NBSLME)	-	-	-	-	NA	NA	NA	NA
Lane snapper, *Lutjanus synagris*	-	See text (NBSLME)	MEX-O Cuba-O	2016 2016	GOM-F	2016	NA	NA	NA	NA
Shelf Shrimps										
Northern brown shrimp, Penaeus aztecus			USA - F MEX – F	2016 2014	GOM-F SE-F	2016 2013	NA	NA	NA	NA
Northern pink shrimp, *Penaeus duorarum*			USA - F MEX - O	2017 2012	GOM-F SE-F	2017 2017	NA	NA	NA	NA
Northern white shrimp, *Penaeus setiferus*			USA - F	2016	GOM-F SE-F	2016 2013	NA	NA	NA	NA
Southern brown shrimp, *Farfantepenaeus subtilis*		See text FREN_GUY	-	-	-	-	NA	NA	NA	NA
Southern pink shrimp, Farfantepenaeus notialis		See text (NBSLME)	-	-	-	-	NA	NA	NA	NA
Southern white shrimp, *Litopenaeus schmitti*		(See text (NBSLME)	-	-	-	-	NA	NA	NA	NA
Redspotted shrimp, *Farfantepenaeus brasiliensis*		See text (NBSLME)	-	-	-	-	NA	NA	NA	NA
Atlantic seabob, *Xiphopenaeus kroyeri*		GUY_SUR – F 2019	MEX-F GUY-SUR-F	2014	-	-	NA	NA	NA	NA

F: fully exploited; O: overexploited.

Table 3.7. Groundfish catch (t) by country during the period 2015-2019.

Group: Groundfish. Species: Sciaenidae (Family) - Croakers, drums nei. Species code: --								
Country	**2015**	**2016**	**2017**	**2018**	**2019**	**Rank**	**%**	**%cum**
Colombia	0	42	125	83	209,27	1	38,01	
Venezuela, Bolivarian Republic of	0	95	100	100	100	2	32,69	70,70
Guatemala	106	73	46	77	47	3	28,88	99,59
United States of America	0	0	1	3	0	4	0,33	99,92
Mexico	0	0	0	0	1	5	0,08	100,00
Group: Groundfish. Species: *Cynoscion* spp. - Weakfishes nei. Species code: --								
Mexico	4267	4706	4736	5271	4225	1	74,34	
French Guyana	825	715	973	887	850	2	13,62	87,96
Venezuela, Bolivarian Republic of	3518	0	0	0	0	3	11,27	99,23
Nicaragua	52	77	34	21	19,74	4	0,65	99,88
Dominican Republic	31	2	2	2	0	5	0,12	100,00
Group: Groundfish. Species: *Cynoscion acoupa*. - Acoupa weakfish. Species code: YNA								
Venezuela, Bolivarian Republic of	0	2310	2380	2380	2380	1	100,00	100,00
Group: Groundfish. Species: *Cynoscion virescens*. - Green weakfish. Species code: YNV								
Venezuela, Bolivarian Republic of	0	660	680	680	680	1	100,00	100,00
Group: Groundfish. Species: *Macrodon ancylodon* - King weakfish. Species code: WKK								
Venezuela, Bolivarian Republic of	0	828	850	850	850	1	100,00	100,00
Group: Groundfish. Species: *Micropogonias furnieri* - Whitemouth croaker. Species code: CKM								
Venezuela, Bolivarian Republic of	0	828	850	850	850	1	100,00	100,00

Table 3.8. Groupers catch (t) by country during the period 2015-2019.

Country	2015	2016	2017	2018	2019	Rank	%	%cum
Group: Reef and slope species- Groupers. Species: Serranidae (Family) – Groupers, seabases nei. Species code: --								
Mexico	10419	8684	11565	9726	9816	1	96.24	
Antigua and Barbuda	163	163	163	163	163	2	1.56	97.81
Nicaragua	105	111	116	155	145.7	3	1.21	99.02
Venezuela, Bolivarian Republic of	245	32	35	35	35	4	0.73	99.75
Colombia	30	7	16	0	72.2	5	0.24	99.99
Grenada	1	1	1	1	1	6	0.01	100.00
Group: Reef and slope species- Groupers. Species: *Epinephelus* spp. - Groupers nei. Species code: --								
Dominican Republic	758	758	815	787	795	1	68.75	
Venezuela. Boliv. Rep of	228	125	130	130	130	2	13.05	81.80
United States of America	65	57	62	42	1	3	3.99	85.79
Saint Kitts and Nevis	18	39	52	55	46	4	3.69	89.48
Bahamas	69	29	44	38	15	5	3.43	92.91
French Guyana	20	17	23	21	15	6	1.69	94.60
United States Virgin Islands	18	26	21	15	15	7	1.67	96.27
Aruba	12	22	20	20	20	8	1.65	97.92
Cuba	19	17	14	14	10	9	1.30	99.22
Saint Vincent and the Grenadines	17	3	0	0	0	10	0.35	99.57
Puerto Rico	5	3	2	3	2.29	11	0.27	99.84
British Virgin Islands	1	1	1	1	1	12	0.09	99.93
Bermuda	2	1	0	1	0	13	0.07	100.00
Group: Reef and slope species- Groupers. Species: *Epinephelus morio* - Red grouper. Species code: GRP								
United States of America	2575	2408	1782	1272	1	1	94.51	
Dominican Republic	84	84	90	109	100	2	5.49	100.00
Group: Reef and slope species- Groupers. Species: *Epinephelus striatus* - Nassau grouper. Species code: GPN								
Bahamas	53	31	51	81	163	1	66.24	
Colombia	0	0	27	1	72.2	2	17.51	83.75
Cuba	30	20	23	20	0	3	16.25	100.00
Group: Reef and slope species - Groupers. Species: *Epinephelus guttatus* - Red hind. Species code: EEU								
Grenada	120	110	110	110	110	1	63.88	
Saint Vincent and the Grenadines	47	18	31	16	22	2	15.28	79.16
Bermuda	18	30	14	23	20	3	11.98	91.14
Puerto Rico	27	15	7	13	14.7	4	8.75	99.89
United States of America	0	1	0	0	0	5	0.11	100.00
Group: Reef and slope species - Groupers. Species: *Mycteroperca* spp. - Brazilian groupers nei. Species code: --								
Mexico	1822	1327	2022	1486	1643	1	100.00	100.00
Group: Reef and slope species - Groupers. Species: *Mycteroperca microlepis* - Gag grouper. Species code: MKM								
United States of America	383	562	323	344	44	1	100.00	100.00
Group: Reef and slope species - Groupers. Species: *Mycteroperca bonaci* - Black grouper. Species code: MAB								
Bermuda	25	14	15	16	18	1	100.00	100.00

Table 3.9. Snappers (part one) catch (t) by country during the period 2015-2019.

Country	2015	2016	2017	2018	2019	Rank	%	%cum
Group: Reef and slope species- Snappers. Species: Lutjanidae (Family) - Snappers, jobfishes nei. Species code: --								
Mexico	1791	2082	1988	2332	1844	1	42.85	
Dominican Republic	1116	1116	1199	1409	1335	2	26.36	69.21
Venezuela, Bolivarian Republic of	2447	112	115	115	115	3	12.40	81.61
Antigua and Barbuda	333	333	333	333	333	4	7.11	88.72
Colombia	15	33	507	67	102.2	5	3.09	91.81
Costa Rica	96	66	65	65	65	7	1.52	93.34
Grenada	70	70	70	70	70	6	1.49	94.83
Cuba	80	67	60	60	50	9	1.35	96.18
Anguilla	50	43	52	52	52	8	1.06	97.25
Aruba	30	40	45	45	48	10	0.89	98.13
Puerto Rico	20	55	41	63	12.9	12	0.82	98.95
Barbados	21	31	31	22	25	11	0.56	99.51
United States Virgin Islands	17	23	25	10	10	13	0.36	99.87
Bermuda	2	5	2	2	2	14	0.06	99.93
Saint Vincent and the Grenadines	2	1	2	2	2	15	0.04	99.97
United States of America	3	2	0	1	2	16	0.03	100.00
Group: Reef and slope species- Snappers. Species: *Lutjanus* spp. - Snappers nei. Species code: --								
Bahamas	357	258	192	523	284.1	1	48.13	
Nicaragua	300	155	156	191	179.54	2	29.27	77.40
British Virgin Islands	70	70	70	70	70	3	10.44	87.83
Saint Kitts and Nevis	21	32	47	72	61	4	6.94	94.78
Saint Lucia	34	39	35	27	40.05	5	5.22	100.00
Group: Reef and slope species- Snappers. Species: *Lutjanus campechanus* - Northern red snapper. Species code: SNR								
Mexico	4211	4995	4674	5594	4164	1	66.06	
United States of America	3058	2940	3072	3072	3	2	33.94	100.00
Group: Reef and slope species- Snappers. Species: *Lutjanus griseus* - Gray snapper. Species code: LJI								
Mexico	359	581	398	651	452	1	80.99	
United States of America	147	142	109	107	1	3	16.79	97.78
Bermuda	8	10	19	16	14	2	2.22	100.00
Group: Reef and slope species- Snappers. Species: *Lutjanus analis* - Mutton snapper. Species code: LJN								
Venezuela, Bolivarian Republic of	0	158	165	165	165	1	55.07	
United States of America	102	69	88	102	2	2	30.61	85.68
Colombia	0	0	0	0	114.04	3	9.62	95.30
Puerto Rico	20	9	6	9	11.71	4	4.70	100.00

Table 3.10. Snappers (part two) catch (t) by country during the period 2015-2019.

Group: Reef and slope species- Snappers. Species: *Lutjanus synagris* - Lane snapper. Species code: SNL								
Country	**2015**	**2016**	**2017**	**2018**	**2019**	**Rank**	**%**	**%cum**
Cuba	1369	1212	924	817	971.8	1	55.89	
Venezuela, Bolivarian Republic of	0	597	615	615	615	2	25.78	81.68
Mexico	192	202	213	226	195	3	10.85	92.53
Colombia	2	27	181	76	102.56	4	4.10	96.63
Puerto Rico	56	29	22	27	38.9	5	1.83	98.46
Bermuda	16	15	17	12	12	6	0.76	99.22
United States of America	21	18	21	14	0	7	0.78	100.00
Group: Reef and slope species- Snappers. Species: *Ocyurus chrysurus* - Yellowtail snapper. Species code: SNY								
Mexico	1777	2433	1972	2725	1953	1	46.54	
United States of America	997	1050	1278	891	0	2	18.07	64.61
Nicaragua	705	908	734	939	882.66	3	17.87	82.48
British Virgin Islands	250	250	250	250	250	4	5.36	87.84
Cuba	174	158	170	187	171.5	5	3.69	91.53
Dominican Republic	166	166	178	172	170	6	3.65	95.18
Venezuela, Bolivarian Republic of	168	124	130	130	130	7	2.92	98.10
Puerto Rico	76	43	27	33	48.2	8	0.97	99.07
Colombia	0	3	50	8	13.01	9	0.32	99.39
Bermuda	14	20	16	12	9	10	0.30	99.70
United States Virgin Islands	12	15	13	10	11	11	0.26	99.96
Saint Vincent and the Grenadines	3	2	2	1	2	12	0.04	100.00
Group: Reef and slope species- Snappers. Species: *Lutjanus purpureus* - Southern red snapper. Species code: SNC								
Guyana	1095	814	950	1016	1736	1	46.36	
Venezuela, Bolivarian Republic of	0	623	643	643	643	2	21.08	67.44
Cuba	378	457	429	409	356.2	3	16.76	84.20
Dominican Republic	313	313	337	325	325	4	13.33	97.53
Colombia	5	6	24	171	54.06	5	2.15	99.68
Saint Vincent and the Grenadines	7	3	7	14	8	6	0.32	100.00

Table 3.11. Shrimps and Atlantic seabob catch (t) by country during the period 2015-2019.

Group: Shelf shrimps. Species: *Penaeus aztecus* - Northern brown shrimp. Species code: ABS								
Country	**2015**	**2016**	**2017**	**2018**	**2019**	**Rank**	**%**	**%cum**
United States of America	50969	37821	45284	51110	71	1	72.65	
Mexico	13179	14433	14629	16165	11329	2	27.35	100.00
Group: Shelf shrimps. Species: *Penaeus duorarum* - Northern pink shrimp. Species code: APS								
United States of America	4360	4330	7976	9332	0	1	56.08	
Mexico	4127	2314	4581	2592	2571	2	34.91	90.99
Cuba	918	764	701	1121	672.1	3	9.01	100.00
Group: Shelf shrimps. Species: *Penaeus setiferus* - Northern white shrimp. Species code: PST								
United States of America	43645	54767	54007	39733	2864	1	97.29	
Mexico	1120	1020	1243	1142	904	2	2.71	100.00
Group: Shelf shrimps. Species: *Litopenaeus schimitti* (=*Penaeus schmitti*) - Southern white shrimp. Species code: PNT								
Venezuela, Bolivarian Republic of	0	2493	2570	2570	2570	1	100.00	100.00
Group: Shelf shrimps. Species: *Penaeus* spp. - Penaeus shrimp nei. Species code: --								
Mexico	3563	1352	3955	1514	3932	1	36.25	
Nicaragua	1556	1155	1035	1086	1020.84	2	14.82	51.07
Honduras	1000	1000	1000	1000	979	3	12.61	63.67
Trinidad and Tobago	776	776	776	776	776	4	9.82	73.50
Guyana	500	411	600	421	478	5	6.10	79.60
Venezuela, Boliv Rep of	2276	5	5	5	5	6	5.81	85.41
French Guyana	759	625	400	250	255	7	5.80	91.21
Suriname	511	377	315	379	305	8	4.78	95.99
Colombia	125	117	315	0	113.89	9	1.70	97.69
Guatemala	138	126	109	122	93	10	1.49	99.17
Dominican Republic	66	64	69	62	60	11	0.81	99.99
Costa Rica	5	0	0	0	0	12	0.01	100.00
Group: Shelf shrimps. Species: *Xiphopenaeus kroyeri* - Atlantic seabob. Species code: BOB								
Guyana	17641	20334	21765	19946	14040	1	66.51	
Suriname	6310	7674	8272	9886	6456	2	27.39	93.91
Mexico	864	1357	959	1520	1565	3	4.45	98.35
United States of America	507	724	263	213	0	4	1.21	99.56
Colombia	0	0	0	0	375.87	5	0.27	99.83
Venezuela, Bolivarian Republic of	0	58	60	60	60	6	0.17	100.00

Table 3.12. Pelagic resources (mackerels) catch (t) by country during the period 2015-2019.

Group: Pelagic species. Species: *Scomberomorus cavalla* - King mackerel. Species code: KGM								
Country	**2015**	**2016**	**2017**	**2018**	**2019**	**Rank**	**%**	**%cum**
Mexico	6150	5517	6827	6179	5170	1	63.10	
United States of America	1948	2246	2499	2375	11	2	19.20	82.30
Venezuela, Boliv Rep of	1092	574	590	590	590	3	7.27	89.57
Trinidad and Tobago	1	494	494	494	494	4	4.18	93.75
Dominican Republic	277	288	309	275	285	5	3.03	96.78
Guyana	358	314	192	143	398	6	2.97	99.75
Grenada	12	12	12	12	12	7	0.13	99.88
Puerto Rico	14	11	7	13	8.84	8	0.11	99.99
Saint Kitts and Nevis	0	0	0	1	1	9	0.004	100.00
Saint Vincent and the Grenadines	0	0	0	1	1	10	0.004	100.00
Group: Pelagic species. Species: *Scomberomorus maculatus* - Atlantic Spanish mackerel. Species code: SSM								
Mexico	7750	8422	8603	9433	7433	1	86.63	
United States of America	1328	1747	1501	1844	0	2	13.36	99.99
Grenada	1	1	1	1	1	3	0.01	100.00
Group: Pelagic species. Species: *Scomberomorus brasiliensis* - Serra spanish mackerel. Species code: BRS								
Venezuela, Boliv Rep of	747	881	910	910	910	1	46.52	
Trinidad and Tobago	0	695	695	695	695	2	29.68	76.20
Guyana	387	399	307	313	701	3	22.49	98.69
Colombia	0	0	0	0	122.75	4	1.31	100.00
Group: Pelagic species. Species: *Scomberomorus regalis* - Cero. Species code: CER								
Venezuela, Boliv Rep of	0	171	175	175	175	1	70.20	
Dominican Republic	57	75	81	3	25	2	24.31	94.51
Puerto Rico	14	4	3	5	12.46	3	3.88	98.39
United States of America	3	3	4	6	0	4	1.61	100.00

Table 3.13. Pelagic resources (Scombroidei and *Scomberomorus* spp.) catch (t) by country during the period 2015-2019.

Group: Pelagic species. Species: Scombroidei (Suborder) - Tuna-like fishes nei. Species code: --								
Country	**2015**	**2016**	**2017**	**2018**	**2019**	**Rank**	**%**	**%cum**
Trinidad and Tobago	369	369	369	419	423.53	1	41.78	
Costa Rica	112	161	160	160	160	2	16.14	57.91
Dominican Republic	145	21	13	300	200	3	14.55	72.46
Guyana	3	229	10	102	312	4	14.06	86.52
Venezuela, Boliv Rep of	28	39	64	0	0	5	2.81	89.33
Guatemala	1	107	0	0	0	6	2.31	91.64
Antigua and Barbuda	20	20	20	20	20	7	2.14	93.78
Colombia	0	7	7	0	75.84	8	1.93	95.71
Saint Lucia	23	15	17	13	15.6	9	1.79	97.50
United States of America	15	0	0	0	36	10	1.09	98.59
Dominica	2	3	10	5	5	11	0.54	99.13
Saint Kitts and Nevis	14	2	5	0	0	12	0.45	99.58
United States Virgin Islands	0	2	0	5	5	13	0.26	99.83
Puerto Rico	3	1	1	1	1.73	14	0.17	100.00
Group: Pelagic species. Species: *Scomberomorus* spp. - Seerfishes nei. Species code: --								
Colombia	12	85	515	0	80.89	1	38.98	
Cuba	145	120	108	108	90	2	32.12	71.10
Nicaragua	110	124	79	56	52.64	3	23.72	94.82
French Guyana	9	8	10	9	9	4	2.53	97.35
United States Virgin Islands	6	9	6	4	0	5	1.41	98.75
France	0	10	10	0	0	6	1.13	99.88
Saint Lucia	1	0	0	0	0.17	7	0.07	99.94
British Virgin Islands	1	0	0	0	0	8	0.06	100.00

Table 3.14. Elasmobranchii and hammerhead sharks catch (t) by country during the period 2015-2019.

Group: Elasmobranch. Species: Elasmobranchii - Sharks, rays, skates, etc. nei. Species code: --								
Country	**2015**	**2016**	**2017**	**2018**	**2019**	**Rank**	**%**	**%cum**
Mexico	3743	5074	4155	5683	3955	1	61.90	
United States of America	906	711	485	693	328	2	8.55	70.45
Guyana	569	748	623	329	774	3	8.33	16.88
Cuba	550	460	408	407	390	4	6.06	14.39
Venezuela, Boliv Rep of	1303	162	165	165	165	5	5.37	11.43
Trinidad and Tobago	293	276	301	301	302.02	6	4.03	9.40
Nicaragua	232	234	196	114	107.16	7	2.42	6.45
Colombia	0	30	427	1	0	8	1.25	3.67
Costa Rica	107	86	85	85	85	9	1.23	2.48
Antigua and Barbuda	22	22	22	22	22	10	0.30	1.53
Barbados	23	15	18	11	10	11	0.21	0.51
Grenada	15	15	15	15	15	12	0.21	0.42
Martinique	4	4	4	4	4	13	0.05	0.26
Puerto Rico	4	3	2	4	3	14	0.04	0.10
Saint Lucia	3	1	3	1	0.59	15	0.02	0.07
Belize	0	5	0	0	0	16	0.01	0.04
Saint Vincent and the Grenadines	2	1	0	0	0	17	0.01	0.02
Bermuda	0	1	0	0	0	18	0.00	0.01
Group: Elasmobranch. Species: Sphyrnidae (Family) - Hammerhead sharks, etc. nei. Species code: --								
Mexico	147	199	163	223	171	1	82.09	
Trinidad and Tobago	40	40	39	39	38.98	2	17.91	100.00
Group: Elasmobranch. Species: *Sphyrna* spp. - Hammerhead sharks nei. Species code: --								
Colombia	0	0	0	0	0.13	1	100.00	100.00
Group: Elasmobranch. Species: *Sphyrna tudes* - Smalleye hammerhead. Species code: SPQ								
Colombia	0	0	0	0	0.4	1	100.00	100.00

Table 3.15. Requiem and *Mustelus* spp. sharks catch (t) by country during the period 2015-2019.

Group: Elasmobranch. Family: Carcharhinidae - Requiem sharks nei. Species code: --								
Country	**2015**	**2016**	**2017**	**2018**	**2019**	**Rank**	**%**	**%cum**
Mexico	1352	1103	1501	1235	1277	1	87.75	
Venezuela, Bolivarian Republic of	862	6	6	6	6	2	12.02	99.77
Bermuda	3	3	2	2	2	3	0.16	99.93
Saint Vincent and the Grenadines	0	0	0	3	2	4	0.07	100.00
Group: Elasmobranch. Species: *Carcharhinus limbatus* - Blacktip shark. Species code: CCL								
United States of America	102	84	101	69	58	1	58.54	
Venezuela, Bolivarian Republic of	0	68	70	70	70	2	39.31	97.84
Trinidad and Tobago	2	2	4	5	2.25	3	2.16	100.00
Group: Elasmobranch. Species: *Carcharhinus porosus* - Smalltail shark. Species code: CCR								
United States of America	102	84	101	69	58	1	58.54	
Venezuela, Bolivarian Republic of	0	99	100	100	100	1	94.54	
Colombia	0	4	4	3	12.03	2	5.46	100.00
Group: Elasmobranch. Species: *Rhizoprionodon porosus* - Caribbean sharpnose shark. Species code: RHR								
Venezuela, Bolivarian Republic of	0	260	265	265	265	1	92.65	
Colombia	0	3	32	18	30.69	2	7.35	100.00
Group: Elasmobranch. Species: *Mustelus* spp. - Smooth-hounds nei. Species code: --								
Venezuela, Boliv Rep of	0	335	345	345	345	1	61.10	
Trinidad and Tobago	172	172	173	173	173.15	2	38.50	99.60
Bermuda	1	2	1	1	1	3	0.27	99.87
Colombia	3	0	0	0	0	4	0.13	100.00

Table 3.16. Transboundary stock status in elasmobranchs. (*NW ATL subpopulation)

	OTHER SOURCES (after 2010)				**FIRMS**		**FAO categorization**	**Reference year**	**IUCN**	**Assessment year**
Common name/ Species name	**Stock unit**	**Year**	**Overfished**	**Overfishing**	**Abundance Level**	**Exploitation rate**	WECAFC/SAG/IX/2018/3		https://www.iucnredlist.org/	
Blacktip shark, *Carcharhinus limbatus*	USGM SEUS	2020	NO	NO	-	-	-	-	VU/ Unknown*	2005
Smalltail shark, *Carcharhinus porosus*	NBRAZ	2020	YES	-	-	-	-	-	CR/ Decreasing	2019
Caribbean sharpnose shark, Rhizoprionodon porosus	-	-	-	-	-	-	-	-	VU/ Decreasing	2019
Brazilian sharpnose shark, Rhizoprionodon lalandii	-	-	-	-	-	-	-	-	VU/ Decreasing	2019
Smalleye hammerhead, *Sphyrna tudes*	-	-	-	-	-	-	-	-	CR/ Decreasing	2019
Bonnethead shark, *Sphyrna tiburo*	USGM SEUS	2013	NO	NO	-	-	-	-	EN/ Decraesing	2019
Smalleye smoothhound, *Mustelus higmani*	-	-	-	-	-	-	-	-	EN/ Decraesing	2019

USGM: USA Gulf of Mexico; SEUS: Southeast USA; NBRAZ: North Brazil

VU: Vulnerable; EN: Endangered; CR: Critically Endangered

4. STRADDLING STOCKS

As indicated above, straddling stocks are those defined in section 2 for the purpose of the present review. They include one group of small pelagic fishes, the flying fishes (Exocoetidae), the tuna and tuna-like species, and a selected group of elasmobranchs (sharks and rays) that are commercially exploited, threatened and/or protected in the WECAFC region.

The flying fish resources

Three species of flying fish, Margined flyingfish (*Cypselurus cyanopterus*), Fourwing flyingfish (*Hirundichthys affinis*), and Sailfin fliyingfish (*Parexocoetus brachypterus*) are economically exploited through direct harvesting, mainly in the eastern Caribbean Sea (Oxenford *et al.* 1995). However, the target species of the offshore flying fish fisheries of the eastern Caribbean (accounting for ~ 99% of all flying fish landed) is the Fourwing flyingfish (*Hirundichthys affinis*) (CRFM 2019). The Fourwing flyingfish is a nerito-oceanic species that prefers the waters above the shelf and slope but is often found in open ocean waters (Shakhovskoy 2018) (**Figure 4.1**). In the eastern Caribbean, the species displays a north–south migration from Dominica to Tobago (Oxenford 1994).

The Fourwing flyingfish is a short-lived species (~18 months) with a strong inter-annual variability (Oxenford *et al.* 2007). It spawns throughout the year with two peaks, one in December-January and another in April-May (Oxenford 1994**,** Khokiattiwong *et al.* 2000), when its highest seasonal abundance occurs. It is seasonally targeted by the fisheries in the southern end of the eastern Caribbean (Medley *et al.* 2010). Eggs are highly adhesive and are spawned on natural flotsam, as well as on floating fishing gear. The amount of natural flotsam in the Eastern Caribbean, particularly Sargassum, can vary according to flows from source rivers and prevailing ocean currents which may constrain flying fish population size (CRFM 2019). This species is consumed by large pelagic fishes, particularly Common dolphinfish, and it is also the preferred bait used in longline fisheries in the Eastern Caribbean Islands (Fanning and Oxenford 2011). In the region, the areas of major abundance (based on spatial distribution of the catches) are in the eastern Caribbean countries, mostly around Barbados, Grenada and Saint Vincent and the Grenadines.

There are three genetically discrete sub-regional stocks identified and acknowledged within the WECAFC region. A genetic study on the Fourwing flyingfish indicated a lack of gene flow between three areas within the WECAFC region, the eastern Caribbean Islands (Barbados, Dominica, Tobago), Curaçao, and off Caiçara do Norte (Brazil), suggesting the existence of at least three stock units of Fourwing flyingfish (*Hirundichthys affinis*) in the central western Atlantic (Gomes *et al.* 1999).

The Fishery

Flying fish fisheries are concentrated in the southern end of the Lesser Antilles Island chain. Barbados, Martinique and Tobago all have historically important directed flying fish fisheries and to a lesser extent

Dominica, Grenada and Saint Lucia (CRFM 2019). They are likely exploiting a single stock unit that at least extends from Dominica to Trinidad and Tobago.

The Fourwing flyingfish supports important small-scale fisheries in the region in terms of employment generation, food security and supply of bait for fisheries targeting large pelagic fish species. Like other small-scale fishers in the Caribbean, fishers involved in flying fish fisheries often belong to the lower socio-economic strata of society (CRFM, 2012a).

Historical landings of Flying fishes nei (in which Fourwing flyingfish is the dominant species in the reported landings) fluctuate throughout the time series around 2 000 and 3 000 tonnes per year between 1950 and 1983. Thereafter landings reached its highest records in 1983, 1985 and 1988, of over 4 000 tonnes each year. After 1988 landings dropped and fluctuated to around 1 500 tonnes, until recently when landings dropped around 500 tonnes in 2016, largely due to the decrease of the landings in Barbados. Over 93% of flying fish landings have been caught by Barbados between 2015 and 2019 (**Table 4.1, Figure 4.2**), the remaining landed catch have been from Saint Kitts and Nevis, Grenada, Martinique, USA, and Saint Lucia over the same period.

There were more than 1 700 boats in the region, of small to medium size, engaged in flying fish fisheries in the early 2000s. In recent times, there are more than 1850 registered boats in Barbados capable of targeting flying fish and more than 2800 in the region (CRFM 2019). In Trinidad and Tobago, the flying fish fishery is located on the Caribbean Sea coast of the island of Tobago. In Saint Lucia, 331 vessels were engaged in the flying fish fishery in 2007 (FAO 2010). There are no targeted flying fish fisheries in Saint Vincent and the Grenadines. In the case of Dominica, there has been a shift from the flying fish fishery to the large pelagic fishery within the last eight years due to the increased use of FADs.

The fishing effort for flying fish is highly seasonal (December-June), driven by the seasonal availability of both flying fish and the large pelagic species, particularly dolphinfish. The most recent estimates of fishing effort in the sub-region —in terms of the number of fishing trips during which flying fish were caught— were assembled by Medley *et al.* (2010) for Barbados, Saint Lucia and Tobago for the period 1988-2008. The mean total number of flying fish fishing trips conducted per year by the fleets of these three countries over this period was 78 200. Barbados day boats account for most fishing trips averaging 43 300 per year, followed by Barbados ice boats averaging around 21800. Tobago day boats contribute on average 10800, while St. Lucia day-boats make some 2 300 trips per year.

The socio-economics information available for the flying fish fishery is mostly related to a diagnostic study to determine poverty and vulnerability levels in CARICOM fishing communities (CRFM 2012a) conducted in some countries that have directed flying fish fisheries, which included Barbados, Grenada, and other countries that do not have an important contribution in the flying fish fishery. The study identified poverty and vulnerability with reference to unsatisfied basic needs (UBN). Households with more than one UBN were classified as poor households. Households with one UBN were classified as vulnerable. In Grenada, about 6% of the fishers' households were classified as poor; while in Barbados, poverty was not an issue. However, vulnerability was an important issue for both countries, Grenada with 25.62% household being vulnerable and Barbados with 7.37%. The study indicated that vulnerability statistics correlate to the level of development of flying fish value chains across the Eastern Caribbean, the best example today is Barbados which has the most complex value chain that begins with an active commercial harvest and ends in value-added products processed for local and export markets.

State of the stock

The Fourwing flyingfish Stock Recruitment Model and associated risk assessment approach with decision rules to facilitate management decision-making was applied in the most recent stock assessment for the Fourwing flyingfish in the Eastern Caribbean (Medley *et al.* 2010). The results of the stock assessment suggested that the stock was not overfished, and that overfishing was not occurring (**Table 4.2**) (http://firms.fao.org/firms/resource/13753/en). The catch rates had remained stable overall in the time series as catches increased. Given the potential stock area and estimates of a relatively large stock size from tagging and survey estimates, it is likely that the potential yield exceeds total catches taken throughout the history of the fishery. There is no immediate action required by management to conserve the stock unless there is a significant increase in catches. In the proposed sub-regional management plan for Fourwing flyingfish (CRFM 2014), a catch trigger point of 5 000 tonnes was to be established to ensure the stock does not become overfished.

The major gap in the flying fish resource is the significant uncertainty in the most recent assessments that continue to stem from the poor data available on catches and effort (CRFM 2019). However, in recent years, massive Sargassum influxes that occurred throughout the southeastern Caribbean in 2011-2012, 2014-2015 and 2018 appear to have affected the availability of flying fish and may have affected the catch composition of the pelagic fishery. Thus, declines in recent flying fish catches in years of Sargassum influx may be primarily due to reductions in catchability rather than stock abundance. Research will be needed to determine the impacts of Sargassum on flying fish population dynamics in the eastern Caribbean fishery or if there is a catchability/connectivity effect between open ocean waters and the waters around the Lesser Antilles island-chain (**Figure 4.2**).

The tuna and tuna-like resources

The tunas and several tuna-like species include the most economically important species because of their global and regional economic importance and their intensive international trade. The tunas, for the purpose of this report, are classified into major tunas all of which belong the *Thunnus* and *Katsuwonus* genera, and into small tunas, which include three genera (*Euthynnus*, *Auxis*, *Thunnus*). The tuna-like species consists of istiophorid species occurring in the WECAFC region, Swordfish, the Wahoo, and the Common dolphinfish.

Major tunas include Albacore tuna (*Thunnus alalunga*), Bluefin tuna (*Thunnus thynnus*), Yellowfin tuna (*Thunnus albacares*), Bigeye tuna (*Thunnus obesus*) and Skipjack tuna (*Katsuwonus pelamis*). In the WECAFC region, the most important major tunas are the Yellowfin tuna, the Skipjack tuna and the Bluefin tuna; the first two because of the volume of catches and the latter to its high economic value.

Yellowfin tuna is considered a single Atlantic-wide stock, cosmopolitan open-water pelagic and oceanic species occurring above and below the thermocline to depths of up to 400 m distributed throughout the WECAFC region (**Figure 4.3**). However, a recent study on population genomics at a global geographic scale challenges current stock delineation (Pecoraro *et al.* 2016, Pecoraro *et al.* 2018) indicating that there is a strong genetic differentiation between populations in the eastern and western Atlantic. Yellowfin tuna is sensitive to low concentrations of oxygen and therefore, it is not usually caught below 250 m in the tropics, and is found in waters above 18°C. This species schools primarily by size, either in monospecific or multi-species groups. In the region, particularly in the Caribbean Sea, Yellowfin tuna is associated with Whale sharks and whales, with a certain seasonality depending on the presence of these mammals in waters of the Caribbean Sea (Gaertner and Medina-Gaertner 1999). Spawning in the WECAFC region consistently takes place from May through November in the Gulf of Mexico and to a lesser extent in the southeastern Caribbean Sea (Arocha *et al.* 2000) at sea surface temperatures above 24°C. In the region, the areas of major abundance (based on spatial distribution of the catches) are in the Gulf of Mexico, the southern Caribbean Sea, off the NBSLME and the southern limit of the region off Brazil (**Figure 4.4**).

Skipjack tuna, like Yellowfin tuna, is another cosmopolitan open-water pelagic and oceanic species occurring in offshore waters to depths of 260 m normally found in highly oxygenated waters between 20°C and 30°C. In the WECAFC area, it is commonly found in mixed schools with Yellowfin tuna and associated with birds, drifting objects, Whale sharks and whales (Gaertner and Medina-Gaertner 1999). The Skipjack tuna distributed throughout the WECAFC region is considered to belong to the western Atlantic stock (**Figure 4.3**), although a recent review based on movement patterns in the Atlantic suggested that due to the low north-south mixing in the western Atlantic (Fonteneau 2015), the mixing rates of remote fractions of Skipjack between Gulf of Mexico/Caribbean Sea and southern Brazil were probably very low or absent, suggesting that current stock structure is not a fully valid one for assessments and management of the resource. Skipjack tuna has short lifespan, with high fecundity spawning opportunistically and seasonally throughout the year in warm waters above 25°C (Cayré and Farrugio 1986; Andrade and Santos 2004) in the Gulf of Mexico and the southeastern Caribbean Sea (Brenner and McNulty 2018; Pagavino *et al.* 1997). In the region, the areas of major abundance (based on spatial distribution of the catches) are the southern Caribbean Sea and to a lesser extent the southwestern Gulf of Mexico (**Figure 4.5**).

Bluefin tuna, the most economically valuable tuna, is long lived with a wide geographical distribution and living permanently in the temperate waters of the North Atlantic and aggregating along oceanfronts to feed (ICCAT 2006-2016). The Bluefin tuna in the WECAFC region is part of the metapopulation occurring in the western North Atlantic occupying distinct and patchy suitable habitats that display late maturation and have distinct spawning grounds in the Gulf of Mexico (Fromentin and Powers 2005) (**Figure 4.6**). In the region, the areas of major abundance (based on spatial distribution of the catches) in recent years are in the northern Gulf of Mexico (ICCAT 2020a) (**Figure 4.7**).

The other two major tuna species, Albacore, and Bigeye tuna are widely distributed throughout the Atlantic Ocean including the WECAFC region (**Figure 4.8**). Albacore tuna is considered a temperate species, while Bigeye tuna is mostly a tropical species. Albacore tuna is longer-lived (15 years) than Bigeye tuna (9 years), both species spawn in tropical waters off the NBSLME (ICCAT 2006-2016, Arocha 2020) and southwest of the Sargasso Sea (Luckhurst and Arocha 2016). Albacore in the WECAFC region is part of the North Atlantic stock, although some studies support the hypothesis that various subpopulations may exist within the northern stock, while Bigeye tuna occurring in the region is part of an Atlantic-wide stock (ICCAT 2006-2016). In the region, the areas of major abundance (based on spatial distribution of the catches) for Albacore tuna in recent years include the southern Caribbean Sea, off the NBSLME and the area of the high seas within the WECAFC region (**Figure 4.9**), while Bigeye tuna major abundances are in the southern Caribbean Sea and the area of the high seas within the WECAFC region (**Figure 4.10**).

Small tunas include Blackfin tuna (*Thunnus atlanticus*), Little tunny (*Euthynnus alleteratus*), Frigate and Bullet tuna (*Auxis thazard*, *A. rochei*), and the Atlantic bonito (*Sarda sarda*) is also included in the small tuna subgroup due to its presence in the tuna purse seine fishery in the Caribbean Sea. Blackfin tuna exists only in the western Atlantic limited to most of the WECAFC region and is the most relevant and common species within the small tunas group (**Figure 4.11**). It is an epipelagic species, often found over reefs, bays, offshore, and the high seas. It sometimes occurs in large schools, often with Yellowfin tuna and Skipjack tuna. A recent study on the genetic structure of Blackfin tuna in the region (Saillant *et al.* 2016), indicated that preliminary analyses suggest the occurrence of a weak pattern of isolation by distance where genetic distance increases as a function of geographic distance (i.e. southern USA vs Venezuela-northern Brazil). In the region, the areas of major abundance (based on spatial distribution of the catches) for Blackfin tuna in recent years are in the Caribbean Sea mostly associated to catches from the purse seine and pole and line fisheries off Venezuela (Narváez *et al.* 2017) and in the southeastern Gulf of Mexico (**Figure 4.12**). Little tunny, Frigate tuna, Bullet tuna, and Atlantic bonito are less oceanic and more associated to continental shelves than other tunas. All species are mostly distributed across the region, except for Atlantic bonito, which seems to have a more limited distribution in the Gulf of Mexico, southeast USA, and the southern Caribbean Sea (**Figures 4.13, 4.14 and 4.15**). In the region, the areas of major abundance (based on spatial distribution of the catches) for this group of small tunas were aggregated for the four species and these areas are in the south central Caribbean and off the NBSLME in the boundary between the EEZs in the area and the ABNJ (**Figure 4.16**).

The Fishery

The tuna fishery started in the western Atlantic Ocean during the late 1950s. Several Japanese longliners conducted commercial feasibility operations in the Caribbean Sea between 1955 and 1958. The encouraging results that lead to a substantial increase in the number of vessels operating in the area and the establishment of a Venezuelan-Japanese based longline fishing operation in Cumaná in 1957 (Kawaguchi 1974). The main target of the fishery were Yellowfin tuna and Albacore tuna. About the same time (1957), Cuba also started longline operations with Japanese vessels in the Gulf of Mexico, the Atlantic and Caribbean targeting tunas, marlins and Bluefin tuna off Florida. The purse-seine fishery in the western Atlantic is opportunistic. It was started in the late 1970s by Venezuelan purse seiners that fished mostly in the eastern Pacific (Miyake *et al.* 2004). The vessels that fish in WECAFC region were generally from the Pacific, and only few smaller vessels remain in the area operating with the baitboat fishery that started in the late 1970s.

In the WECAFC region, the catches of the initial target species, Yellowfin and Albacore tunas, started increasing very rapidly and were the most important species caught by both longlines and surface gears for a period of time. However, since 1972, with the development of the surface fishery (baitboats and purse seines), the Yellowfin and Skipjack catch increased, while the Albacore catch has stabilized. The Yellowfin catch was the greatest until 1991, when it was exceeded by the Skipjack catch (ICCAT 2020b). Over the most recent years (2015-2019), Yellowfin tuna has been the species with the highest reported landings in the region with over 25 000 tonnes, while the rest of the major tuna species were below 10 000 tonnes over the same period, with the exception Bigeye tuna which exceed the 10 000 tonnes (**Figure 4.17A**). For the Tuna-like species (Swordfish, Atlantic blue marlin , Atlantic sailfish, Atlantic white marlin), combined catches are rarely over 1 000 tonnes in the region. As for small tunas, Bonito is by far the species that represent the largest catches of this group followed by Blackfin tuna (**Figure 4.17B**).

The dominant major tuna species caught in the region belong the group known as tropical tunas which include, Yellowfin tuna, Bigeye tuna and Skipjack tuna, these species are the main target of the tuna fisheries in the region. For Yellowfin tuna, little over 90% of the reported landings in the WECAFC region come from eight countries within the area, of which Brazil, Suriname and Venezuela account close to 70% of the reported landings over 2015-2019 (**Table 4.3**). In the case of Bigeye tuna, four countries in the WECAFC account close to 90% of the reported landed catch for the same period; however, foreign fleets, like Japan and China combined account for 20% of the landed catch and Brazil 54% (**Table 4.4**). For Skipjack tuna, about 90% of the landed catch come from five WECAFC countries of which Brazil and Venezuela account for 82% of the landed catch for the same period (**Table 4.5**).

The other two tuna species, Bluefin tuna and Albacore tuna, are considered temperate tunas. Bluefin tuna caught in the WECAFC region is under strict catch quota regulations since the early 1980s, and of the coastal states and islands within the WECAFC region, only three countries have catch quotas, namely, Bermuda, Mexico and the USA. During 2015-2019, only the USA and Mexico have reported landed catch (**Table 4.4**), the USA has landed around 1 000 tonnes annually (of the 1 247.86 tonnes TAC) and Mexico has landed under 100 tonnes annually (of the 128.44 tonnes TAC); while Bermuda has a catch quota of 5.31 tonnes (ICCAT 2020b, 2021).

Albacore tuna, the other tuna species considered temperate, is caught in the region as bycatch of the tropical tuna's targeted fishery by WECAFC countries. However, about 55% of the reported landed catch during 2015-2019 is from the seasonal targeted fishery of Taiwan operating mainly in the high seas of the WECAFC region (**Table 4.5**). Of the main four WECAFC countries landing Albacore tuna, of which most the landed catch is from the tropical tuna fishery, the landed catch of Dominican Republic is unlikely. In this case, it is likely that catches come from fishing on mFADs.

Most of the Yellowfin tuna and Skipjack tuna catch in the region since 1990s is attributed to the industrial surface fleet (Purse seine and Baitboat/Pole and Line) from Venezuela which operated mostly in the southern Caribbean Sea, with occasional excursions off the NBSLME (ICCAT 2020b, **Figures 4.18, 4.19**). The purse seine fishery in the southern Caribbean has been opportunistic, mostly from Venezuelan purse seiners that fished occasionally in the Caribbean when in transit from the eastern Pacific fishing grounds; however, a fleet of about four purse seiners normally operates in the southern Caribbean. The Venezuelan bait boat/pole and line fleet consists of five vessels that operate individually or in company of the purse seine vessels. The catch from the industrial surface fleet is destined for the canning industry, although in recent years is also commercialized frozen in the local market. Purse seine catches also occur, at smaller volumes, at the southern limit of the WECAFC region in addition to handline gear for the same area.

The abundance of tuna distribution is represented from the spatial distribution of catches for each species from all gears combined in 5x5 degrees squares in the WECAFC region. Yellowfin tuna highest abundance within the EEZ's occur in the GOM, the southeastern Caribbean and off the NBSLME, and in the high seas at the southern end of the WECAFC region as well as part of Brazil's EEZ's around its offshore archipelago islands of Sao Pedro and Sao Paulo (**Figure 4.4**). Skipjack tuna show a similar distribution pattern because is caught mostly with surface gears. Its highest abundance is in the central and southeastern Caribbean, the eastern part of Cuba, and like Yellowfin tuna, in the high seas at the southern end of the region as well as part of Brazil's EEZs around its offshore archipelago islands (**Figure 4.5**).

According to the spatial distribution of catches of Bluefin tuna by gear, longline and hand line are the preferred gears use to catch the species (**Figure 4.20**). The highest concentration is found in the GOM and along the southeast USA within their EEZ, and some high seas hot spots occur west of USA (**Figure 4.7**).

Bigeye and Albacore tunas are mostly caught by pelagic longline gear and most of it spatial distribution is based on catches from the pelagic longline gear. Most of the Bigeye abundance is southwest of the region, in the high seas off Brazil as well as part of Brazil's EEZs around its offshore archipelago islands (**Figure 4.10**), as well as off the central Venezuela coast, but the Bigeye tuna caught in that area comes from the Venezuelan surface fleets operating in the area. Albacore tuna highest abundance occur in the high seas off NBSLME, but also inside the EEZ´s of the northern part of the NBSLME and in the eastern Caribbean (**Figure 4.9**). Another area of important abundance of Albacore tuna is at the northwest corner of the Antillean Island Arc between the high seas and several SIDS EEZ's.

The second group of species in the tuna fisheries are those belonging to the small tunas, which include Blackfin tuna, Little tunny, Frigate and Bullet tuna, and the Atlantic bonito. The Atlantic bonito is the one species that yields the highest average landed catch for the period of 2015-2019 of 3 380 tonnes, most of which is reported by Mexico (**Table 4.6**). Although there is no indication of a directed fishery in Mexico, it appears that is caught in trammel nets used for the mackerel fishery off the Yucatan Peninsula when large schools migrate through the area during the warmer months (Carta Nacional Pesquera 2017). Blackfin tuna is the second species of small tunas with a high average landed catch (1 242 tonnes), of which 91.16% of the landed catch is reported by four countries in the region, where Cuba lands 68.11% of the accumulated catch from 2015 to 2019 followed by Saint Lucia, Grenada and Venezuela (**Table 4.6**). Cuba´s landings come from their longline fishery off the western side of the island around the Yucatan Channel. Most of the landed catch from Saint Lucia and Grenada come from the Small-Scale Fisheries associated with FADs (CRFM 2015). Whereas Venezuela's landings come —in contrast— from the tuna surface fleets as part of the bycatch (Narváez *et al.* 2017). The other small tuna species —Little tunny, Frigate and Bullet tuna— were mostly caught by the SSF from Colombia (Little tunny) and Venezuela (Frigate and Bullet tuna) using trammel nets during their runs along the southern Caribbean coasts of both nations. Colombia accounted for 70.16% of the accumulated landed catch for Little tunny and Venezuela for 73.29% of the landed catch of Frigate and Bullet tuna (**Table 4.6**).

The main fishing effort for major tunas is from industrial, semi-industrial and from some SSF and those associated with FADs in the region. The number of industrial and semi-industrial vessels operating in the region targeting major tunas is not clearly identified, from different sources an estimated number of vessels in this category is about 440 vessels (**Table 4.7**). The largest category is the longline fleet with an estimate of 330 vessels, in addition to 87 vessels from Japan operating in the region. The surface industrial fleet comprises of four baitboat/pole and line (Venezuela) vessels and 23 purse seiners of which most of them are operating outside WEACFC but have opportunistic and seasonal sets within the region´s EEZs and in the high seas.

Across the region, the gear of preference is the pelagic longline gear for which Yellowfin tuna is the main target species in WECAFC, but seasonally the target changes according to preferences of the fleet and/or nation and the market value for certain species. The estimated longline effort in number of hooksX1000 (Taylor *et al.* 2020) is mainly concentrated in the high seas within the WECAFC region, particularly off the NBSLME and the southeastern corner of the WECAFC region (**Figure 4.21**). Areas of high fishing effort within the region´s EEZs occur in the southern central Caribbean (off Venezuela), around Barbados, and offshore Brazil´s Archipelago islands. Another area of important effort distribution from the pelagic longline fleets is the GOM and off the northeastern USA within the region's limit.

The amount of fishing effort from the SSF directed at tunas is not possible to quantify for several reasons. One of them is the multiespecific nature of the SSF targeting large pelagic fishes in the region. In SIDS as well as in countries with very narrow shelf and exposed to migration routes of large pelagic fishes, the target species for SSF will vary seasonally as well as the amount of effort (in number of boats) allocated to that fishery in any given time. In countries that report to ICCAT and have semi-industrial or SSF are likely to report fishing effort at least as the number of vessels/boats involved in the fishery of large pelagic fishes. However, countries like Mexico, Saint Vincent and The Grenadines, Trinidad and Tobago, and Venezuela that are members of ICCAT and have important SSF that target large pelagic species, do not report fishing effort on a regular basis to ICCAT or any other RFB. In most cases, when reported, have been the product of specific research projects towards that end (e.g. Arocha *et al.* 2015). A rough potential estimate of boats involved in the SSF fishery of large pelagic fishes that include tunas and tuna-like species is about 8877 boats of sizes below 20 m LOA (**Table 4.7**). The number of vessels indicated in the table from SSF of countries that have expressed that target tunas or large pelagic fishes are to be viewed with caution because there is no clear indication from some countries the number of boats directly involved in the fishery. Another reason is the variety of gears used to capture large pelagic fishes, because some gears are very selective like line gear (longline, handline and trolling) and other non-selective like trammel and drift-gill nets. In some countries, like Venezuela, some boats can carry several types of gear at any given time and switch between them accordingly. It is presumable that other countries in the region may display a similar practice.

Another effort issue in the region is the development of FAD fisheries triggered by depletion of the islands nearshore fishery resources and the resulting economic stress created among small-scale fishers (Ehrhardt *et al.* 2017). Fishers in the region utilize a combination of moored and drifting FADs; most of the effort on drifting FADs (dFAD) is targeted toward flying fish, while moored FADs (mFAD) fishing is heterogeneous, although mostly directed at large pelagic fishes (Doray 2007). The effort definition for this type of fisheries will become a challenge noting that the boat to FAD ratio can be highly variable across the region from several boats to a single FAD vs a one-on-one ratio. The FAD fishery development has been highly variable across the region, although one commonality is that all nations lack either financial resources or human resources for proper data collection, most of what has been collected vary considerably according to when projects begin and/or end. However, efforts continue towards the development of sub-regional plan that would enhance FAD fisheries (CRFM 2015).

State of the stocks

Yellowfin tuna. The most recent stock assessment conducted for Yellowfin tuna conducted in July 2019 applied two production models and one age-structured model to the available catch data through 2018 (ICCAT 2020b). The combined results of all models used to develop management advice resulted in the median estimate of B/B_{MSY} is 1.17 and the median estimate of F/F_{MSY} is 0.96. The median MSY estimated is 121 298 tonnes. The results point to a stock status of not overfished, with no overfishing (**Table 4.2**). Current management advice is an Atlantic-wide TAC of 110 000 tonnes, it also includes area closures in the eastern Atlantic, FAD limitations, vessel authorization and limits on number of vessels and gears.

Skipjack tuna. A full stock assessment was conducted for western Atlantic Skipjack tuna in 2014. Four models were used for this assessment: a mean length- based mortality estimator, a catch-only model, a Bayesian surplus production model, and a Stock Production Model Incorporating Covariates (ICCAT 2015). The stock was determined to most likely not be overfished ($B_{2013}/B_{MSY}>1$) or undergoing overfishing ($F_{2013}/F_{MSY}<1$). Catches in 2013 (17996 tonnes) were well below the estimated maximum sustainable yield (30 000 tonnes-32 000 tonnes).

Bluefin tuna. The western stock assessment was conducted in 2020 as strict update from the last stock assessment. Both sets of results from the Virtual Population Analysis (VPA), and Stock Synthesis models were equally weighted to formulate advice. Current F (average of 2015-2017) relative to the F0.1 reference point was 0.8 (VPA) and 0.84 (Stock Synthesis), indicating that overfishing is not occurring (ICCAT 2021a). Under the updated models, the current TAC is likely to have led to overfishing relative to F0.1 beginning in 2018. The updates of the VPA and Stock Synthesis model used were informative and found evidence of stock decline and provided a range of options for 2021, 2022 and 2023 TAC advice.

Albacore tuna. The northern stock assessment was in 2020. The biomass dynamic model used in the assessment included data through 2018. Assessment results indicated that the stock is in the green quadrant of the Kobe plot, e.g. not being overfished nor experiencing overfishing (ICCAT 2021a). Management advice for the 2021- 2023 period following the interim Harvest Control Rule adopted by the Commission in 2017, with a recommended TAC of 37801 tonnes (in which several WECAFC countries have a specific TAC) is expected to maintain the stock levels above BMSY until 2033 with a probability higher than 60%.

Bigeye tuna. The most recent stock assessment for Bigeye tuna was conducted in July 2021. Two Surplus Production Models and Stock Synthesis model were chosen to provide stock status. It was recommended that final management advice be developed from the distribution of the projections for the 27 Stock Synthesis runs of the uncertainty grid (ICCAT 2021b). The results of the assessment, based on the median of the entire uncertainty grid shows that in 2019 the Atlantic Bigeye tuna stock was overfished (median SSB_{2019}/SSB_{MSY} = 0.94 and 80% CI of 0.71 and 1.37) and was not undergoing overfishing (median F_{2019}/F_{MSY}=1.00 and 80% CI of 0.63 and 1.35). The average of MSY was estimated as 86 833 tonnes with (80% CI of 72,210 and 106,440) from the uncertainty grid deterministic runs.

Blackfin tuna. ICCAT's Standing Committee on Research and Statistics (SCRS)-Small Tunas Species Group decided to apply an Ecological Risk Assessment (ERA) on a selected group of species for which available life history data existed (ICCAT 2016b). The approach consisted of defining the risk to a population of being depleted as a function of (1) Population Productivity, which determines the rate at which the population can recover from depletion and (2) Population Susceptibility, which defines its exposure to fishing activity. Productivity and Susceptibility are used to produce a single risk score and risk categories - high, moderate, and low, are assigned. As a result, considering only the small tuna in the WECAFC area of the Atlantic Ocean, the 2016 ERA indicated that Blackfin tuna was estimated as one of the most vulnerable species caught by the longline fleet in the region, with high risk (ICCAT 2017b). However, CRFM's technical group concluded that on a qualitative basis there was no evidence that overfishing was occurring on the Blackfin tuna stock, indicating that trends of annual nominal landings for the data used (Dominica, Grenada, Saint Lucia and Saint Vincent and the Grenadines) indicated a general increasing trend (CRFM 2013). Strong caution is warranted based on recent preliminary findings on stock structure (Saillant *et al.* 2016), in which Blackfin tuna caught in the southeastern Caribbean is likely to share the same genetic affinity with those specimens caught by the eastern Caribbean islands.

The remaining small tunas that include, Little tunny (*Euthynnus alleteratus*), Frigate and Bullet tuna (*Auxis thazard*, *A. rochei*), Atlantic bonito (*Sarda sarda*) were assessed with an ERA also known as productivity and susceptibility analysis (PSA). Results indicated that Frigate and Bullet tuna from the North Atlantic were the most productive, thus with a low vulnerability to overfishing. In contrast, Little tunny showed moderate vulnerability to overfishing (ICCAT 2016b). However, recent assessment using Data-Limited assessment methods that included northwest Atlantic Little tunny indicated that the stock was above stock status target (Pons *et al.* 2019), and therefore not overfished.

<u>The tuna-like species</u> include five billfish species: Atlantic blue marlin (*Makaira nigricans*)*,* Atlantic sailfish *(Istiophorus albicans),* Atlantic white marlin *(Tetrapturus albidus),* Longbill spearfish *(Tetrapturus pfluegeri),* Roundscale spearfish *(Tetrapturus georgii*) and Swordfish (*Xiphias gladius*). All of which are long-lived species with high fecundity. It is noted that Atlantic sailfish (*I. albicans*) and Atlantic white marlin (*T. albidus*) are presently recognized as *Istiophorus platypterus* and *Kajikia albida* by ICCAT, not so in the Aquatic Sciences and Fisheries Information System (ASFIS). Other tuna-like species include the Wahoo (*Acanthocybium solandri*), and the Common dolphinfish (*Coryphaena hippurus*).

In the WECAFC region, Swordfish is an important economically valuable resource within the tuna-like species group. Of the billfish species, Atlantic blue marlin and Atlantic sailfish represent important fishery resources in SIDS as well as for some coastal communities in developing countries as part of their food security, while for developed countries all billfish species are highly valuable for the recreational fishery sector (Gentner *et al.* 2018).

Swordfish is considered an oceanic meso-pelagic species widely distributed throughout tropical and temperate waters and do not form schools nor dense aggregations (Ward *et al.* 2000). It is widely distributed across the region over open waters and close to coastal areas where the slope drop is steep and is part of the North Atlantic stock (**Figure 4.22**). Swordfish spawns within the WECAFC region in the high seas as well as in the Gulf of Mexico and in the southeastern USA over a protracted season (Arocha 2007). Some areas of the Caribbean Sea, Gulf of Mexico and southeastern USA are considered important nursery grounds for Swordfish (Neilson *et al.* 2009). Swordfish is known to display north-south migratory movements between spawning and nursery grounds in the region and major feeding grounds off New England (USA) and Grand Banks (Canada), where fish remain or return to the same feeding grounds at least after one year, and juveniles remain in the nursery area at least for one year (Arocha and Prince 1999, Stone 2000, Neilson *et al.* 2013). In the region, the areas of major abundance (based on spatial distribution of the accumulated catches) for Swordfish in recent decades (1990-2018) include the Gulf of Mexico, southeastern USA, west of The Bahamas and to a lesser extent off northeast of Puerto Rico, the eastern Caribbean Sea and east of the Lesser Antilles (**Figure 4.23**). Another area of high abundance is found in the southern limits of the WECAFC area in the high seas and around Brazil's offshore archipelago´s islands.

Atlantic blue marlin is an epipelagic oceanic species widely distributed across the region often over open waters of the Caribbean EEZs and the high seas (**Figure 4.24**). Often found in open seas with surface temperatures between 22-31°C. Like Swordfish, adults of this species do not form schools or dense aggregations and in the region, Atlantic blue marlin is considered part of a single Atlantic-wide stock. Spawning is thought to occur in the Gulf of Mexico (Kraus *et al.* 2011), but also in the Mona Passage (Dominican Republic), north of Puerto Rico, and southern Bahamas (Rooker *et al.* 2012, Prince *et al.* 2005, Serafy *et al.* 2003). Migratory movements in the WECAFC region show important horizontal displacement within and between the Gulf of Mexico and southern Caribbean Sea, and between the southern Caribbean and the southeastern USA (Ortiz *et al.* 2003). However, fish tagged outside the Gulf of Mexico and the Caribbean Sea (e.g. The Bahamas, Bermuda and Puerto Rico,) show that most of the migratory movements are into the Atlantic Ocean (https://igfa.org/igmr-tracks/), with incursions into the southern Caribbean Sea. It has been hypothesized that the southern Caribbean Sea is a feeding ground, and the Gulf of Mexico is a spawning and nursery area. The areas of major abundance (based on spatial distribution of the accumulated catches) for Atlantic blue marlin in recent decades (1990-2018) include the Caribbean Sea, and to a lesser extent the Gulf of Mexico and off the NBSLME (**Figure 4.25**).

The Atlantic sailfish is the least oceanic of the Atlantic billfishes, displaying a strong tendency to approach continental coasts, islands, and reefs (de Sylva 1974; Nakamura 1985) (**Figure 4.24**). In the region, Atlantic sailfish are considered part of the western stock where they normally form groups of several individuals and are occasionally found in schools when feeding and seasonally in "hot spots" like Isla Mujeres (Mexico) and La Guaira (Venezuela) (Kurvers *et al.* 2017, Lam *et al.* 2016, Arocha *et al.* 2016). Atlantic sailfish in the WECAFC region spawns in several located areas between 5°N and 30°N, derived from information on larval surveys and reproductive biology of spawning fish (Simms *et al.* 2010, Mourato *et al.* 2018). Larval surveys indicate spawning in the Gulf of Mexico and the southeastern USA, while spawning fish occur in the southeastern Caribbean Sea around the La Guaira-Venezuela hot spot; however, occasional spawning takes place off the NBSLME between June and October (Mourato *et al.* 2018). The areas of major abundance (based on spatial distribution of the accumulated catches) for Atlantic sailfish in recent decades (1990-2018) include the southern and eastern Caribbean Sea and off the NBSLME, the eastern GOM, around western Cuba (**Figure 4.26**). There are also localized areas of high accumulated catch in the western GOM and north of Puerto Rico, possibly attributed to sport fishing catches. The southern limits of WECAFC are also an area of high abundance of Atlantic sailfish, within EEZ and in the high seas.

The remaining three billfish species, Atlantic white marlin, Longbill spearfish, and the Roundscale spearfish, have not attracted large or high interest from commercial fisheries, although they are commonly caught as bycatch in tuna and coastal large pelagic fish fisheries and are highly attracted by the recreational sector. However, Atlantic white marlin has a similar spatial distribution as Atlantic blue marlin within the region (**Figure 4.24**); while the two spearfishes have a more open "blue" waters spatial distribution that have made these two species relatively uncommon in the commercial catches (**Figure 4.27**). White marlin in the region is part of the Atlantic-wide stock, which has been the most affected by tuna and some small-scale fisheries suffering a steep population decline. In the WECAFC region, Atlantic white marlin spawns seasonally in two localized areas northeast of the Greater Antilles (northeast of Dominican Republic, and north-northeast of the Puerto Rico Trench) (Arocha and Barrios 2009). Like Atlantic blue marlin, migratory movements in the WECAFC region show strong horizontal displacement between the southern Caribbean and the southeastern USA (Ortiz *et al.* 2003). However, fish tagged with PSAT north the WECAFC region show that the migratory movements are into the Atlantic Ocean, with incursions into the southern Caribbean Sea, and fish tagged in the southern Caribbean Sea remain in the area for a limited time (Hoolihan *et al.* 2015). The areas of major abundance (based on spatial distribution of the catches) for Atlantic white marlin in recent decades include the southeastern Caribbean Sea, some areas of the GOM, and an area east of the Antilles Islands EEZs and the high seas (**Figure 4.28**). Another area of major abundance is the southern limits of the WECAFC region, within Brazil's EEZ and the high seas in that area. Then along the NBSLME offshore area is another relative abundant area for Atlantic white marlin bordering between several countries EEZs and the high seas.

The two spearfish species, Longbill spearfish and Roundscale spearfish, are oceanodromous and mostly found in open ocean waters within the WECAFC region. There is no defined stock structure for either species, although ICCAT separates them into western and eastern stocks. The Longbill spearfish is more commonly caught as bycatch in the tuna fisheries and as directed catch of some offshore artisanal fisheries of the region (Arocha *et al.* 2007, Arocha *et al.* 2015). Of the two species, only the Longbill spearfish is known to spawn in open waters of the eastern-central Caribbean Sea (Arocha *et al.* 2007). Limited information exists for Roundscale spearfish, other than is easily confused with Atlantic white marlin by untrained fishers, but is widely caught as bycatch of the tuna longline fisheries in the region (Arocha and Silva 2011, Beerkircher *et al.* 2009). The areas of known major abundance (based on spatial distribution of the catches) for the Longbill spearfish in recent decades (1990-2018) include the southeastern Caribbean Sea and southeast of the Lesser Antilles to east of Barbados and into the area of the high seas along that latitude (**Figure 4.29**). There are other areas of important abundance around the aforementioned areas, and in the northwest and southwest of the Yucatan Peninsula. In the case of the Roundscale spearfish, the few countries in the region that can identify the species started reporting it separately in recent times; therefore, spatial catch distribution of the species is not sufficient to develop a spatial distribution map.

The Common dolphinfish is widely distributed in surface oceanic waters and near coastal areas across the region (**Figure 4.30)**; common in northern area of the southeastern USA, throughout the Gulf of Mexico and from the Caribbean Sea to the northeastern coast of Brazil, noting that the species is only seasonally abundant at these areas (Oxenford 1999). In the region, the Common dolphinfish is considered a single panmictic population (Merten *et al.* 2015). The species is found offshore under floating objects, like Sargasso mats, logs, and FADs; it displays a protracted spawning behavior, with multiple spawns during the spawning period during which peak spawning seasonality varies across the region (Arocha *et al.* 1999, Oxenford 1999). Areas of highest abundance of Common dolphinfish based on reported catches occur in the southeastern Caribbean and around the Eastern Caribbean Islands through to Barbados and Trinidad (**Figure 4.31**). Other of important abundance areas include northeastern Brazil and the western GOM.

The Wahoo is an oceanic, epipelagic species frequently found solitarily or forming small, loose aggregations rather than compact schools. In the WECAFC region, it is widely distributed and seasonally abundant in most locations (**Figure 4.32)**. Periods of peak abundance occur from the fall through spring in the southeastern and northern Caribbean islands, and are restricted to the warmer months (late spring through early fall) in northern areas of the Gulf of Mexico, southeastern USA, and Bermuda (Oxenford *et al.* 2003). The limited information on stock structure in the region suggests a single stock hypothesis with stock boundary beyond the WECAFC region (Constantine 2002). Like the Common dolphinfish, is found offshore in the vicinity of drifting objects, like Sargasso mats, and FADs. Spawning information is mostly limited to the northern areas of the region where it appears to take place during the warmer months (May-October) (Oxenford *et al.* 2003); although at-sea observers from the Venezuelan Pelagic Longline Observer Program have identified spawning of Wahoo in the central-eastern Caribbean during the spring months (**VPLOP**). The areas of highest abundance are in the high seas around Bermuda, in the southeastern Caribbean and around the eastern Caribbean Islands through to Barbados and Trinidad, and in the southern part of the NBSLME eastward to the high seas off Brazil (**Figure 4.33**).

The Fishery

The Swordfish fishery is a specialized longline directed fishery that occurs setting the longline gear at dusk, fishing during the night and using light-sticks attached near the baited hook.

The recent history of the Swordfish northwestern Atlantic fishery started as a seasonal fishery off the northeastern USA and Canada Maritimes with harpoon initially and longlines later, as well with gillnets. In the mid North Atlantic within WECAFC, Swordfish were caught as a by catch product by the Japanese longline fleet targeting Bigeye tuna. In 1978, after the ease of USA Food and Drug Administration regulations on mercury content in Swordfish, the USA fishery expanded south to the Straits of Florida, Gulf of Mexico, Caribbean Sea and into the Atlantic off Puerto Rico by the late 1980's the Swordfish fishery had expanded to the waters off the NBSLME (Arocha 1997). During the same time in the 1980´s, Venezuela initiated an exploratory Swordfish fishery that developed into a formal Swordfish directed operation throughout the year until the mid-1990’s after which it shifted its operation towards the tuna fishery and landing Swordfish as part of the commercial bycatch (Arocha and Marcano 2005).

Signs of Swordfish being overfished began to appear in the early 1990s and several management measurements were implemented by ICCAT to reduce fishing mortality and to rebuild the North Atlantic stock (Neilson *et al.* 2013). During that time Swordfish fishing operations were reduced, nursery areas were defined, protected and trade minimum size limits were enforced. The Venezuelan Swordfish operation ceased entirely by 1999 due to trade enforcement on minimum size limits by the USA (to where almost all the Swordfish catch was destined) and because the southern Caribbean was mostly another nursery area for North Atlantic (NA) Swordfish (Arocha *et al.* 2013, Arocha and Prince 1999). Presently the NA Swordfish stock is recovered and is under country specific catch quota management procedure (Neilson *et al.* 2013).

Most of the reported landed catch for Swordfish (91.84%) come from four countries operating within the WECAFC region for the most recent period (**Table 4.8**). Over half of the reported landed catch is from a foreign fleet likely operating in the high seas of the WECAFC region, while the USA has the highest reported landed catch (32.1%) of the WECAFC member countries. The remaining proportion of the landed catch over the recent period is distributed between regional fleets and foreign fleets operating in the region, of which Saint Vincent and the Grenadines, Venezuela, Mexico, and Grenada account for slightly over 7% of the catch, which likely comes as part of the commercial bycatch of the tuna longline fisheries of those countries.

Across the WECAFC region, the gear of preference for the targeted Swordfish fishery is the pelagic longline gear, broadly used (**Figure 4.34**). Pelagic drift gillnets were used in the early 1990s by USA fishers in the northern limits of the WECAFC region (Arocha 1997), who may be responsible for the catches west of Bermuda. Artisanal drift gillnet off central Venezuela targeting billfishes have also landed incidental catches of Swordfish. The "other" gear category is likely from troll fisheries off northern Cuba, and southern Haiti (possible around mFADs).

The fishery for billfish species in the WECAFC region seems to start as a recreational activity since the 1930's in the USA (Ehrhardt and Fitchett 2016) and in the 1940´s off the central coast of Venezuela, when trials started, and Atlantic white marlins were caught with hand line; and the first Atlantic blue marlin caught with rod and reel under sport fishing regulations by one of the Yachting Club holding the tournaments was recorded in 1947 (Alió 2013). By 1950's, recreational billfish tournaments were taking place in the region (Rodriguez-Ferrer *et al.* 2005). Some billfish species have also been part of the commercial bycatch of Japanese longline fishing in the Caribbean Sea since their early days of commercial operations off Venezuela in the late 1950's when it was indicated that Atlantic white and blue marlins were seasonally abundant during their Yellowfin tuna fishing operations (Kawaguchi 1974).

Concerns were raised in the 1970s, later in the 1980s, and in the 1990's when trends in abundance indices from recreational fisheries in the region began to drop in all three major species (Atlantic blue marlin, White marlin and Sailfish) and it was attributed to the increase of catch of billfishes from tuna fishing operations as a consequence of increased fishing effort in the Atlantic (ICCAT 1994, Babcock and Arocha 2016, Ehrhardt and Fitchett 2016). In the 2000s, the stock assessments results led to the implementations of Atlantic wide management actions by ICCAT to limit catch on all major billfish species and recommend the release of all billfish caught by tuna fisheries (ICCAT 2020b).

The billfishes are mostly caught by pelagic longline gear as part of the bycatch for Yellowfin tuna directed fisheries across WECAFC region; although there are exceptions by species where in some areas where they are targeted by the SSF fisheries of several countries in WECAFC, other gears are also used. In addition, the sport fishery for billfish, although mostly catch-and-release, some trophy size catches are landed. In the most recent years, the billfish landed catch are from four species: Blue and Atlantic white marlin, Atlantic sailfish and Longbill spearfish.

Most of the Atlantic blue marlin accumulated landed catch (90.27%) for the period 2015-2019 in the region were reported by seven countries (**Table 4.8**). Over half of the landed catch (55.75%) came from SSF target and opportunistic/seasonal fisheries from Dominica, Dominican Republic, France (Martinique and Guadalupe) and Saint Lucia utilizing mFADs as attractants and using line gear to catch the fish (Reynal *et al*. 2015, CRFM 2015, Gentner *et al.* 2018, Arocha 2019, http://firms.fao.org/firms/fishery/976/en#TargetSpecies). The remaining of the landed catches (44.25%) were mostly part of the commercial bycatch from the tuna directed fisheries;

however, in the case of Venezuela almost half of the Atlantic blue marlin reported catch came from the artisanal drift gillnet fishery fishing off La Guaira's billfish hot spot (Arocha *et al.* 2011).

Atlantic blue marlin, in the high seas is mostly caught by longlines, but within the EZZs is caught by rod and reel around Bermuda and along the coast of the USA (**Figure 4.35**). In the GOM and northwestern Caribbean is mostly caught with longline gear. In central and eastern Caribbean is caught with a variety of gears other than longline. Under "other" gears category it includes troll fishing as well as drop lines with live bait around mFADs off Dominican Republic (Gentner et al. 2018) and drop lines with live bait in Haiti (Valles 2016), as well as in the eastern Caribbean in Guadalupe, Martinique and Saint Lucia. In the central Caribbean off Venezuela, in addition to the longline, most of the Atlantic blue marlin catch is taken by the artisanal fishery operating in the billfish hot spot (La Guaira) using drift gillnets. Off the NBSLME, some fisheries use drift nets from semi-industrial fisheries, which can occasionally catch Atlantic blue marlin in the area. At the southern part of WECAFC, other than longline, some rod and reel and other type of line gear are used as well.

Atlantic sailfish in the region is mostly caught by seven countries which account for 93.31% of the accumulated landed catch for the period of 2015-2019 (**Table 4.9**). Six of them operate with longline gear and Atlantic sailfish is considered part of the commercial bycatch of its main target species (i.e. Yellowfin tuna); while the catch of the other (Domincan Republic) comes entirely from trolling around mFADs or using "drop-lines" with live bait (Gentner *et al*., 2018, Arocha 2019). In the case of Venezuela, 20-30% of the landed catch came from the artisanal drift gillnet fishery fishing off La Guaira's billfish hot spot; but, like in Atlantic white marlin, the recent catch history of Atlantic sailfish from the VAOS longline fleet is on average almost twice of the combined landed catch from the artisanal drift gillnet and the commercial bycatch from the longline fleets (Arocha *et al.* 2015). This historical comparison shows the impact of the Venezuelan Artisanal Offshore (VAOS) longline fleet in total removals of Atlantic sailfish in the southwestern Caribbean Sea and off NBSLME in the region. However, due to the lack of reporting from the VAOS fleet in recent years (2015-2019), the impact in total removals of Atlantic sailfish in the areas is unknown. The reported catches from other two most important countries landing Atlantic sailfish (Suriname and Panama), are likely caught in the high seas and the EEZs off the NBSLME by fleets that operate in the area (Belize, Panama and St Vincent and The Grenadines) that land Atlantic sailfish as part of an agreement with Suriname (ICCAT 2020c).

Atlantic sailfish in the high seas is entirely caught with longline gear, and some in the region's EEZs (**Figure 4.36**). In the USA EEZ is largely caught with rod and reel by the sport fishery, and other areas of the northwestern Caribbean around Jamaica. In the central Caribbean, important catches occur south of la Española (Dominican Republic and Haiti, Valles 2016, Gentner et al. 2018) which are mostly catches from SSF associated to the mFADs fishery in the area that are taken by troll and/or baited drop-line gear in the area. In the southcentral Caribbean, catches are taken by the artisanal billfish directed drift gillnet fishery operating off central Venezuela and by SSF operating with line gear off northeastern

Colombia. In the southern WECAFC limits, in addition to the longline, Atlantic sailfish catches are also important in the SSF operating with hand lines in the area identified as “other” gear category.

In Atlantic white marlin, most of the accumulated landed catch (92.57%) is from the commercial bycatch of the tuna directed fisheries of Barbados, Grenada, Mexico and Venezuela; the catch landed in Venezuela accounts for over 50% of the reported catch in the region; and like in Atlantic blue marlin, about 20% of the landed catch came from the artisanal drift gillnet fishery fishing off La Guaira’s billfish hot spot (Arocha *et al.* 2012) (**Table 4.9**). However, in the recent history, the highest catch of Atlantic white marlin in Venezuela came from the (VAOS) longline fleet (Arocha *et al.* 2015), but for the most recent period (2015-2019) Atlantic white marlin catches from this fleet have not been reported to ICCAT nor to FAO. In the case of Barbados and Grenada, the catch is mostly taken by their different types of boats operating with longline gear (Gentner *et al*., 2018, Arocha 2019). Costa Rica is the country with the second most important accumulated landed catch of Atlantic white marlin in the region (18.98 %); however, Costa Rica has declared that it does not have vessels targeting large pelagics in the WECAFC region (http://www.fao.org/fi/oldsite/fcp/en/cri/profile.htm, ICCAT 2020c), although there are reported landings of large pelagic fish species in their national fishery statistics in its Caribbean landing port Limón (http://www.incopesca.go.cr/publicaciones/); therefore is not clear if this important removal of Atlantic white marlin has its origin in the WECAFC region.

Like the other billfish species, Atlantic white marlin is taken almost entirely by longlines in the high seas of WECAFC, as well as most of the EEZs in the region (**Figure 4.37**). Although, there are some exceptions like off Bermuda, along the southeastern USA and northern GOM where a small proportion of the Atlantic white marlin catch is taken by the sport fisheries in those areas, including the eastern Caribbean where billfish tournament take place in Grenada and Puerto Rico. South of la Española (Dominican Republic and Haiti) an important take of Atlantic white marlin is reported from troll and baited drop-line gear which in both cases are likely catches from SSF associated to the mFADs fishery in the area. In the southern limits of WECAFC, within Brazil’s EEZ, some catches of Atlantic white marlin come the artisanal fishery operating with line gear.

The Longbill spearfish catch in the WECAFC region is of recent time, the total reported landed catch came from five countries, two of which are likely catching Longbill spearfish in WECAFC´s high seas (St Vincent and the Grenadines, Spain), the rest of the catch is mostly caught within WECAFC´s EEZs (**Table 4.9**). Over 93% of the reported accumulated catch come from the commercial bycatch of St Vincent and the Grenadines and Venezuela´s main target species (i.e. Yellowfin tuna). It is likely the same case for Mexico and Spain, but in the case of Dominica the Longbill spearfish catch is coming from the mFAD fishery in their area of operation which is likely a bycatch product of their targeted mFAD fishery for Yellowfin tuna and Common dolphinfish (Sidman *et al.* 2014, CRFM 2015). The available spatial information of the catches of Longbill spearfish come from the commercial operations of pelagic longline in the area; most of which occur in the high seas and the Caribbean Sea and south to some locations in the high seas in FAO fishing area 41 (**Figure 4.38**). However, in the northwestern GOM, Yucatan Channel, Straits of Florida and The Bahamas, the reported catch is entirely from rod and reel from the sport fisheries in that area.

The directed fishery for Common dolphinfish is mostly from the SSF and the recreational fisheries across the region, and a limited proportion is part of the commercial bycatch of the tuna longline fishery. About 92% of the Common dolphinfish accumulated landed catch for 2015-2019 is from 11 countries in WECAFC which makes it an important fishery resource across the region (**Table 4.10, Figure 4.39**). Of those countries, the reported catches from Barbados and Venezuela are almost entirely from their SSF longline fleets operating within several EEZs and in the margin with the high seas (Arocha et al. 2015, Arocha 2019, ICCAT 2020b). The USA including Puerto Rico, the Common dolphinfish landed catch within the WECAFC region is from the sport fishery (commercial and recreational) and from the pelagic longline fishery (directed and as by catch of other migratory species) in almost equal proportions (SAFMC 2003, CFMC 2019). Important Common dolphinfish landed catches in the region, which accounts for 50.21% of the total accumulated landed catch come from the mFAD fishery of France (and Guadalupe & Martinique), Saint Lucia, Dominican Republic, Dominica, and Grenada in which the main gear is hand-line gear (trolling or drop-lines) (CRFM 2015, Arocha 2019). The Common dolphinfish catches from Suriname are likely part of the commercial bycatch of the longline fishery operating within its EZZ, and from Costa Rica is unclear for the reason expressed above in the section of Atlantic white marlin reported landed catches.

The spatial distribution of Common dolphinfish catches by gear (excluding recreational fishery) in the region show that is caught by pelagic longline in the western GOM, likely by the Mexican fleets targeting large pelagic species, and in the high seas north of Puerto Rico and around Bermuda (**Figure 4.40**). In the Caribbean Sea Common dolphinfish is caught by artisanal drift-gillnet, commercial pelagic longline, and likely by “other” type of line gear (i.e. trolling) around the Eastern Caribbean Islands. In the NBSLME is caught by commercial pelagic longline and by “other” undefined gear. In the southern part of WECAFC, off Brazil most of the catch is by hand-line gear possibly by the recently developed SSF in that area that targets large pelagic fishes (ICCAT 2020b), with some coming from commercial pelagic longline and baitboat.

The Wahoo is not part of a fishery but is caught seasonally by several countries in the region when is available in the area where a fishery for large pelagic fishes is a common practice. Most of the Wahoo landed catch (91.22%) is reported by 12 countries in the region which makes it also an important resource for SIDS (**Table 4.10**). The primary method for catching Wahoo is by trolling (commercial and recreational) and with longline gear targeting pelagic migratory species. Of those 12 countries, 20.62% of the accumulated reported catch for the period of 2015-2019 come from pelagic longline targeting pelagic migratory species (Panama, Mexico, Saint Vincent and The Grenadines and Venezuela). The USA landed catch is mostly from the recreational fishery and a small proportion is from the commercial bycatch of Common dolphin directed fishery or other pelagic migratory species (SAFMC 2003). Another group of countries that land Wahoo come from SSF of SIDS using line gear by trolling around mFADs or in open water.

Spatial abundance of Wahoo in the region is better represented because its interaction with the pelagic longline fishery targeting migratory fishes and because of better reporting in the last 20 years. Most of the Wahoo reported catch is taken by the pelagic longline gear through the region (**Figure 4.41**), and in some areas like around Bermuda and off the southeastern coast of the USA, Wahoo is taken by rod and reel recreational fisheries; while in the eastern Caribbean is mostly caught with “other” line gear like trolling and hand-line, and in the southern WECAFC area is caught with hand-line and baitboat in addition to the pelagic longline gear.

State of the stocks

Swordfish. The last assessment for Swordfish in the North Atlantic was conducted in 2017 (ICCAT 2020b). The population of Swordfish in the North Atlantic is estimated to be at or above levels needed to produce MSY (B/B_{MSY}=1.04) and is not overfished (F/F_{MSY}=0.78) (**Table 4.2**). Management advice through 2021 is a TAC of 13 200 tonnes, in which several WECAFC member countries have a specific TAC, as well as a minimum size limit.

Atlantic blue marlin. A full stock assessment was conducted for Atlantic blue marlin in 2018, using the available data through 2016, and applying both surplus production and age-structured models (ICCAT 2019). The results of the 2018 assessment indicated that the estimated MSY (median = 3 001 tonnes), the estimated relative biomass (B/B_{MSY}=0.69) and relative fishing mortality (F/F_{MSY}=1.03) were such that the current stock status is overfished and undergoing overfishing. Current management advice is a TAC of 2 000 tonnes, in which several WECAFC member countries have a specific TAC.

Atlantic sailfish. A full stock assessment was conducted for western Atlantic sailfish in 2016, using the available data through 2014, and applying a Surplus Production, a Stock Reduction Analysis (catch only) and Stock Synthesis model (ICCAT 2017a). Models could not provide stock status due to the large uncertainty in benchmark estimates, and generally poor model convergence. Therefore, based on point estimates of the Surplus Production and Stock Synthesis models, ICCAT indicated that the stock is neither overfished nor experiencing overfishing. Current management advice is a western Atlantic sailfish catch limit of 67% of the MSY that was estimated between 1 438 tonnes and 1 636 tonnes.

Atlantic white marlin. A full stock assessment was conducted for the combined Atlantic white marlin/Roundscale spearfish in 2019 using the available data through 2017 and applying both surplus production and age-structured models (ICCAT 2019a). The results of the 2019 assessment indicated that the estimated relative biomass (B/B_{MSY}=0.58) and relative fishing mortality (F/F_{MSY}=0.65) were such that the current stock status is overfished but not undergoing overfishing. Current management advice is a TAC of 400 tonnes, in which several WECAFC member countries have a specific TAC.

Spearfishes. No stock assessments have been conducted as individual species. Only in the Roundscale spearfish when is combined with Atlantic white marlin. However, efforts continue to estimate the proportion of the two species in the catches that would allow a potential separation over the time series. In the case of the Longbill spearfish, no assessments have been conducted.

Common dolphinfish. The CRFM 2010 stock assessment analyzed data from the eastern Caribbean Islands, Venezuela, northeastern Brazil, and the USA (CRFM 2010). The standardized CPUE indices for the eastern Caribbean corroborated that the stock was not declining. In Brazil, the stock assessment in the northeast indicated that the stock was fully exploited (Lessa *et al.* 2009), although there is uncertainty in the data. The one stock assessment reported for this stock in Southeast USA waters, produced highly uncertain results due to absence of reliable data in many sectors for many years (Prager 2000).

Wahoo. Using data-limited assessment methods that use biological information and fisheries data to estimate proxies of stock status of Wahoo in the northwest Atlantic indicated that both models used (length-based spawning potential ratio-LBSPR and length-based Integrated Mixed Effects-LIME) estimated low Spawning Potential Ratio (SPR) values for the Northwest stock, suggesting that this stock is overfished (Pons *et al.* 2019). A recommendation offered indicated that length-based models should be applied to the length data coming from the fleet that targets the broadest range of sizes, including juveniles and adults when the data are available.

The elasmobranch resources (Sharks and rays)

The elasmobranch resources considered in this section are considered pelagic and mostly open water species which include four requiem sharks (*Carcharinidae*), three hammerhead sharks (*Sphyrnidae*), one mackerel shark (Shortfin mako, *Isurus oxyrinchus*), one thresher shark (Bigeye thresher, *Alopias superciliosus*), one Whale shark (*Rhincodon typus*), one stingray (Pelagic stingray, *Pteroplatytrygon violacea*) and one devilray (Giant oceanic manta ray, *Mobula birostris*).

The main requiem shark species from a fisheries point of view in the WECAFC region are Blue shark, (*Prionace glauca*), Silky Shark (*Carcharhinus falciformis*), Oceanic whitetip shark (*Carcharhinus longimanus*), Tiger shark (*Galeocerdo cuvier*). Most requiem sharks included in this section are oceanic (Blue shark, Silky shark, Oceanic whitetip shark) (**Figure 4.42**). The Tiger shark is mostly littoral and semipelagic but are known to move into open ocean waters (**Figure 4.43**).

The Blue shark (*Prionace glauca*) is distributed throughout the region, it is found from the surface to at least 1,160 m depth (Queiroz *et al.* 2012). It occasionally occurs inshore where the continental shelf is narrow, preferring temperatures of 12-20°C; it is found at greater depths in tropical waters. A behavioral characteristic of this species is its tendency to segregate temporally and spatially by size and/or sex, during feeding, mating-reproduction, gestation, and birth processes (Nakano and Stevens 2008, Coelho *et al.* 2018). In the Caribbean Sea, Blue sharks displayed temporal and spatial sexual segregation dominated by immature and mature males, but with a seasonal occurrence of mature females with advanced pregnancy in the area (Tavares *et al.* 2012). Genetically Blue shark in the WECAFC region likely belongs to an Atlantic-wide population (Veríssimo *et al.* 2017), although it is managed under the North Atlantic stock unit by ICCAT.

The Silky shark (*Carcharhinus falciformis*) has an oceanic and coastal distribution, found near the edge of continental and insular shelves, as well as far from land in the open sea, to depths of 500 m. It is widely distributed throughout the region but is commonly caught as bycatch in pelagic longline fisheries across the WECAFC region. There is no indication of a regional stock structure, although most catches consist of adult specimens in the northern and southern range of the WECAFC region, while off the NBSLME and southeastern Caribbean Sea the catch consist of juvenile and small specimens (Rigby *et al.* 2017, Arocha *et al.* 2015).

The Oceanic whitetip shark (*Carcharhinus longimanus*) is a wide-ranging oceanic species of tropical and temperate seas worldwide, with a preference for surface waters usually found far offshore in the open sea, but it sometimes occurs in water as shallow as 37 m inshore, particularly off oceanic islands or in continental areas where the shelf is very narrow (Rigby *et al.* 2019b). The species is caught globally as target and bycatch in pelagic large- and small-scale longline, purse seine, and gillnet fisheries and is often retained for the meat and fins, unless regulations prohibit retention. The species has a high catchability due to its preference for surface waters and its inquisitive nature. Steep population declines have occurred in all oceans. The Oceanic Whitetip Shark was once one of the most abundant pelagic shark species in tropical seas worldwide but is now rare in some regions including the WECAFC (Young *et al.* 2017).

The Tiger shark (*Galeocerdo cuvier*) is a wide-ranging, oceanic species, inhabits shelf, reef, and slope habitats, is sometimes associated with coral reefs, and makes long-distance excursions into the high seas (Assael 2016). This species has relatively fast growth rates and large litters (on average 26-33 pups) but the likely triennial reproductive cycle reduces its ability to recover from fishing pressure (Ferreira and Simpfendorfer 2019). The species is caught by commercial, and artisanal fisheries as bycatch in the WECAFC region, off the central coast of Venezuela is caught as bycatch of the billfish artisanal drift-gillnet fisheries, and off the NBSLME with bottom gillnet by the Venezuelan multi-gear fleet in which most of the catch consists of juvenile Tiger sharks.

The members of the family Sphyrnidae are generally considered coastal, occasionally occurring in brackish water with a global distribution mostly in warm waters. Although, the species reviewed in this section are known to occur in open ocean waters of the high seas (ICCAT 2013). Three species are commonly caught within the WECAFC region.

The Scalloped hammerhead (*Sphyrna lewini*) found globally, is generally coastal and semi-oceanic pelagic shark, found over continental and insular shelves and nearby deep water, ranging from the intertidal and surface usually to 275 m depth (Rigby *et al.* 2019f). However, there are records where it is found in open ocean waters around sea mounts and rises (Bessudo *et al.* 2011). Additionally, they have been observed close to shore and even entering estuarine habitats. The species is caught globally as target and bycatch in pelagic commercial and small-scale longline, purse seine, and gillnet fisheries, and is retained for the meat and fins. Scalloped hammerhead shark is found across the WECAFC region except for the Caribbean Sea basin and the Lesser Antilles (**Figure 4.44**). The species is common in inshore small-scale fisheries, as well as offshore operations. It is caught with pelagic longlines, fixed bottom longlines, and fixed bottom nets. Adults spend most of the time offshore in midwater and females migrate to the coastal areas to pup (Klimley 1987). Genetic data reveal that the global population structure varies between males and females. Only males move across ocean basins, while females only move regionally and not between discontinuous continental coastlines (Duncan *et al.* 2006).

The Smooth hammerhead (*Sphyrna zygaena*) is generally a coastal and semi-oceanic pelagic shark that occurs on the continental shelf to at least 200 m depth, and possibly deeper. It is the most oceanic of the hammerhead species and capable of long distances over open ocean waters in the high seas (Santos and Coelho 2018), commonly leaving coastal habitats at 2-3 years of age (Clarke *et al.* 2015). In the WECAFC region, the Smooth hammerhead is caught as bycatch in pelagic industrial and small-scale longline, and gillnet fisheries, and is often retained for the fins, and sometimes the meat (Tavares and Arocha 2008). In the region this species is found from Canada south to the Virgin Islands and from off the NBSLME south to Argentina and is absent from the Gulf of Mexico and the Caribbean Sea (**Figure 4.45**). They occasionally venture into freshwater and estuaries. Juveniles form large aggregations, while adults occur individually or in small groups (Rigby *et al.* 2019e). There are no data available on the global population size of the Smooth hammerhead. Genetic studies reveal structure between the Atlantic and Indo-Pacific, however contrasting results may indicate female philopatry and male mediated gene flow (Testerman 2014). Despite its widespread occurrence, biological data on this species is limited. It attains a maximum size of about 400 cm total length (TL) (Ebert *et al.* 2013, Weigmann 2016).

The Great hammerhead (*Sphyrna mokarran*) is a large (600 cm total length), semi-oceanic pelagic shark generally solitary and coastal, but displaying movements to open ocean waters in the high seas (Hammerschalg *et al*. 2011). Generally, occurs close inshore and well offshore at depths ranging from near surface to 300 m and are commonly seen in shallow coastal areas such as over continental shelves and lagoons to depths of 80 m (Rigby *et al.* 2019c). It is caught globally as target and bycatch in pelagic large- and small-scale longline, and gillnet fisheries, and is often retained for the fins. It has a long lifespan of up to 44 years and only breeds once every two years, which combined with high bycatch mortality, makes it susceptible to depletion where it is taken in unmanaged fisheries. There are no data available on the global population size of the Great hammerhead. Genetic studies support two subpopulations, the Atlantic and Indo-Pacific, no genetic structure was found within the Atlantic (Testerman 2014). In the WECAFC region it ranges from North Carolina (USA) south to Uruguay, including the Gulf of Mexico and Caribbean Sea (**Figure 4.42**).

The Shortfin mako (*Isurus oxyrinchus*) is a large (to 445 cm total length) neritic, epipelagic, and mesopelagic species, widespread in temperate and tropical oceans and widely distributed across the WECAFC region (**Figure 4.42**), it occurs from the surface to depths of 888 m (Rigby *et al*. 2019d). Like the Blue shark´s behavioral characteristic to segregate spatially, Shortfin mako seems to display some latitudinal distribution in the Atlantic, with the larger specimens tending to occur along the equatorial and tropical regions and the smaller sizes occurring mainly towards higher latitudes, both in the North and Southern hemispheres (Coelho *et al.* 2018). Is occasionally found to close inshore waters where the continental shelf is narrow. It is caught globally as target and bycatch in coastal and pelagic commercial and small-scale longline, and gillnet fisheries, and is generally retained for the high-value meat as well as its fins. The species reaches a maximum size of about 445 cm total length. The species has low biological productivity with a triennial reproductive cycle and late age at maturity. There are no data available on the absolute global population size of the Shortfin Mako. Genetic results indicate one global population, however there is some genetic structuring between ocean basins like in the Atlantic where there is some indication that the North Atlantic population appeared to be isolated from the South Atlantic (Schrey and Heist 2003).

The Bigeye thresher (*Alopias superciliosus*) is a large (to 484 cm total length) pelagic shark, occurring worldwide in tropical and temperate seas from the surface down to depths of 955 m; it is found in coastal waters over continental shelves, sometimes close inshore in shallow waters, and on the high seas in the epipelagic and mesopelagic zones far from land; it is also caught near the bottom in deep water on continental slopes (Rigby *et al.* 2019a). It is present near the surface at night and makes deep dives during the day (Clarke *et al.* 2015). In the WECAFC region is found in the southeatern USA, some parts of the Gulf of Mexico and around Cuba, and in the southern Caribbean Sea and off the NBSLME (Arocha et al. 2017) (**Figure 4.42**). It has a low fecundity (average two pups per litter) and the lowest intrinsic rebound potential of the thresher shark species. It is caught globally as target and bycatch in pelagic commercial and small-scale longline, and gillnet fisheries. Genetic results indicate one global population, however there is some genetic structuring between the Northwest Atlantic and the Pacific Oceans (Morales *et al.* 2018).

The Whale shark (*Rhincodon typus*) is a cosmopolitan tropical and warm temperate species. Genetic results indicate that two major subpopulations exist, in the Atlantic Ocean and Indo-Pacific, respectively. Pronounced size- and sex-based segregation is present in most of the species' known coastal feeding areas, with coastal sites typically dominated by juvenile male sharks (Pierce and Norman 2016). Whale sharks are found in both coastal and oceanic habitats (**Figure 4.46**) (Rowat and Brooks 2012). They spend most of the time in the epipelagic zone, but dive to at least 1,928 m in depth

(Tyminsky *et al.* 2015). Most Whale shark sightings occur at a small number of known coastal feeding areas for the species (Sánchez *et al.* 2020), where the sharks aggregate on the surface to exploit seasonal productivity such as fish spawning events or zooplankton blooms (Rowat and Brooks 2012).

The Pelagic stingray (*Pteroplatytrygon violacea*) is a medium-sized ray (to 80 cm disc width) that is circumglobal throughout the tropical and temperate oceans. It occurs in the epipelagic zone mostly to depths of 100 m, although it has been recorded to 381 m. The Pelagic stingray is perhaps the only species of stingray that occurs in the pelagic zone (Neer 2008). In the WECAFC region is found off Bermuda, the southern Caribbean Sea, around the Lesser Antilles and off the NBSLME (**Figure 4.47**). The species is taken as bycatch in pelagic longline fisheries around the world. It is mostly discarded but is retained and utilized in some areas. It is usually found from the surface to 100 m depth over deep water but has been reported to 381 m (Kyne *et al.* 2019). It reaches a maximum size of 90 cm disc width (DW). Parturition (birth) was seen to occur in July off the Island of La Tortuga (Venezuela) detected from an important volume of catches in the area (Arocha *et al.* 2013).

The Giant oceanic manta Ray (*Mobula birostris*) is a large (to 700 cm disc width) ray with a circumglobal distribution in tropical and temperate waters throughout major oceans. It is a neritic and oceanic pelagic ray, common in areas with regular upwelling along coastlines, oceanic islands, and offshore pinnacles and seamounts. The species can exhibit diel patterns in habitat use, moving inshore during the day to clean and socialize in shallow waters, and then moving offshore at night to feed to depths of 1 000 meters, it can also spend long periods of time offshore without visiting shallow coastal waters (Marshall *et al.* 2020). In the WECAFC region it is often found in areas relatively close to land formations, i.e. continental slope, rises/seamounts, islands, reefs (**Figure 4.46**). The Giant oceanic manta ray may be the largest living ray species attaining a maximum size of 700 cm disc width (DW) with anecdotal reports up to 910 cm DW (Compagno 1999). The global population size is not known, but local and regional abundance has been estimated and is mostly small, numbering less than 500 individuals, with exceptions. The species has an extremely slow life history, producing only one pup on average every 4-5 years. It is targeted or taken as bycatch in artisanal small-scale fisheries, and taken as bycatch in large-scale tuna fisheries.

The Fishery

The fishery for elasmobranch species in this section can be directed and taken as the commercial part of the bycatch from the tuna and Swordfish longline fishery. In countries where directed fisheries exist, the pelagic elasmobranch catches are mostly taken by SSF fisheries of several countries in WECAFC region. In addition, a sport fishery for large coastal sharks exists in the USA, although is mostly limited to one shark per vessel/trip (NMFS 2006).

Like the transboundary elasmobranch fishery section, most of the elasmobranch catches in the region are reported in groupings: Elasmobranchii (Sharks, rays, skates, etc. nei), Carcharhinidae (Requiem shark nei), Sphyrnidae (Hammerhead sharks, etc. nei), Rajiformes (Rays, stingrays, mantas nei); generic like *Carcharhinus* spp., *Sphyrna* spp., *Alopias* spp., *Isurus* spp.; and straddling-specific like Blue shark, Shortfin mako, Silky shark, Tiger shark, Great hammerhead, and Scalloped hammerhead. In this section, the fishery descriptions will focus initially on the species for which specific catch data and fishery information exits, like the Blue shark, and Shortfin mako.

In Blue shark, most of the accumulated landed catch (93.17%) during 2015-2019 is from the commercial bycatch of the tuna longline fishery of three WECAFC member countries, and from Spain who is responsible for over 50% of the Blue shark catch reported for the WECAFC region (**Table 4.11**). Other than Panama, Suriname, and Venezuela that account for 39.72% of the WECAFC Blue shark reported catch in recent years, the rest of member countries (St. Vincent and the Grenadines, Colombia and Trinidad and Tobago) that report it, account for 1.78% of the accumulated recent catch. The rest (5.05%) is reported by non-WECAFC member countries. The spatial distribution of Blue shark accumulated catches by gear for the period of 1990-2019 is mostly from the pelagic longline gear that targets tuna in the case of the Asian fleets and WECAFC countries and Swordfish by European countries (Portugal and Spain) that fish in the high seas of the WECAFC region and its adjacent areas (**Figure 4.48**). Most of the reported catch by longline is from the high seas and to some extent in the southern Caribbean and along the NBSLME through to the southern limits of the region. A small fraction of the catches off central Venezuela come from the artisanal drift gillnet fishery targeting billfishes; there are also important fractions of the catch in the high seas that are from unclassified gear which most likely come from longline fishery targeting Swordfish but that may not have been reported in the early years of the period. Limited catches are observed in the upper WECAFC region (Yucatan Channel and off Florida USA). The areas of important abundance of Blue shark within the EEZs of the region is off central Venezuela and off Suriname, the rest are in the areas of the high seas (**Figure 4.49**).

Shortfin mako shark catch in the region is mostly caught by four countries which account for 92.38% of the accumulated landed catch for the period of 2015-2019 (**Table 4.11**). Spain is responsible for 65.40% of the total accumulated catch, followed by Venezuela with 12.66%, the USA with 9.80% and Mexico with 4.52%. Like in Blue shark, most of the reported catches of Shortfin mako are caught with longline gear mostly associated to tuna and/or Swordfish fisheries (**Figure 4.50**). However, an important fraction in the southcentral Caribbean is taken by the artisanal drift gillnet fishery targeting billfishes off Venezuela; and like in Blue shark, in the high seas some localized fractions of catches from unclassified gear likely come from longline fishery targeting Swordfish but that may not have been reported and/or reclassified. In the Caribbean Sea there are two areas of important abundance based on accumulated catches, one is the southeast, off Venezuela, and another is northwest, off Yucatan and Belize (**Figure 4.51**). Other areas of important abundance in WECAFC's EEZs include the southwestern GOM and off Guyana and Suriname. The rest is mostly found in the high seas.

This part on the fishery of straddling elasmobranch species will focus first on species specific, followed by generic and higher groups. The requiem sharks (Silky shark, Oceanic whitetip), Bigeye thresher sharks and Pelagic stingrays are mostly taken by the pelagic longline gear of the tuna and Swordfish fisheries in the region, by both, industrial and SSF fleets; however, there are several SSF fisheries in the region that catch these species with drift gillnets. While Tiger shark and the hammerhead sharks are mostly taken by bottom longline gear and drift and set gillnets, and occasionally as bycatch of the tuna pelagic longline gear. The large pelagic elasmobranchs like, the Whale shark and Giant oceanic manta ray are mostly entangled in nets or accidentally hooked. In most cases, when caught in tuna commercial fisheries they´ll be released; unlike when they are entangled in gears from SSF, where in some coastal communities the animal will be landed and processed for its meat.

Recent catches of specific sharks like, Tiger shark, Silky shark, Hammerhead sharks (Great, and Scalloped), and thresher shark are reported by very few countries in recent years (**Table 4.11**). The Tiger shark is one of the most reported catch (93.67%) coming from three WECAFC countries (Mexico, USA and Venezuela). Silky shark is mostly reported (99.80%) from Costa Rica; while the Bigeye thresher shark is reported by Mexico in the last year of the series, and by Venezuela. Most of the reported catches of the two hammerhead species (85.18% for Scalloped hammerhead, and 81.55% for Great hammerhead) are from Venezuela (**Table 4.12**), and the rest of the reported catches are shared by the USA and Colombia. At the generic level, only Colombia reports *Carcharhinus* spp. and *Sphyrna* spp. for the last year of the recent catch (**Tables 4.11, 4.12**); Trinidad and Tobago is the only reporting country for *Isurus* spp. and *Alopias* spp. for the last year of the time series. At the family level (Carcharrinidae and Sphyrnidae), known as Requiem sharks nei and Hammerhead sharks nei, Mexico accounts for most of the recent catch (over 80%) in both groups (**Tables 4.11, 4.12**). The rest of the sharks and rays reported catches for the region are in the form of two general groups, Rajiformes (Rays, stingrays mantas nei) and a broader group, Elasmobranchii that includes all sharks, skates, and rays. In Rajiformes, most of the reported catches (96.85%) are attributed to five countries (**Table 4.12**), which represent an important volume of catches in the region of fisheries targeting batoids fishes, although as indicated in the section on transboundary species, those catches most likely come from coastal fisheries. Finally, the group Elasmobrachii that aggregates all sharks, rays, skates, and other species not else included (nei) is the one in which most of the region´s reported catches on shark and rays are declared (**Table 4.12**). Most of the reported catches of Elasmobrachii (96.10%) are caught by seven countries, five of which have important large pelagic (e.g. tunas, Swordfish, Common dolphinfish) fisheries in which sharks are part of the bycatch or have directed shark fisheries but do not discriminate by species. In Guyana, sharks are caught by large near shore artisanal fleet that is multi-specific using gillnets, trawl nets and pelagic longline. All shark specimens are landed dressed (headless and gutted). Over the years, it has been difficult to record the sharks catch by species; however, the species identified when landed whole are hammerhead sharks, tiger sharks, and other small coastal sharks (ICCAT 2020). In Trinidad, the Scalloped hammerhead is likely only straddling shark species caught by their SSF in addition to other small coastal sharks (Shing 2006). In Cuba and Nicaragua, the reported catches will most likely be from small scale/artisanal coastal fisheries, with occasional catches from tuna longline fisheries (FAO 2018).

Fishery for Whale shark in the region is very limited and is likely to be due to incidental encounter with SSF, sometimes coastal fisheries where the shelf is very narrow, like in some areas along the Venezuelan coasts where annual encounters were frequent most of which consisted of juveniles sharks (< 7 m). Most encounters were due to entanglement with drift gillnets or were harpooned, resulting in the capture of Whale sharks, (Sanchez *et al.* 2020). However, a local shark NGO started interacting with fishing communities offering seminars that helped in transforming some of those communities to monitor and report Whale shark sighting and reduce Whale shark deaths in the area.

State of the stocks

The elasmobranch resources in this section subject to direct fishing pressure and for which formal stock assessments have been conducted include the Blue shark and the Shortfin mako shark. The stock assessment results presented are those for the North Atlantic only as they are relevant to the WECAFC region. In the case of the rest of the species of elasmobranchs for which no formal stock assessments have been conducted, their stock status is based on an ERA, also known as PSA, a common tool used to provide information for data-limited shark populations (Cortés *et al.* 2010). Only two species have not been assessed by RFMOs, the Whale shark and Giant Manta oceanic manta ray, but they are threatened by open water fisheries. In this case, the assessment information provided is from the IUCN red list (https://www.iucnredlist.org/). However, the IUCN red list also provides assessments for the elasmobranchs species reviewed in this section, the assessments are included in **Table 4.13** for comparative purposes.

Blue shark. A full stock assessment was conducted for North Atlantic Blue shark in 2015, using the available data through 2014, applying a Bayesian Surplus Production and a Stock Synthesis models (ICCAT 2016a). All scenarios considered with both models indicated that the stock was not overfished, and that overfishing was not occurring. However, ICCAT recognizes that there remains a high level of uncertainty in data inputs and model structural assumptions. Thus, the possibility of the stock being overfished, and that overfishing was occurring could not be ruled out.

Shortfin mako. The 2017 assessment of the status of North and South Atlantic stocks of Shortfin mako shark was conducted with updated time series of relative abundance and annual catches through 2015 (ICCAT 2020b). For the North Atlantic stock, several stock assessment model runs were selected to provide stock status and management advice. Although all results indicated that stock abundance in 2015 was below B_{MSY}, results of the production models were more pessimistic (B/B_{MSY}: 0.57 to 0.85) and those of the age-structured model (Stock Synthesis) were less pessimistic (SSF/SSF_{MSY}=0.95). F was above F_{MSY}. The combined 90% probability from all the models is the North stock is overfished and experiencing overfishing, it was noted that it could take about 25 years to rebuild mako shark stocks even if fishing mortality rates were cut to zero (ICCAT 2020b).

The 2012 ERA conducted by ICCAT was a quantitative assessment consisting of a risk analysis to evaluate the biological productivity of the shark stocks and a susceptibility analysis to assess their propensity to capture and mortality in pelagic longline fisheries. One stock with the lowest productivity was the Bigeye thresher (*Alopias superciliosus*). The highest susceptibility values corresponded to Shortfin mako (*Isurus oxyrinchus*), North Atlantic Blue shark (*Prionace glauca*), and Bigeye thresher. Based on the results, the Bigeye thresher and Shortfin mako sharks were the most vulnerable stocks to overfishing. In contrast, North Atlantic Pelagic stingray (*Pteroplatytrygon violacea*) had the lowest vulnerabilities. While for the rest of the species Silky Shark, Oceanic whitetip shark, Tiger shark, and Great hammerhead in the North Atlantic had moderate vulnerability to overfishing (ICCAT 2020b).

Whale shark. For the WECAFC region, the Atlantic subpopulation trend is based on Whale shark sightings in the area off Belize, which dropped from a mean of 4-6 sharks per day between 1998 and 2001 to less than two per day in 2003, with reports from diving guides indicating that numbers have remained low until 2016, and from feeding aggregations in the GOM (Pierce and Norman 2016). IUCN Species Survival Commission (SSC) Shark Specialist Group has classified this species as endangered (EN) and with a decreasing population trend based on the declining numbers of mature individuals.

Giant oceanic manta ray. IUCN SSC Shark Specialist Group suspected that the Giant oceanic manta ray at a global level has undergone a population reduction of 50-79% over the past three generation lengths (87 years); further population reduction is suspected over the next three generation lengths (2018-2105) due to ongoing levels of exploitation, and a reduction in area of occupancy due to suspected local and regional extinctions; it is assessed as endangered and decreasing population (Marshall *et al.* 2020).

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TABLES: STRADDLING STOCKS

Table 4.1. Flying fish catch (t) by country during the period 2015-2019.

Group: Pelagic Species. Species: Flying fish - Exocoetidae. Species code: FFV								
Country	**2015**	**2016**	**2017**	**2018**	**2019**	**Rank**	**%**	**%cum**
Barbados	378	469	777	775	775	1	93.79	
Saint Kitts and Nevis	33	17	9	22	8	2	2.63	96.42
Grenada	16	16	16	16	16	3	2.36	98.78
Martinique	7	7	7	7	7	4	1.03	99.82
United States of America	0	0	4	0	0	5	0.12	99.94
Saint Lucia	0	1	1	0	0.02	6	0.06	100.00

Table 4.2. Stock status of key regional species, major tunas, small tunas and tuna-like species in the WECAFC region.

	ICCAT (or CRFM#)				FIRMS		FAO categorization	Reference year
Common name/ Species name	**Stock unit**	**Assessment year**	**Overfished**	**Overfishing**	**Abundance Level**	**Exploitation rate**	WECAFC/SAG/IX/2018/3	
Key regional species								
Flying Fish/ *Hirundichthys affinis*	Subregional stock	2007#	NO	NO	Pre-exploitation biomass	No or Low fishing mortality	-	-
Major tunas								
Yellowfin tuna/ *Thunnus albacares*	Atlantic	2019	NO	NO	Intermediate abundance	Moderate fishing mortality	O	2015
Skipjack tuna/ *Katsuwonus pelamis*	West Atlantic	2014	NO	NO	Not Applicable	Not Applicable	F	2013
Northern Bluefin tuna/ *Thunnus thynnus*	West Atlantic	2020	-	NO	Not Assessed	Moderate fishing mortality	?	2015
Albacore/ *Thunnus alalunga*	North Atlantic	2020	NO	NO	Intermediate abundance	No or low fishing mortality	F	2014
Bigeye tuna/ *Thunnus obesus*	Atlantic	2021	YES	NO	Low abundance	High fishing mortality	O	2014
Small tunas								
Blackfin tuna/ *Thunnus atlanticus*	West Atlantic	2016	-	Vulnerability: High*	-	-	-	-
Little tunny/ *Euthynnus alletteratus*	NW Atlantic	2014-2016	NO**	Vulnerability: Moderate***	-	-	-	-
Frigate tuna/ *Auxis thazard*	NW Atlantic	Not assessed	-	Vulnerability: Low**	-	-	-	-
Bullet tuna/ *Auxis rochei*	NW Atlantic	Not assessed	-	Vulnerability: Low**	-	-	-	-
Atlantic bonito/ *Sarda sarda*	NW Atlantic	2016	-	Vulnerability: Low**	-	-	F-O	2016
Tuna-like species								
Swordfish/ *Xiphias gladius*	North Atlantic	2017	NO	NO	Intermediate abundance	Moderate fishing mortality	F	2015
Atlantic sailfish/ *Istiophorus albicans*	West Atlantic	2016	NOT LIKELY	NOT LIKELY	Intermediate abundance	No or low fishing mortality	F	2014
Blue Marlin/ *Makaira nigricans*	Atlantic	2018	YES	YES	Low abundance	High fishing mortality	O	2016
Atlantic white marlin/ *Tetrapturus albidus*	Atlantic	2019	YES	NO	Intermediate abundance	High fishing mortality	-	-
Longbill spearfish/ *Tetrapturus pfluegeri*	West Atlantic	Not assessed	-	-	-	-	-	-
Roundscale spearfish/ *Tetrapturus georgii*	Not defined	Not assessed	-	-	-	-	-	-
Common dolphinfish/ *Coryphaena hippurus*	NW Atlantic	Not assessed	-	-	-	-	-	-
Wahoo/ *Acanthocybium solandri*	NW Atlantic	2014-2016	YES***	-	-	-	-	-

*ICCAT. 2017b. **ICCAT. 2016b. ***Pons et al. 2019. F: fully exploited; O: overexploited; U: non-fully exploited.

Table 4.3. Yellowfin tuna catch (t) by country during the period 2015-2019.

Group: Pelagic Species. Species: *Thunnus albacares*- Yellowfin tuna. Species code: YFT								
Country	**2015**	**2016**	**2017**	**2018**	**2019**	**Rank**	**%**	**%cum**
Brazil	13080	14216	11996	15741	11875	1	45.11	
Venezuela, Boliv. Rep. of	3127	4204	5059	2743	2029	2	11.57	56.68
Suriname	2632	2384	3050	3370	3538	3	10.10	66.77
Panama	1580	1683	1620	2104	2382	4	6.32	73.09
Mexico	1176	1574	1305	1763	1376	5	4.85	77.94
Grenada	1167	1607	1257	1391	1300	6	4.53	82.47
Trinidad and Tobago	1179	1057	890	1214	981.59	7	3.59	86.06
United States of America	669	742	718	448	323	8	1.96	88.02
France	632	403	346	488	864	9	1.84	89.86
Belize	0	2163	359	8.96	0	10	1.71	91.57
Japan	612	454	410	144	685	11	1.55	93.12
Colombia	0	1911	24	25	0	12	1.32	94.44
St. Vincent & The Grenadines	153	434	772	373	105	13	1.24	95.68
Barbados	262	324	270	248	121	14	0.83	96.50
Dominican Republic	70	350	376	111	195	15	0.74	97.25
Saint Lucia	175	191	232	199	171.85	16	0.65	97.90
Dominica	194	179	209	116	120	17	0.55	98.45
El Salvador	31	381	91	21	18	18	0.37	98.82
Taiwan Province of China	68	67	60	180	110	19	0.33	99.14
Martinique	86	89	90	90	91.1	20	0.30	99.45
China	0	13	22	35	130	21	0.13	99.58
Guatemala	0	18	71	40	13	22	0.10	99.68
Bermuda	10	9	25	32	50	23	0.08	99.76
Guyana	14	0	1	52	48	24	0.08	99.84
Spain	31	10	21	9	3.04	25	0.05	99.89
Vanuatu	64	0	0	0	0	26	0.04	99.93
Saint Kitts and Nevis	1	5	30	12	1	27	0.03	99.96
Korea, Republic of	11.01	11.64	2.93	5.93	0	28	0.02	99.99
Puerto Rico	5	2	1	2	1.78	29	0.01	99.99
United States Virgin Islands	2	5	2	0	0	30	0.01	100.00

Table 4.4. Bigeye tuna and Bluefin tuna catch (t) by country during the period 2015-2019.

Country	2015	2016	2017	2018	2019	Rank	%	%cum
Group: Pelagic Species. Species: *Thunnus obesus* - Bigeye tuna. Species code: BET								
Brazil	6792	6537	5277	4168	5417	1	54.00	
Japan	1337	1038	1106	1235	1737	2	12.36	66.36
China	5	443	281	659	3104	3	8.60	74.97
St. Vincent & The Grenadines	496	622	889	428	504	4	5.63	80.59
Suriname	495	2	229	303	759	5	3.42	84.02
Panama	301	355	109	419	497	6	3.22	87.24
Belize	28	640	223	353	225	7	2.81	90.05
Spain	218	209	499	300	8.93	8	2.37	92.42
Venezuela, Boliv Rep of	132	156	318	165	28	9	1.53	93.95
Taiwan Province of China	63	80	108	238	229	10	1.38	95.32
Korea, Republic of	484.87	24.35	15.07	60.39	0	11	1.12	96.44
United States of America	149	87	123	79	66	12	0.97	97.41
El Salvador	166	57	36	45	46	13	0.67	98.08
Guyana	6	0	180	3	2	14	0.37	98.45
France	0	49	48	81	0	15	0.34	98.79
Trinidad and Tobago	77	37	25	17	13.17	16	0.32	99.11
Guatemala	0	65	42	33	0	17	0.27	99.38
Barbados	30	19	16	29	14	18	0.21	99.59
Grenada	16	16	16	16	16	19	0.15	99.74
Saint Lucia	6	10	25	13	12.89	20	0.13	99.87
Colombia	0	53	0	1	0	21	0.10	99.97
Mexico	2	2	2	2	2	22	0.02	99.99
Saint Kitts and Nevis	0	4	1	0	0	23	0.01	100.00
Group: Pelagic Species. Species: Thunnus thynnus - Bluefin tuna. Species code: BFT								
ICCAT USA	877	1002	986	1014	1185	1	95.10	93.79
ICCAT MEX	53	55	34	80	39	2	4.90	100.00

Table 4.5. Skipjack and Albacore tuna catch (t) by country during the period 2015-2019.

Country	2015	2016	2017	2018	2019	Rank	%	%cum
Group: Pelagic Species. Species: *Katsowonus pelamis* - Skipjack tuna. Species code: SKJ								
Brazil	465	459	4693	4461	2195	1	48.85	
Venezuela, Boliv. Rep. of	2019	1914	2222	1267	927	2	33.23	82.08
Suriname	841	155	60	6	0	3	4.23	86.31
Colombia	0	599	5	1	0	4	2.41	88.72
Saint Lucia	87	138	142	122	77.66	5	2.26	90.97
France	0	25	221	282	4	6	2.12	93.09
Cuba	120	89	99	87	58.5	7	1.81	94.89
Panama	89	185	0	0	8	8	1.12	96.02
St. Vincent & The Grenadines	47	0	86	36	35	9	0.81	96.83
Dominican Republic	54	60	64	4	20	10	0.80	97.63
Guatemala	0	11	86	54	44	11	0.78	98.41
Spain	0	0	71	26	0	12	0.39	98.79
Dominica	16	27	28	11	10	13	0.37	99.16
Grenada	17	17	17	17	17	14	0.34	99.50
Mexico	7	10	8	11	8	15	0.18	99.67
Taiwan Province of China	2	4	13	12	10	16	0.16	99.84
Puerto Rico	5	4	4	7	6.83	17	0.11	99.94
Barbados	1	1	1	1	1	18	0.02	99.96
Saint Kitts and Nevis	0	1	1	1	0	19	0.01	99.98
United States of America	0	1	1	1	0	20	0.01	99.99
United States Virgin Islands	1	1	1	0	0	21	0.01	100.00
Group: Pelagic Species. Species: *Thunnus alalunga* - Albacore tuna. Species code: ALB								
Taiwan Province of China	2375	2496	1823	2265	2639	1	55.44	
Suriname	211	275	598	637	587	2	11.03	66.48
St. Vincent & The Grenadines	405	399	398	271	211	3	8.05	74.53
Dominican Republic	102	102	110	592	430	4	6.39	80.91
Venezuela, Boliv. Rep. of	351	287	301	165	221	5	6.33	87.25
Spain	0	0	0	759	0.06	6	3.63	90.88
Panama	0	200	0	196	198	7	2.84	93.71
United States of America	95	105	91	64	90	8	2.13	95.84
Trinidad and Tobago	95	71	48	33	19	9	1.27	97.11
Grenada	47	47	47	47	47	10	1.12	98.24
Barbados	16	38	32	15	7	11	0.52	98.75
Japan	50	55	0	0	0	12	0.50	99.26
China	0	26	17	33	0	13	0.36	99.62
Vanuatu	64	0	0	0	0	14	0.31	99.92
Mexico	1	2	1	2	1	15	0.03	99.96
Saint Lucia	0	2	1	1	0.66	16	0.02	99.98
Puerto Rico	1	1	0	0	0.16	17	0.01	99.99
Bermuda	0	1	0	0	1	18	0.01	100.00

Table 4.6. Atlantic bonito, Blackfin tuna, Little tunny, Frigate and Bullet tuna catch (t) by country during the period 2015-2019.

Country	2015	2016	2017	2018	2019	Rank	%	%cum
Group: Pelagic Species. Species: *Sarda sarda* - Atlantic bonito. Species code: BON								
Mexico	2915	3685	3236	4127	2705	1	98.60	
Trinidad and Tobago	0	16	16	16	15.68	2	0.38	98.98
Colombia	0	2	8	3	49.8	3	0.37	99.35
France	0	22	2	16	18	4	0.34	99.69
Grenada	5	5	5	5	5	5	0.15	99.84
Belize	0	0	0	10	0	6	0.06	99.90
Dominica	2	7	1	0	0	7	0.06	99.96
Saint Kitts and Nevis	0	0	0	3	1	8	0.02	99.98
United States of America	1	1	1	0	0	9	0.02	100.00
Group: Pelagic Species. Species: *Thunnus atlancticus* - Blackfin tuna. Species code: BLF								
Cuba	830	786	941	1004	669.8	1	68.11	
Saint Lucia	80	156	119	96	127.48	2	9.31	77.43
Grenada	107	100	100	100	100	3	8.16	85.59
Venezuela, Boliv Rep of	81	197	25	39	4	4	5.57	91.16
Dominica	24	34	32	17	25	5	2.13	93.28
Dominican Republic	41	31	33	0	10	6	1.85	95.14
Bermuda	20	17	17	16	10	7	1.29	96.42
United States of America	19	17	17	0	1	8	0.87	97.29
Puerto Rico	16	10	6	12	9.16	9	0.86	98.15
France	12	14	14	6	0	10	0.74	98.89
Trinidad and Tobago	0	5	5	10.01	5.01	11	0.40	99.29
Mexico	4	5	4	6	5	12	0.39	99.68
St. Vincent & The Grenadines	0	0	5	0	9	13	0.23	99.90
United States Virgin Islands	1	1	2	0	0	14	0.06	99.97
Saint Kitts and Nevis	0	0	0	1	1	15	0.03	100.00
Group: Pelagic Species. Species: *Euthynnus alletteratus* - Little tunny. Species code: LTA								
Colombia	0	53	1533	66	499.12	1	70.16	
United States of America	205	184	178	106	0	2	21.95	92.10
Saint Vincent/Grenadines	33	11	15	44	23	3	4.11	96.21
Cuba	10	9	7	7	5	4	1.24	97.45
United States Virgin Islands	8	10	8	4	4	5	1.11	98.56
Puerto Rico	7	2	3	6	10.68	6	0.94	99.50
Bermuda	4	3	2	1	2	7	0.39	99.89
Saint Lucia	2	0	0	0	1.43	8	0.11	100.00
Group: Pelagic Species. Species: *Auxis thazard, A. rochei* - Frigate and Bullet tuna. Code: FRI/BLT								
Venezuela, Boliv Rep of	64	70	115	67	26	1	73.29	
Colombia	0	6	53	0	58.65	2	25.21	98.50
France	0	0	0	7	0	3	1.50	100.00
Group: Pelagic Species. Species: *Auxis thazard* - Frigate tuna. Species code: FRI								
Belize	0	0	0	0	31	1	96.88	
Bermuda	0	0	1	0	0	2	3.13	100.00

Table 4.7. Estimated number of vessels (longliner-LL, Purse seiner-PS, Baitboat-BB) operating in WECAFC region.

WECAFC Member	LL	LOA (m)	PS	LOA (m)	BB	LOA	SSF	LOA (m)	Source
Antigua and Barbuda							332		CRFM. 2020. CRFM Statistics and Information Report - 2018. Belize City, Belize. 84pp.
Barbados	32	12.8							ICCAT Annual Reports Part II (2019) Vol.3
Belize	12	20-30	7	<30					ICCAT Annual Reports Part II (2019) Vol.3
Bermuda							106	15	ICCAT Annual Reports Part II (2019) Vol.3
Brazil	83	13-28					300	10-20	ICCAT Annual Reports Part II (2019) Vol.3
Cuba							2344		http://www.fao.org/fishery/facp/CUB/es
Curaçao			5				91	7-14	ICCAT Annual Reports Part II (2019) Vol.3
Dominica							199		FIRMS - Fishery Fact Sheet - Dominica Large pelagic handline and trolling fishery (fao.org)
Dominican Republic							260		Gentner et al. 2018 FAO Fish&Aqua Circ, 1162
European Union*							584	7	Reynal et al. 2015. Collect. Vol. Sci. Pap. ICCAT, 71(5): 2288-2296
Grenada							405	5-20	Gentner et al. 2018 FAO Fish&Aqua Circ, 1162
Guatemala			2	79					ICCAT Annual Reports Part II (2019) Vol.3
Guyana	7								ICCAT Annual Reports Part II (2019) Vol.3
Haiti							11036	5-7	USAI-MARNDR. 2019. (mFAD fishing)
Mexico	27								ICCAT Annual Reports Part II (2019) Vol.3
Panama	25	21-33	6	44-72					ICCAT Annual Reports Part II (2019) Vol.3
Saint Kitts and Nevis							87	<40	http://firms.fao.org/firms/fishery/982/en#TargetSpecies
Saint Lucia							928		FIRMS - Fishery Fact Sheet - Saint Lucia Large pelagic fishery (fao.org)
Saint Vincent & The Grenadines	4	47-49					900		CRFM. 2020. CRFM Statistics and Information Report - 2018. Belize City, Belize. 84pp.
Suriname**							1369		CRFM. 2020. CRFM Statistics and Information Report - 2018. Belize City, Belize. 84pp.
Trinidad and Tobago	24						136		http://firms.fao.org/firms/fishery/973/en ICCAT Annual Reports Part II (2019) Vol.3
United States of America	36	20-27							ICCAT Annual Reports Part II (2019) Vol.3
Venezuela	78	24-29	4	50-70	5	25	700	11-20	ICCAT Annual Reports Part I (2018) Vol.3
Japan (Atlantic)	87								ICCAT Annual Reports Part II (2019) Vol.3

*(Guadalupe & Martinique). **vessels from Panama/St. Vincent & The Grenadines/Belize land ICCAT species.

Table 4.8. Swordfish and Atlantic blue marlin catch (t) by country during the period 2015-2019.

Country	2015	2016	2017	2018	2019	Rank	%	%cum
Group: Pelagic Species. Species: *Xiphias gladius* - Swordfish. Species code: SWO								
Spain	1451	1608	1592	1525	113.73	1	55.76	
United States of America	594	825	635	709	858	2	32.10	87.86
St. Vincent & The Grenadines	103	38	55	30	27	3	2.24	90.10
Venezuela, Boliv. Rep. of	29	53	52	31	31	9	1.74	91.84
Mexico	32	37	36	41	36	4	1.61	93.45
Grenada	37	29	36	36	35	5	1.53	94.98
Costa Rica	22	22	20	20	20	6	0.92	95.90
Barbados	29	20	21	18	10	7	0.87	96.77
Japan	22	19	19	5	20	8	0.75	97.53
Trinidad and Tobago	17	13	36	3	5.91	10	0.66	98.19
Taiwan Province of China	7	8	12	25	15	11	0.59	98.78
China	1	17	12	23	0	12	0.47	99.25
Guyana	0	6	34	10	2	13	0.46	99.72
Portugal	0	0	7	3	0	14	0.09	99.80
Korea, Republic of	1	1	3	1	0	15	0.05	99.86
Bermuda	1	2	0	0	1	16	0.04	99.89
France	0	0	0	4	0	17	0.04	99.93
Cuba	1	1	1	0	0	18	0.03	99.95
Saint Kitts and Nevis	0	0	0	2	0	19	0.02	99.97
Puerto Rico	0	0	0	0	1.13	20	0.01	99.98
Dominica	0	0	1	0	0	21	0.01	99.99
Vanuatu	1	0	0	0	0	22	0.01	100.00
Group: Pelagic Species. Species: *Makaira nigricans* - Blue Marlin. Species code: BUM								
Dominican Republic	73	170	183	176	175	1	19.49	
France	117	106	138	126	215	2	17.61	37.11
Venezuela, Boliv. Rep. of	130	164	181	120	107	3	17.59	54.69
Saint Lucia	53	91	134	93	81.87	4	11.36	66.05
Mexico	73	67	81	75	79	5	9.41	75.46
Grenada	60	60	60	60	60	6	7.53	82.99
Dominica	62	49	70	54	55	7	7.28	90.27
Japan	22	28	28	7	37	8	3.06	93.33
Barbados	34	11	24	21	13	9	2.58	95.91
Trinidad and Tobago	35	19	0	0	0	10	1.35	97.27
China	0	4	6	5	16	11	0.78	98.04
Saint Kitts and Nevis	2	2	8	14	4	12	0.75	98.80
Taiwan Province of China	1	3	3	5	4	13	0.40	99.20
Bermuda	3	2	1	2	2	14	0.25	99.45
Spain	2	1	4	0	0	15	0.18	99.62
Cuba	2	2	2	0	0	16	0.15	99.77
St. Vincent & The Grenadines	0	0	2	2	1	17	0.13	99.90
Belize	2	1	1	0	0	18	0.10	100.00

Table 4.9. Atlantic Sailfish, Atlantic white marlin and Longbill spearfish catch (t) by country during the period 2015-2019.

Country	2015	2016	2017	2018	2019	Rank	%	%cum
Group: Pelagic Species. Species: *Istiophorus albicans* - Sailfish. Species code: SAI								
Suriname	195	481	442	480	447	1	25.87	
Venezuela, Boliv. Rep. of	213	295	517	508	463	2	25.26	51.13
Panama	0	415	0	461	378	3	15.87	67.00
Grenada	200	186	186	186	186	4	11.94	78.94
Dominican Republic	91	119	128	124	125	5	7.43	86.37
Trinidad and Tobago	51	53	63	51	51	6	3.40	89.77
Mexico	35	47	39	53	47	7	2.80	92.57
Barbados	54	56	42	21	15	8	2.38	94.95
St. Vincent & The Grenadines	1	85	10	10	5	9	1.40	96.35
Cuba	22	19	16	16	10	10	1.05	97.40
Spain	26	10	21	13	1.27	11.00	0.90	98.30
Japan	11	13	7	3	18	12	0.66	98.96
Colombia	0	6	10	6	0	13	0.28	99.24
Martinique	4	4	4	4	4	14	0.25	99.49
Taiwan Province of China	4	3	3	4	3	15	0.22	99.71
Dominica	3	3	3	2	2	16	0.16	99.87
Saint Lucia	1	1	4	2	0	17	0.10	99.97
France	0	0	0	1	0	18	0.01	99.99
Saint Kitts and Nevis	0	0	0	1	0	19	0.01	100.00
Group: Pelagic Species. Species: *Tetrapturus albidus)* - Atlantic white marlin. Species code: WHM								
Venezuela. Boliv Rep of	117	167	158	101	115	1	52.78	
Costa Rica	33	53	50	50	50	2	18.98	71.76
Mexico	26	20	29	22	26	3	9.89	81.65
Barbados	10	14	17	22	11	4	5.95	87.60
Grenada	26	15	9	11	10	5	5.71	93.31
Trinidad and Tobago	32	20	0	0	0	6	4.18	97.49
St. Vincent & The Grenadines	0	0	8	8	5	7	1.69	99.18
Spain	0	3	4	0	0	8	0.56	99.75
Saint Lucia	1	0	1	1	0.15	9	0.25	100.00
Group: Pelagic Species. Species: *Tetrapturus pfluegeri* - Longbill spearfish. Species code: SPF								
St. Vincent & The Grenadines	1	7	63	84	12	1	61.53	
Venezuela, Boliv. Rep. of	32	35	6	10	4	2	32.06	93.59
Mexico	0	4	0	4	1	3	3.32	96.90
Spain	1	0	1	1	3.4	4	2.36	99.26
Dominica	0	1	1	0	0	5	0.74	100.00

Table 4.10. Common dolphinfish and Wahoo catch (t) by country during the period 2015-2019.

Country	2015	2016	2017	2018	2019	Rank	%	%cum
Group: Pelagic Species. Species: *Coryphaena hippurus* - Common dolphinfish. Species code: DOL								
France	1566	1	0	958	1338	1	20.26	
Venezuela. Boliv. Rep. of	968	812	836	836	386	2	20.12	40.38
Saint Lucia	505	435	403	390	388	3	11.12	51.50
Dominican Republic	199	393	422	485	460	4	10.27	61.77
Guadeloupe	230	270	270	270	270	5	6.87	68.64
Barbados	373	405	185	155	151	6	6.65	75.30
Dominica	295	186	228	209	210	7	5.91	81.21
United States of America	148	99	85	173	103	8	3.19	84.40
Suriname	182	79	82	89	99	9	2.78	87.19
Grenada	105	100	100	100	100	10	2.65	89.83
Costa Rica	27	108	105	105	105	11	2.36	92.19
St. Vincent & The Grenadines	0	6	105	126	99	12	1.76	93.95
Saint Kitts and Nevis	52	64	65	68	30	13	1.46	95.42
Martinique	44	46	46	46	90.3	14	1.43	96.85
Puerto Rico	60	26	17	38	42.46	15	0.96	97.81
Antigua and Barbuda	22	22	22	22	22	16	0.58	98.38
United States Virgin Islands	25	28	28	9	9	17	0.52	98.90
Cuba	22	19	16	16	10	18	0.44	99.34
Trinidad and Tobago	24	21	8	6	5.1	19	0.34	99.67
Mexico	7	7	8	8	6	20	0.19	99.86
Bermuda	4	3	4	5	5	21	0.11	99.97
British Virgin Islands	1	1	1	1	1	22	0.03	100.00
Group: Pelagic Species. Species: *Acanthocybium solandri* - Wahoo. Species code: WAH								
Suriname	360	139	143	132	148	1	24.27	
Saint Lucia	87	147	110	76	126.64	2	14.39	38.67
Bermuda	86	96	92	69	82	3	11.19	49.85
Panama	0	109	0	77	123	4	8.14	57.99
St. Vincent & The Grenadines	9	11	126	82	27	5	6.71	64.70
Aruba	47	47	40	40	45	6	5.77	70.47
Grenada	40	40	40	40	40	7	5.27	75.73
Venezuela, Boliv Rep of	30	64	51	0	0	8	3.82	79.55
France	45	38	41	13	0	9	3.61	83.16
United States of America	38	45	39	10	4	10	3.58	86.74
Dominican Republic	92	2	2	0	0	11	2.53	89.27
Mexico	12	18	13	20	11	12	1.95	91.22
Spain	1	3	1	61	0.03	13	1.74	92.95
United States Virgin Islands	13	17	14	4	4	14	1.37	94.32
Saint Kitts and Nevis	6	9	15	12	6	15	1.26	95.59
Barbados	10	11	10	7	9	16	1.24	96.82
Trinidad and Tobago	9	10	8	7	6	17	1.05	97.88
Dominica	10	10	5	3	6	18	0.90	98.77
Puerto Rico	8	5	3	7	6.5	19	0.78	99.55
Colombia	0	2	7	0	6.66	20	0.41	99.96
British Virgin Islands	1	0	0	0	0	21	0.03	99.99
Belize	0	0	0	0.48	0	22	0.01	100.00

Table 4.11. Blue shark, Shortfin mako, Silky shark, Bigeye thresher shark, Tiger shark and other sharks catch (t) by country during the period 2015-2019.

Country	2015	2016	2017	2018	2019	Rank	%	%cum
Group: Elasmobranch. Species: *Prionace glauca* - Blue shark. Species code: BSH								
Spain	1585	1330	448	747	487.77	1	53.45	
Suriname	195	344	496	541	383	2	22.77	76.22
Panama	0	262	0	437	242	3	10.94	87.16
Venezuela, Boliv. Rep. of	129	116	105	112	55	4	6.01	93.17
Taiwan Province of China	184	136	56	0	0	5	4.37	97.54
St. Vincent & The Grenadines	0	136	0	0	0	6	1.58	99.13
Portugal	0	0	15	34	0	7	0.57	99.69
China	0	5	0	2	2	8	0.10	99.80
Colombia	0	0	0	0	8.95	9	0.10	99.90
Trinidad and Tobago	4	2	2	0	0.29	10	0.10	100.00
Group: Elasmobranch. Species: *Isurus* spp. - Mako sharks. Species code: --								
Trinidad and Tobago	0	0	0	0	0.15	1	100.00	100.00
Group: Elasmobranch. Species: *Isurus oxyrinchus* - Shortfin mako. Species code: SMA								
Spain	72	100	81	59	35.14	1	65.40	
Venezuela. Boliv. Rep. of	13.97	11.1	15.74	14.26	12.12	4	12.66	78.06
United States of America	12	17	14	7	2	2	9.80	87.86
Mexico	4	5	4	6	5	3	4.52	92.38
St. Vincent & The Grenadines	2	3	4	2	3	5	2.64	95.02
Taiwan Province of China	9	2	1	0	0	6	2.26	97.28
Trinidad and Tobago	1	1	2	2	1.16	7	1.35	98.63
Portugal	0	0	0	5	0	8	0.94	99.57
Colombia	0	0	0	0	1.28	9	0.24	99.81
Costa Rica	0	1	0	0	0	10	0.19	100.00
Group: Elasmobranch. Species: Carcharhinidae - Requiem sharks nei. Species code: --								
Mexico	1352	1103	1501	1235	1277	1	87.75	
Venezuela, Bolivarian Republic of	862	6	6	6	6	2	12.02	99.77
Bermuda	3	3	2	2	2	3	0.16	99.93
St. Vincent & The Grenadines	0	0	0	3	2	4	0.07	100.00
Group: Elasmobranch. Species: *Carcharhinus* spp. - Carcharhinus sharks nei. Species code: --								
Colombia	0	0	0	0	11.36	1	100.00	
Group: Elasmobranch. Species: *Carcharhinus falciformis* - Silky shark. Species code: FAL								
Costa Rica	71	124	120	120	120	1	99.80	
United States of America	1	0	0	0	0	2	0.18	99.97
Colombia	0	0	0	0	0.14	3	0.03	100.00
Group: Elasmobranch. Species: *Alopias* spp. - Thresher sharks nei. Species code: --								
Trinidad and Tobago	1	1	1	1	0.63	1	100.00	100.00
Group: Elasmobranch. Species: *Alopias superciliosus*. - Bigeye thresher shark. Species code: BTH								
Mexico	0	0	0	0	64	1	80.00	
Venezuela. Boliv. Rep. of	0	4	4	4	4	2	20.00	100.00

Table 4.11...... continued.

Group: Elasmobranch. Species: *Galeocerdo cuvier*. - Tiger shark. Species code: TIG								
Venezuela, Boliv Rep of	0	31	32	32	32	1	36.60	
United States of America	11	0	30	28	40	2	31.41	68.02
Mexico	12	22	13	25	17	3	25.65	93.67
Colombia	0	0	0	0	6.91	4	1.99	95.66
Trinidad and Tobago	1	1	1	1	1.01	5	1.44	97.10
Saint Lucia	1	0	1	2	0.82	6	1.39	98.49
Puerto Rico	2	0	0	0	2.24	7	1.22	99.71
Bermuda	0	0	1	0	0	8	0.29	100.00

Table 4.12. Hammerhead sharks, Great hammerhead shark, Scalloped hammerhead shark, and other sharks and rays catch (t) by country during the period 2015-2019.

Country	2015	2016	2017	2018	2019	Rank	%	%cum
Group: Elasmobranch. Species: Elasmobranchii - Sharks, rays, skates, etc. nei. Species code: --								
Mexico	3743	5074	4155	5683	3955	1	61.54	
United States of America	906	711	485	693	328	2	8.50	70.04
Guyana	569	748	623	329	774	3	8.28	78.32
Cuba	550	460	408	407	390	4	6.03	84.35
Venezuela. Boliv. Rep. of	1303	162	165	165	165	5	5.33	89.68
Trinidad and Tobago	293	276	301	301	302.02	6	4.01	93.69
Nicaragua	232	234	196	114	107.16	7	2.40	96.10
Colombia	0	30	427	1	0	8	1.25	97.34
Costa Rica	107	86	85	85	85	9	1.22	98.56
Japan	44	66	17	17	15	10	0.43	98.99
Antigua and Barbuda	22	22	22	22	22	11	0.30	99.29
Barbados	23	15	18	11	10	12	0.21	99.50
Grenada	15	15	15	15	15	13	0.20	99.71
Spain	0	0	33	0	0	14	0.09	99.80
Martinique	4	4	4	4	4	15	0.05	99.85
Taiwan Province of China	0	0	16	0	3	16	0.05	99.90
Puerto Rico	4	3	2	4	3	17	0.04	99.95
Saint Lucia	3	1	3	1	0.59	18	0.02	99.97
Belize	0	5	0	0	0	19	0.01	99.98
St. Vincent & The Grenadines	2	1	0	0	0	20	0.01	99.99
Korea. Republic of	2	0	0	0	0	21	0.01	100.00
Bermuda	0	1	0	0	0	22	0.00	100.00
Group: Elasmobranch. Species: Rajiformes - Rays, stingrays, mantas nei. Species code: --								
Cuba	1343	1216	1320	1257	1078.1	1	57.80	
Venezuela. Boliv. Rep. of	2184	209	215	215	215	2	28.26	86.06
Mexico	18	62	20	69	192	3	3.36	89.42
Colombia	0	5	117	51	93.01	4	2.47	91.89
Nicaragua	124	172	124	58	54.52	5	4.95	96.85
Dominican Republic	103	45	48	2	15	6	1.98	98.83
French Guiana	11	11	14	13	10	7	0.55	99.38
Martinique	1	1	1	1	1	8	0.05	99.42
United States of America	2	7	46	7	0	9	0.58	100.00
Group: Elasmobranch. Species: Sphyrnidae - Hammerhead sharks, etc. nei. Species code: --								
Mexico	147	199	163	223	171	1	82.09	
Trinidad and Tobago	40	40	39	39	38.98	2	17.91	100.00
Group: Elasmobranch. Species: *Sphyrna* spp. - Hammerhead sharks nei. Species code: --								
Colombia	0	0	0	0	0.13	1	100.00	
Group: Elasmobranch. Species: *Sphyrna mokarran* – Great hammerhead. Species code: SPK								
Venezuela, Bolivarian Republic of	0	32	35	35	35	1	81.55	
United States of America	13	0	0	18	0	2	18.45	100.00

Table 4.12...... continued.

Group: Elasmobranch. Species: *Sphyrna lewini* – Scalloped hammerhead shark. Species code: SPL							
Venezuela, Boliv Rep of	26	11	12	12	12	1	85.18	
United States of America	0	1	7	2	1	2	12.84	98.02
Colombia	0	0	0	0	1.7	3	1.98	100.00

Table 4.13. Stock status of elasmobranchs in the WECAFC region.

Common name/ Species name	ICCAT				FIRMS		FAO categorization / Reference year		IUCN - Assessment year
	Stock unit Assessment year		Overfished	Overfishing	Abundance Level	Exploitation rate	WECAFC/SAG/ IX/2018/3		https://www.iucnredlist.org/
Blue shark/ *Prionace glauca*	North Atlantic	2015	NOT LIKELY	NOT LIKELY	Intermediate abundance	Moderate fishing mortality	F	2016	NT/ Decreasing 2018
Silky Shark/ *Carcharhinus falciformis*	North Atlantic	2012	-	Vulnerability: Moderate*	-	-	-	-	VU/ Decreasing 2017
Oceanic whitetip shark/ *Carcharhinus longimanus*	North Atlantic	2012	-	Vulnerability: Moderate*	-	-	-	-	CR/ Decreasing 2018
Tiger shark/ *Galeocerdo cuvier*	North Atlantic	2012	-	Vulnerability: Moderate*	-	-	-	-	NT/ Decreasing 2018
Scalloped hammerhead shark/ *Sphyrna lewini*	North Atlantic	2012	-	Vulnerability: Low*	-	-	-	-	CR/ Decreasing 2018
Smooth hammerhead/ *Sphyrna zygaena*	North Atlantic	2012	-	Vulnerability: Low*	-	-	-	-	VU/ Decreasing 2018
Great hammerhead/ *Sphyrna mokarran*	North Atlantic	2012	-	Vulnerability: Moderate*	-	-	-	-	CR/ Decreasing 2018
Shortfin mako/ *Isurus oxyrinchus*	North Atlantic	2017	YES	YES	Low abundance	High fishing mortality	O	2016	EN/ Decreasing 2018
Bigeye thresher shark/ *Alopias superciliosus*	North Atlantic	2012	-	Vulnerability: High*	-	-	-	-	VU/ Decreasing 2018
Pelagic stingray/ *Pteroplatytrygon violacea*	North Atlantic	2012	-	Vulnerability: Low*	-	-	-	-	LC/ Unknow 2018
Giant oceanic manta ray/ *Mobula birostris*	Atlantic	Not assessed	-	-	-	-	-	-	EN/ Decreasing 2019
Whale shark/ *Rhincodon typus*	Atlantic	Not assessed	-	-	-	-	-	-	EN/ Decreasing 2016

*ICCAT 2020b. LC: Least Concern; NT: Near Threaten; VU: Vulnerable; EN: Endangered; CR: Critically Endangered.

5. STOCKS MANAGED BY REGIONAL FISHERIES MANAGEMENT ORGANIZATION OVERLAPPING WITH WECAFC

Regional Fisheries Management Organization and Regional Fisheries Advisory Bodies in WECAFC region

The main organizations and groups involved in governance of fisheries in the region include one RFMO, the ICCAT and four Regional Fishery Advisory Bodies (WECAFC, CRFM, OSPESCA, COPPESAALC) (**Table 5.1**). The CRFM is a Regional Fishery Advisory Body for the CARICOM member countries, while the OSPESCA is part of the Central American Integration System (SICA) that works with the Spanish speaking Central American countries, Belize and Dominican Republic. The work of the Commission for Small-Scale and Artisanal Fisheries and Aquaculture of Latin America and the Caribbean (COPPESAALC) is mostly related with the planning and development of artisanal fisheries and aquaculture in Latin America and the Caribbean. WECAFC covers additional countries and has thus a mandate of creating cohesion and involvement in its region.

The International Commission for the Conservation of Atlantic Tuna (ICCAT) was established by the International Convention for the Conservation of Atlantic Tunas, which was signed in 1966 and entered into force in 1969 (https://www.iccat.int/). The objective of the Convention is to conserve tuna and tuna-like species in the Atlantic Ocean and to maintain the populations of these fishes at levels that will permit the maximum sustainable catch. The Commission has established three subsidiary bodies, i.e. the Standing Committee on Finance and Administration, the Standing Committee on Research and Statistics, and the Compliance Committee. The Commission also appoints the Executive Secretary who will manage the ICCAT Secretariat. ICCAT currently has 52 contracting parties (country) represented by three members each country, and five countries have been granted the status of cooperating non-contracting party, of those contracting and non-contracting parties 18 are also members of WECAFC. Noting that the Convention text does not specifically refer to the precautionary or ecosystem approaches, ICCAT has evolved in redefining the list of ICCAT target species under its mandate, which now include several species of elasmobranchs (sharks and rays). It has also established several binding measures for mitigating bycatch and for conserving non-target species, including multiple measures for shark species as well as measures for seabirds and sea turtles (https://www.iccat.int/en/RecRes.asp). ICCAT has also established minimum standards for the vessel monitoring system (VMS) in the ICCAT convention area and adopted several measures to combat IUU fishing.

The Western Central Atlantic Fishery Commission (WECAFC) was established in 1973 by Resolution 4/61 of the FAO Council under Article VI, Paragraph 1 of the FAO Constitution. Its general objective is to promote the effective conservation, management and development of the living marine resources in the Western Central Atlantic, in accordance with the FAO Code of Conduct for Responsible Fisheries (http://www.fao.org/fishery/rfb/wecafc/en#Org-OrgsInvolved). It assist its members in implementing relevant international fisheries instruments; promoting, coordinating and, undertaking the collection, exchange, dissemination, analysis and study of statistical, biological, environmental and socio-economic data and other marine fishery information; promoting and facilitating the harmonization of relevant national laws and regulations and the compatibility of conservation and management measures; and assisting its members, at their request, in the conservation, management and development of transboundary and straddling stocks under their respective national jurisdictions. WECAFC covers national waters and the high seas, and applies to all living marine resources, irrespective of the management responsibilities and authority of other management organizations or arrangements addressing fisheries and other living marine resources in the area. WECAFC has 34 members; its governing body is the Commission meeting every two years. The Commission established a Scientific Advisory Group (SAG), which provides scientific advice to the Commission; it consists of no more than five scientists, with suitable scientific qualifications and experience. The SAG assesses and reports to the Commission on the status of stocks in the area covered by the Commission and accesses the situation, trends and prospects of fisheries in the region. The Commission also established and confirmed to date 11 Working Groups that normally function in collaboration with other regional partner institutions. Fishery management advice and recommendations are provided to member countries for their implementation by specific Working Groups. The WECAFC Secretariat is provided by FAO. It is based in the Subregional Office for the Caribbean (SLC).

The Caribbean Regional Fisheries Mechanism (CRFM) was officially inaugurated on 27 March 2003, in Belize City, Belize, where it is headquartered, following the signing of the "Agreement Establishing the CRFM" on February 4, 2002. It is an inter-governmental organization with its mission being "to promote and facilitate the responsible utilization of the region's fisheries and other aquatic resources for the economic and social benefits of the current and future population of the region". The CRFM consist of three bodies – the Ministerial Council; the Caribbean Fisheries Forum; and the CRFM Secretariat. Its members are Anguilla, Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago and the Turks and Caicos Islands (www.crfm.int). The Ministerial Council is the highest decision making body of the CRFM and is responsible for formulating the policy of the Mechanism. It is comprised of the Ministers responsible for Fisheries in each Member State. The Caribbean Fisheries Forum is made up of one representative from each member country, an associate member and an observer from each member country. The CRFM Secretariat will be the secretariat of the Forum. The CRFM Secretariat unit comprises a permanent body of technical, scientific and support staff. The staff is located at two offices: one in Belize, the headquarters of the CRFM; the other in the eastern Caribbean.

The Central America Fisheries and Aquaculture Organization (OSPESCA) was established in 1995 within the SICA. It is relevant to highlight that SICA is the institutional framework for the integration of the Central American region. SICA has 25 secretariats and specialized institutions responsible for different topics of high regional interest – OSPESCA being one of them (https://www.sica.int/ospesca/inicio). The establishment of SICA was endorsed by the General Assembly of the UN, allowing its regional bodies and institutions, including OSPESCA, to relate to the UN system. OSPESCA is a regional fisheries advisory body responsible for coordinating strategies, policies and projects for the regional governance and sustainable development of fisheries and aquaculture in the Central America. OSPESCA's work is guided by the "Fisheries and Aquaculture Integration Policy 2015-2025" and covers the inland waters, territorial seas and EEZs of its eight members: Belize, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua and Panama. OSPESCA has three levels of higher authorities representing its eight member countries: the Council of Ministers, the Committee of Vice Ministers, and the Commission of Directors of Fisheries and Aquaculture. Two regional organizations representing small-scale fisherfolk and the fishing and aquaculture industry function as advisory bodies and participate in OSPESCA's activities. OSPESCA coordinates actions of regional impact, offering national authorities, fisherfolk and aquaculture organizations and other actors in the value chain a space to exchange experiences and to work together in favor of the Central American region.

The Commission for Small-Scale and Artisanal Fisheries and Aquaculture of Latin America and the Caribbean (COPPESAALC, formerly COPESCAALC) was established in 1976 (http://www.fao.org/fishery/rfb/coppesaalc/en) by Resolution 4/70 of the FAO Council. Its statutes were updated in 2019, during its XVI meeting in La Habana, Cuba (http://www.fao.org/americas/eventos/ver/en/c/1199907/), to include all small-scale and artisanal fisheries (inland and marine) and aquaculture. COPPESAALC is a member of the Regional Fishery Body Secretariats Network, and its main objective is to promote the sustainable development and management of small-scale and artisanal fisheries and aquaculture, according to the norms and principles of the FAO Code of Conduct for Responsible Fisheries, voluntary guidelines for achieving sustainability in small-scale fisheries and other applicable complementary instruments adopted by FAO. The area of competence of this Commission includes inland waters and marine national waters of Latin America countries, Jamaica and Suriname. The main body is the Commission, which normally meets every two years, with the Secretariat provided by FAO and based at the Regional Office for Latin America, and the Caribbean in Santiago de Chile, Chile. The Commission assists its member states to promote the strengthening and sustainability of small-scale and artisanal fisheries and the development of aquaculture, as sectors that sustain food and nutritional security in rural territories and contribute to boosting local economies, to which establishes cooperative relationships with other international organizations in areas of common interest.

Existence of arrangements that address the governance of pelagic fisheries at the regional/sub regional level

Noting that the fishery resources considered in this report, namely, highly migratory pelagic fish species, small pelagic fishes, only the highly migratory pelagic fish species associated to tuna and tuna-like species fisheries are under the binding mandate of the Regional Fishery Management Organization in the area (i.e., ICCAT). The rest are under specific National Management and Conservation measures of each country within the region.

However, under WECAFC, fishery management advice and recommendations are based on the best available scientific information provided to member countries for their implementation by dedicated Working Groups, established by the Commission. These groups for the purpose of the present report are: (1) WECAFC/OSPESCA/CRFM/CFMC Working Group on Recreational Fisheries; (2) CRFM/WECAFC Working Group on Flyingfish in the Eastern Caribbean. It is from these Working Groups that only one Fishery Management Plan has been developed and adopted by the Commission: the Sub-regional Fisheries Management Plan for Flyingfish in the Eastern Caribbean (CRFM 2014, FAO 2016).

Structure and Operation of the International Commission for the Conservation of Atlantic Tunas

Structure

Overall, ICCAT is formed by contracting parties and cooperating non-contracting parties, several subsidiary bodies and the Secretariat (https://www.iccat.int/en/index.asp).

Contracting Parties. The Commission may be joined by any government that is a member of the United Nations (UN), any specialized UN agency, or any inter-governmental economic integration organization constituted by States that have transferred to it competence over the matters governed by the ICCAT Convention. The Commission has also created a special status known as Cooperating Non-Contracting Party, Entity or Fishing Entity. Parties, entities or fishing entities that are granted this status have many of the same obligations, and are entitled to many of the same privileges, as are Contracting Parties.

The subsidiary bodies established by the Commission analyze an array of information and refer their conclusions and recommendations back to the Commission for final decision-making. These include the Standing Committee on Finance and Administration, the Standing Committee on Research and Statistics, and the Compliance Committee; the Commission has also established two permanent working groups, one on improvement of ICCAT statistics and conservation measures, and another on dialogue between fisheries scientists and managers.

The Secretariat Coordinates and facilitates the work of the Commission. This includes managing the Commission's budget, coordinating research programs, maintaining databases, preparing the collection and analysis of data necessary for stock assessments, preparing publications and organizing the meetings of the Commission and subsidiary bodies.

The Standing Committee on Finance and Administration reviews all financial and administrative matters and prepares a budget.

The Standing Committee on Research and Statistics (SCRS) is the technical body that recommends all policy and procedures for the fishery data collection. It is the SCRS' task to provide the Commission with the most complete and current statistics concerning fishing activities in the Convention area as well as biological information on the stocks that are fished. The SCRS is composed of other subsidiary bodies that examine distinct species or different topics.

Four Panels are responsible for keeping under review the species, group of species, or geographic area under its purview: Panel 1: Tropical Tunas (Yellowfin, Skipjack and Bigeye); Panel 2: Northern Temperate Tunas (Albacore and Bluefin); Panel 3: Southern Temperate Tunas (Albacore and southern Bluefin); and Panel 4: Other species (Swordfish, Billfishes, Sharks). The Panels review scientific and other information and make recommendations for joint action by the Contracting Parties aimed at maintaining the stocks at levels that will permit maximum sustainable catches. The Panels may also recommend to the Commission studies and investigations necessary for obtaining information relating to its species, group of species, or geographic area, as well as the coordination of research programs by the Contracting Parties.

Compliance matters are reviewed by two different bodies: the Conservation and Management Measures Compliance Committee (reviews matters related to Contracting Parties), and the Permanent Working Group on ICCAT Statistics and Conservation Measures (reviews matters related to Non-contracting Parties).

Operation

All the Commission's scientific work and data collection efforts are accomplished by the Contracting Parties themselves. The Secretariat's role is more of being a focal point for data collation/assimilation and coordinating access by scientists to the common databases.

FISHERY DATA

The core of the scientific advice to the Commission is the Fishery data. The main types of data used by ICCAT could be classified according to two criteria: the source of the data, and the intended usage of the data.

Most of the fishery data used by ICCAT is Fishery-dependent, where the main sources are logbooks, observer programs, port sampling, factory/market sampling, and international trade (import/export) statistics. The mandatory fishery data according to the ICCAT Convention and other international agreements is the most basic type: total annual catch by species, flag, stock area and gear. But also, other types of data such as catch/effort samples and size samples also need to be collected and reported to ICCAT.

There is also the collection of Fishery-independent data by ICCAT, but mostly of studies on tunas and tuna-like species that are conducted with tagging programs. There are, however, a few examples of surveys conducted under ICCAT sponsorship (e.g. larval surveys).

The usage of the fishery data can be for stock assessments and scientific advice and for compliance purposes. In the case of compliance purposes, the data used is to ensure that the Recommendations for the management of stocks are being implemented adequately. For example, if a Recommendation establishes catch quotas and minimum sizes for a given stock, the compliance information needed will be in the form of total catches and in the size composition of those catches.

The fishery data to be use for stock assessments and scientific advice can be classified according to two criteria: statistical data and biological data.

The statistical data that is compiled by the ICCAT Secretariat to be used for scientific purposes covers tuna, tuna-like species and shark catches caught in the ICCAT Convention area are: 1) Fleet characterization (e.g. flag, gear, target species, size, tonnage); 2) Task I nominal catches (nominal catch estimates of target and bycatch species, and dead discards); 3) Task II catch & effort (catch by species effort statistics, classified by fishing fleet, gear, time strata and area); 4) Task II size samples (size frequencies of the samples measured for each species classified by fishing fleet, species, gear, sample units, time strata, area); and 5) Task II catch-at-size (catch-at-size estimates classified by fishing fleet, gear, time strata, and area (and by sex in the case of Swordfish) for the major ICCAT species.

The biological data used in ICCAT come from scientists of the Contracting Parties who present the latest results of their studies to the pertinent Species Working Groups and to the SCRS. The advances made by individual scientists are "adopted" as the most up-to-date information and become part of the knowledge base used in stock assessments. These scientific studies are published annually in the ICCAT Collective Volume of Scientific Papers.

THE STANDING COMMITTEE ON RESEARCH AND STATISTICS (SCRS)

All members of the Commission are represented in the SCRS. The Committee is responsible for developing and recommending to the Commission all policy and procedures for the collection, compilation, analysis and dissemination of fishery statistics. The SCRS also coordinates various national research activities, develops plans for special international cooperative research programs, conducts stock assessments, and advises the Commission on the need for specific conservation and management measures.

The SCRS' subsidiary bodies are: 1) The Sub-Committee on Statistics and 2) The Sub-Committee on Ecosystems. In addition, there are seven Species Working Groups, the Working Group on Stock Assessment Methods, and the Ad hoc Working Group on coordination of tagging information.

The Sub-Committee on Statistics oversees the process of data procurement and analysis conducted by the Secretariat and the various stock assessment groups. Any updates and revisions of historical and recent catch data by Contracting Parties are to be presented to this body for revision and adoption.

The Sub-Committee on Ecosystems deals with a wide range of issues, including an Ecosystem Approach to Fisheries and of oceanographic factors affecting tuna biology and fisheries. It also oversees the advances on mitigation measurements and by-catch assessments of species associated to the tuna fisheries in the Convention area. As indicated earlier, the Convention text does not specifically refer to the precautionary or ecosystem approaches; however, ICCAT has recognized that by-catch issues have become particularly important for long-lived marine megafauna such as sharks, sea turtles, seabirds, and marine mammals. It has made efforts to improve the knowledge on by-catch species by creating a meta-database under the supervision of a By-catch Coordinator (Professional Secretariat staff member) to harmonize and analyze fishery datasets related to by-catch species of tuna fisheries in the ICCAT area. As part of his tasks, The By-catch Coordinator oversees updating and maintaining the ICCAT by-catch meta-database.

The Working Group on Stock Assessment Methods (WGSAM) implements quality management procedures for stock assessment methodologies, leading to the review, testing and documentation of assessment methods used by the SCRS. Currently is advancing work on Harvest Control Rules, Limit Reference Points, and Management Strategy Evaluation; Standard diagnostics for stock assessment models; and CPUE standardization/incorporation of oceanographic and environmental changes into the assessment process.

The Ad hoc on coordination of tagging information objective is to channel and make use of the experience of the scientists for new tagging activities.

There are seven Species Working Groups (SWG) responsible for the revision and update of the fishery data specific to one species or species group; the revision and discussion of the latest results of biological and/or methodological studies; and the stock assessments pertinent in each of the Species Groups (**Table 5.2**). It is within the Species Working Groups that the stock assessments and the state of the resource to provide management advise is originated**.**

The SWG operate intersessional and/or at the annual Species Group Meetings prior to the Plenary meeting of the SCRS. Intersessional meetings are mostly related to data preparation in advance for a stock assessment, and for the stock assessments itself. There are also intersessional meetings called by specific SWG that need to address specific issues in relation to upcoming stock assessments like technical meetings on Management Strategy Evaluation (MSE) for a specific SWG, or Joint Tuna-RFMO FAD working group associated to the Tropical Tunas Working Group, among other relevant issues. The SWG annual meeting is a week prior to the SCRS plenary and is when the most recent Fishery Data compiled by the ICCAT Secretariat is reviewed by each SWG; the Executive Summaries of each major species or group of species are revised and updated; annual working plans are developed, recommendations with and without financial implications are made to the Commission; and responses to the Commission (if any) are addressed and responded. All the information compiled and updated by each SWG is presented by the respective SWG Chairperson to the SCRS Plenary, where is discussed and adopted by the SCRS Plenary. The SCRS Plenary reviews and adopts the Report that will be the base of the Scientific Advice to the Commission. The Commission will then act on the conservation and management advice provided by the SCRS, in the form of Recommendations or Resolutions that are binding for all contracting and cooperating non-contracting parties.

Table 5.1. Membership of countries and overseas territories in the WECAFC region (green) in the main fisheries related international bodies.

Country	WECAFC	ICCAT	CRFM	OSPESCA	COPPESAALC
Anguilla*			(green)		
Antigua and Barbuda	(green)		(green)		
Bahamas	(green)		(green)		
Barbados	(green)	(green)	(green)		
Belize	(green)	(green)	(green)	(green)	
Brazil	(green)	(green)			
Canada		(green)			
Colombia	(green)				
Costa Rica	(green)			(green)	(green)
Cuba	(green)				
Curaçao		(green)			
Dominica	(green)		(green)		
Dominican Republic	(green)			(green)	(green)
El Salvador				(green)	(green)
European Union	(green)	(green)			
France	(green)	*St-P_M* (orange)			
Grenada	(green)	(green)	(green)		
Guatemala	(green)			(green)	(green)
Guinea	(green)				
Guyana	(green)	*CnCP* (yellow)	(green)		
Haiti	(green)		(green)		
Honduras	(green)	(green)		(green)	(green)
Jamaica	(green)		(green)		(green)
Japan	(green)	(green)			
Mexico	(green)	(green)			(green)
Monserrat*			(green)		
Netherlands	(green)				
Nicaragua	(green)	(green)		(green)	(green)
Panama	(green)	(green)		(green)	(green)
Republic of Korea	(green)	(green)			
Saint Kitts and Nevis	(green)		(green)		
Saint Lucia	(green)		(green)		
St. Vincent & The Grenadines	(green)	(green)	(green)		
Spain	(green)				
Suriname	(green)	*CnCP* (yellow)	(green)		(green)
Trinidad and Tobago	(green)	(green)	(green)		
Turk and Caicos Islands*			(green)		
United Kingdom*	(green)	(green)			
United States of America	(green)	(green)			
Venezuela	(green)	(green)			(green)

Orange/yellow color indicates a type of participation.
St-P_M: St-Pierre et Miquelon; CNCP: Cooperating Non-Contracting Party.
*The British Government deals with all international relations on behalf of these territories.

Table 5.2. List of the Species Working Groups of the ICCATs SCRS.

SPECIES WORKING GROUPS	SPECIES	STOCKS	OBSERVATIONS
TROPICAL TUNAS (TUN)	*Thunnus albacares* (YFT), *T. obesus* (BET), *Katsuwonus pelamis* (SJK)	YFT: one stock (Atlantic-wide) BET: one stock (Atlantic-wide) SKJ: two stocks (East and West Atlantic)	
ALBACORE (ALB)	*Thunnus alalunga* (ALB)	ALB: three stocks (North, South Atlantic, and Mediterranean)	
BLUEFIN TUNA (BFT)	*Thunnus thynnus* (BFT)	BFT: two stocks (East [including Mediterranean] and West Atlantic)	
BILLFISHES (BIL)	*Makaira nigricans* (BUM), *Istiophorus albicans* (SAI), *Tetrapturus albidus* (WHM), *T. pfluegeri* (SPF), *T. georgii* (RSP), *T. belone* (MSP)	BUM: one stock (Atlantic-wide) WHM: one stock (Atlantic-wide) SAI: two stocks (East and West Atlantic) SPF: two stocks (East and West Atlantic) MSP: one stock (Mediterranean)	RSP is considered part of the WHM species complex in WHM stock assessments, due to historical misidentification with WHM. Therefore, RSP is considered Atlantic-wide for assessment purposes.
SWORDFISH (SWO)	*Xiphias gladius* (SWO)	SWO: three stocks (North, South Atlantic, and Mediterranean)	
SHARKS (SHK)	*Prionace glauca* (BSH), *Isurus oxyrinchus* (SMA), *Lamna nasus* (POR)	BHS: two stocks (North and South Atlantic) SMA: two stocks (North and South Atlantic) POR: three stocks (Northwest, Southwest, and Northeast Atlantic)	There are 21 elasmobranch species, other than those listed, that are under ICCAT's mandate but are evaluated when the SHK group considers it necessary
SMALL TUNAS (SMT)	*Thunnus atlanticus* (BLF), *Euthynnus alletteratus* (LTA), *Auxis rochei* (BLT), *Auxis thazard* (FRI), *Sarda sarda* (BON), *Orcynopsis unicolor* (BOP), *Scomberomorus cavalla* (KGM), *S. brasiliensis* (BRS), *S. maculatus* (SSM), *S. regalis* (CER), *S. tritor* (MAW), *Acanthocybium solandri* (WAH)	No stock boundaries have been defined for any of the species within this Group. However, the SMT WG agreed that the ICCAT Statistical Areas Map #4, that separates the Atlantic into four areas (NW, SW, NE, SE) and the Mediterranean, was adequate for the species in this group. Therefore, studies should be carried based on those spatial areas.	Uncertainties continue regarding the accuracy and completeness of reported landings in all areas. There has been improvement in applying a range of Data-limited models, but robustness still needs to be evaluated before they can be used to provide management advice to the Commission.

6. THE ECOLOGICAL CONNECTIVITY BETWEEN THE AREAS BEYOND NATIONAL JURISDICTION AND THE EXCLUSIVE ECONOMIC ZONES IN THE WECAFC REGION

Ecological connectivity between distant marine ecosystems

The WECAFC region includes FAO fishing area 31 and the northern part of FAO fishing area 41; it also contains the EEZs of 28 nation states and 16 territories belonging to the Netherlands, the United Kingdom of Great Britain and Northern Ireland, France and the United States of America; 29 of all these are considered SIDS, making it one of the most geopolitically complex and vulnerable regions of the world (Singh-Renton and McIvor 2015).

The region encompasses four distinctly LMEs and a large ABNJ linked by major ocean currents (**Figure 6.1**). It occupies of an area of 14 644 544 km^2 of which 10.5% is continental and island shelf, incorporates two of the world's largest semi-enclosed seas, and is influenced by the discharge of some of the world's largest rivers (e.g. Amazon, Orinoco, Mississippi).

Marine ecological connectivity is viewed as the most complex type of ecological spatial connectivity linking various components of marine ecosystems in time and space. Therefore, ecological connectivity between distant marine ecosystems (e.g. EEZs and ABNJ) is affected through two types of connections: circulation (passive) connectivity facilitated by the ocean currents and migratory connectivity achieved by active swimming by marine species. However, it not only involves the movement of species, but also the movement of chemicals (e.g. nutrients and pollutants), materials (e.g., sediments and debris), and energy (in the form of organisms, e.g. Sargasso) which are part of the passive connectivity through ocean currents (Carr *et al.* 2017).

Circulation connectivity mediated by the ocean currents

Energetic ocean currents are the key medium by which distant ocean regions are connected to each other, including the connectivity of the EEZ to the ABNJ. In the case of the WECAFC region, the connection between the EEZ to the ABNJ is influenced by two large scale westward currents (North Equatorial Current, South Equatorial Current) and one eastward counter current (North Equatorial Counter Current) (**Figure 6.2**). The North Equatorial Current (NEC) is found in the North Atlantic from about 7°N to about 20°N, is a broad westward flowing current that forms the southern limb of the North Atlantic subtropical gyre (https://oceancurrents.rsmas.miami.edu). It is fortified by the Atlantic trade wind belt, with an annual mean transport of 8.5 Sverdrups (Sv). The South Equatorial Current (SEC) is a broad, westward flowing current that extends from the surface to a nominal depth of 100 m. Its northern boundary is usually near 4°N, while the southern boundary is usually found between 15-25°S (https://oceancurrents.rsmas.miami.edu). The SEC flows westward toward the Brazilian shelf, and splits at Cabo de Sao Roque (Brazil), near 16°S with one branch, the stronger of the two, heading northwards as the North Brazil Current (NBC) and the other, weaker southwards branch, as the Brazil Current. The

SEC northern branch transport in the upper layer is about 12 Sv. The northern branch of the SEC that will feed the NBC, will retroflect and feed the North Equatorial Counter Current (NECC), which in turn, helps feeds the northern branch of the SEC. The NECC lies between 3°-10°N and is considered to roughly serve as the northern boundary for the SEC (https://oceancurrents.rsmas.miami.edu). The main source of the NECC is the retroflection of about 16 Sv from the upper layers (100 m) of the NBC, starting at between 5°-8°N. Temperature and circulation of the tropical Atlantic have strong seasonal signals, and this results in a transient but regular appearance of the NECC.

The three large-scale currents described above have direct influence in several currents that are the oceanographic link between WECAFC's region ABNJ and the EEZs of boundary states with the high seas (**Figure 6.3**). In a north-pole ward direction the linkage starts with a well-established western boundary current, the NBC, which is fed by the SEC. The NBC is the dominant surface circulation feature in the western tropical Atlantic Ocean. It plays a dual role: firstly, it closes the wind-driven equatorial gyre circulation and feeds a system of zonal countercurrents; and secondly, it provides a conduit for cross-equatorial transport of upper-ocean waters as part of the Atlantic meridional overturning cell (https://oceancurrents.rsmas.miami.edu). One of the major features of the NBC are the large anticyclonic rings shed by the current swirl northwestwards along the South American coast.

As the NBC flows north along the northeastern coast of South America, it reaches French Guyana, where part of it separates from the coast and retroflects to join the NECC (Wilson *et al.* 1994). The rest of the NBC continues flowing northwestward to form the Guiana Current (Condie 1991). At this point (near 6°-8°N), the NBC retroflection is present year-round, in occasions retroflects so severely as to pinch off large isolated warm-core rings exceeding 450 km in overall diameter. Over a 24-year study (1993-2016), the NBC formed, on average, five NBC-rings (NBCRs) per year; with average lifetime of 15.3 weeks (Aroucha *et al.* 2020). The study indicated that NBCRs are larger, rotate faster, live less, and carry more energy in boreal winter months (December-February), while during boreal summer (July-August) and early fall (September), they last longer, have smaller diameters, and carry less energy.

An important feature observed in NBCR is the influence of the Amazon river discharge after its maximum in August, when the Amazon plume surrounds completely the NBC retroflection on the west and on the north (Ffield 2005). The surface layer characteristics of the NBCRs reveal the varying influence of the Amazon plume. The fresher and typically warmer surface waters associated with the Amazon plume are buoyant relative to the saltier and typically colder surface waters carried by the NBC, therefore the varying position of the Amazon plume may seasonally influence the surface dynamics in the region.

As the NBCRs move northwestward towards the Caribbean Sea on a course parallel to the South American coastline during a period of about 3-4 months, the NBCRs stall and decay off the Lesser Antilles (Fratantoni and Richardson 2006). These islands became a barrier to the translation of the NBCRs and the topography east of the island arc contributed to the termination of the NBCRs and only filaments of core water entered the eastern Caribbean. However, NBCRs are observed to move northward as they reach the island arc, and they surround the island of Barbados for a period of several days, leading to fluctuations in temperature and salinity near the island. A study demonstrated that the overall impact of NBCRs on recruitment of coral reef fishes to the island appears to be that of increasing variability (Cowen *et al.* 2003). The regular passage of NBCRs in the vicinity of Barbados seems to have conflicting impacts on larval fish around the island, depending both on species-specific behavior and NBCR type. The physical retention of larvae may be enhanced (concentration at fronts with flows bringing larvae closer to shore) or decreased because of flushing/advection away from the island.

In summary, the NBC and NBCRs contribute to the dispersal of fresh, nutrient- rich outflow from the Amazon River and provide a mechanism for transport of this water northwestward toward Tobago and the Lesser Antilles.

The other surface currents that are the oceanographic link between WECAFC's region ABNJ and the EEZs of boundary states with the high seas are the Guianas, Antilles, and Florida currents (**Figure 6.3**). The Guiana Current (GC) is fed by the NBC, in the spring the current can extend as far as 300 nautical miles offshore (Febres-Ortega and Herrera 1976). In the mid 1970, it was concluded that the GC does not flow uniformly northwestward because the seasonally formed meanders (Febres-Ortega and Herrera 1976). It has been indicated that GC surface water enters the Caribbean primarily between the Windward Islands and between Grenada and the South American continent (**Figure 6.2**). However, some authors have indicated that the inflow to the Caribbean is fed by the main NBC and from NBCRs that collide with the continental margin near Tobago (near 11.2°N) (Johns *et al.* 2002).

The Atlantic inflow into the Caribbean (or the connectivity between the ABNJ and the Antilles Island chain) has been divided among three main groups of passages: the Windward Islands passages (south of Martinique), the Leeward Islands passages (between Martinique and the Virgin Islands) and the Greater Antilles passages (between Puerto Rico and Cuba) (**Figure 6.2**). The inflow to the Caribbean by the main NBC and from NBCRs enters through the largest individual contributor in the south, the Grenada Passage (6 Sv). While the subtropical gyre (NEC) inflow to the Caribbean Sea is about 17 Sv; and it enters mainly through the Greater Antilles and Leeward Islands passages in the northern Caribbean (Johns *et al.* 2002).

Another important feature in the southern area of the region is the influence of the dispersal of the freshwater from the Amazon and Orinoco Rivers, which is discharged into the tropical Atlantic and advected into the Caribbean Sea. Two inflows of freshwater enter the Caribbean Sea (Cherubin and Richardson 2007). The first is south of 12°N, where the Orinoco plume, some NBC water, and some NBCR water enter the Caribbean through Grenada Passage, where the swiftest currents of the Caribbean Current are observed. The second inflow of freshwater is between 14° and 18°N, partly provided by NBCRs, which stall and decay east of the Lesser Antilles, and partly by the NEC, which advects water westward. The freshwater flux from NBCRs exerts a strong forcing on the reef ecosystem as noted by Cowen *et al*. (2003), where changes in the vertical distribution of fish larvae were observed with the intrusion of freshwater potentially affecting survival rates and recruitment success.

The other two passages by which Atlantic water (NEC) enters the Caribbean are the Leeward Islands passages and the Greater Antilles passages (**Figure 6.2**). Of all the passages in the Leeward, the Anegada Passage is relevant because its depth (1 900 m) allows exchange between the Caribbean and Atlantic at levels below the direct influence of the subtropical gyre circulation and the inflow of Atlantic Deep Water (of high salinity, high oxygen, and low nutrients between about 1 500 and 3 500 m) into the Caribbean and Colombian Basins (Johns *et al.* 2002). The transport of Atlantic water into the Caribbean is mostly concentrated in the northern part of the Leeward Islands (Anegada and Antigua Passages). In the northern Caribbean, the transport of Atlantic water into the Caribbean is through the Mona and Windward Passages.

In summary, the three different Passage group (Windward, Leeward, Greater Antilles) in the eastern and north Caribbean are the mayor connection pathways by which Atlantic waters enters the Caribbean and encountering in its path the different Islands.

Moving northward along the ABNJ boundary and the Greater Antilles through to the Bahamas, the next linkage is the Antilles Current (**Figure 6.3**). A western boundary current that flows northward east of the Greater Antilles and then northwestward along and around the northern Bahamas islands in the subtropical North Atlantic before joining the Florida Current and subsequently the Gulf Stream. The Antilles Current is not a continuous flow along the Bahamas and Antilles Island chain, it appeared more as an eddy field along the Bahamas-Antilles arc rather than as a continuous jet (Gun and Watts 1982, Lee *et al.* 1996). A recent study on seasonal variability shows a maximum northward transport in August–September; however, the seasonal component of the variability is weak (Meinen *et al.* 2019). The study finds that on average, this current is carrying 4.7 ×106 m3 of water per second northward and that this flow can vary by more than 100% from day to day (i.e. some days the flow can reverse and go southward). This variability may be the cause of the difficulties in detecting a continuous flow.

Continuing northward, as the Antilles Current joins the Florida Current at around 27°N, the Florida Current becomes the next and last northern boundary between the ABNJ and the EEZ in the WECAFC region (Domingues *et al.* 2019). The Florida current can be considered the "official" beginning of the Gulf Stream System. It is defined here as that section of the system that stretches from the Straits of Florida up to Cape Hatteras. The Florida Current receives its water from two main sources: the Loop Current and the Antilles Current (Baringer and Larsen 2001). The Loop current is the most significant of these sources and can be considered the upstream extension of the Gulf Stream System. The transport increases downstream to a maximum of about 85 Sv near Cape Hatteras. The Gulf Stream begins upstream of Cape Hatteras (35°N), where the Florida Current ceases to follow the continental shelf. The position of the Stream as it leaves the coast changes throughout the year. Noting that the Gulf Stream leaves the WECAFC region it will not be considered in this review.

In the area away from the direct influence of the waters in the ANBJ, two major currents contribute to the connectivity between organisms in the Caribbean Sea and Gulf of Mexico, namely, the Caribbean Current and the Loop Current. Noting that the ecosystem connectivity of interest is between the ABNJ and bordering EEZs in the WECAFC region, the direction of the connectivity in the region is considered poleward; therefore, the NBC and the NBCR are the upstream source of the waters reaching a particular location and influencing it, that is, the NBSLME and the eastern part of the Caribbean Large Marine Ecosystem (CLME); notwithstanding the influence that the Antilles Current can have in the northern part of the CLME. The connectivity between the ABNJ and the South East USA Large Marine Ecosystem (SEUSALME) is mostly influenced by the Gulf Stream system that may likely have more effect on the northern area outside the WECAFC region.

In general, the information provided by the different currents by which pelagic larvae are moved are usually compiled in physical oceanographic models. The use of Lagrangian particle-tracking method in conjunction with high-resolution ocean circulation model, allows estimating the passive (oceanographic) connectivity between the EEZs of coastal nations and the ABNJ (Popova *et al.* 2019). Recent advances have made possible to develop a multi-scale biophysical modeling system, based on an Individual-Based Model (IBM) and Lagrangian framework (Paris *et al.* 2013). The Connectivity Modeling System (CMS) was developed to study complex larval migrations and give probability estimates of population connectivity. The CMS can also provide a Lagrangian description of oceanic phenomena of advection, dispersion, and retention with great precision.

Migratory connectivity achieved by active swimming by marine species

Information on the migratory connectivity between marine ecosystems is achieved by regular movement of marine species from one place to another, often from breeding to feeding (non-breeding) grounds and back. On the scale of a single species or region, connectivity can be analyzed empirically through genetic testing, but for analyses on larger scales, dispersal patterns can be estimated using biophysical models that combine oceanographic data with an understanding of the biology of the stocks (Cowen *et al.* 2006, Paris *et al.* 2013).

In the late 1990s, with the use of higher resolution spatial and temporal measurements of the flow regime surrounding Barbados provided a comprehensive view of the local surface circulation (0-100 m), revealing that external forcing by NBCR played a dominant role in the near-field flow variability surrounding the island. The study by Cowen *et al.* (2003) on the interaction of NBCR with coastal flow dynamics and the biological response of the system was measured by recruitment of coral reef fishes. The study showed that the flow direction and associated residence time in the vicinity of the island appeared to vary depending on the orientation of the NBCR as they collided with the island. During some of the events, larval fishes appeared to be rapidly advected away, resulting in a failure of larval settlement, whereas under other conditions larval retention was enhanced and was followed by a settlement pulse. In other observations, where the depth of chlorophyll_a (Chl a) maximum was influenced by NBCR, changes were observed in the vertical distribution of fish larvae affecting their growth and survival rates, and ultimately their recruitment success. They concluded that the overall results demonstrate that NBCR interfere with the island-scale flow dynamics around Barbados and add considerable variability in the local recruitment signal of coral reef fishes.

Another study on linking spawning aggregations of red hind (*Epinephelus guttatus*) to oceanographic processes in the Eastern Caribbean indicated that the timing of red hind spawning aggregations was synchronized across large spatial scales, based on similar oceanographic features (Nemeth *et al.* 2008). The study revealed that changes in the lunar cycles and seasonal declines in seawater temperatures and current speeds appear to initiate migration and synchronize arrival of red hind to the spawning aggregation sites. Resulting in spawning over brief periods between December and the end of February when annual seawater temperature and current speed reach their minimum. It appeared that due to the presence of slower across-shelf currents in all sites analyzed in Nemeth *et al.* 2008, it was suggested that it might be an indication that maximizes retention of eggs and larvae and therefore enhance self-recruitment at the three sites. The locations of these red hind spawning aggregations are in the vicinity of the Anegada passage and the passages of the Leeward islands, by which a second inflow of freshwater into the Caribbean Sea is partly provided by NBCR, which stall and decay east of the Lesser Antilles, and partly by the North Equatorial Current, which advects water westward (Cherubin and Richardson 2007). Hence, the next questions would be: How much of that influx of freshwater that occurs before or at the time of the spawning aggregations of red hind on those sites is responsible for the slower across-shelf currents that enhances self-recruitment? And would that influx of freshwater have any influence in larval retention, growth and survival, in a similar way as it did around Barbados? Questions like these are what science needs to address to better understand connectivity over a broader scale.

However, efforts have been made within the Wider Caribbean, like that of Cowen *et al.* (2006) who modeled the connectivity of reef fish species using an individual-based modeling of dispersing larvae in a hydrodynamic field replicating five years of history in the Caribbean, and with coral reef habitat identified as 260 nodes (10 x 50 km) in the region. The study noted the variation across the region, but overall, the high levels of self-recruitment, and demographically meaningful immigration was effectively limited to distances less than 100 km. On average, about 21% of recruiting larvae came from within the node, and recruitment from more than 100 km away was marginal.

Other research studies have indicated the need to consider vertical distribution of nutrients, salinity and temperature when developing hydrodynamic oceanographic models for predicting reef fish larval dispersal and connectivity of Caribbean coral reefs, especially in strongly vertically stratified waters. It was found that pelagic surgeonfish (Acanthuridae) larvae are capable of significant offshore dispersal, probably in association with the NBCRs that typically pass northward along the eastern edge of the Lesser Antilles (Oxenford *et al.* 2008). This study showed accumulations of surgeonfish larvae deeper

(100-150 m) than previously known, and coincident with, or slightly above, the depth of the chlorophyll_a maximum and a high-salinity layer.

Generally, fish larvae and juveniles reside in the epipelagic zone (0-200 m), where planktonic food occurs at concentrations acceptable for fast-growing fishes with discrete movement capability (Fuiman and Wegner 2002, Houde 2009). As larval fish grow and detection probability by epipelagic predators increases, individuals will descend to meso and bathypelagic depths, or in the case of deep-demersal species even to the seafloor. Recent data suggest that occupation of multiple depth zones by large pelagic fishes is much more widespread than previously thought (e.g. Whale shark-1 200 m; Bluefin tuna-1 000 m, Swordfish-900 m). Some wide vertical distributions result from active vertical movements away from a center of distribution, either upwards or downwards, while others appear to simply result from tolerance of a wide range of environmental conditions (probably like the surgeonfish example). In the case of the pelagic species mentioned above, which are to be considered primarily epipelagic specimens, they represent examples of active downward fluxes. Likewise, if the center of distribution of mesopelagic fishes is between 200 and 1 000 m, most species will likely occur between these depths during daylight, then their nocturnal migration would be considered an upward active flux into the epipelagic zone.

Therefore, the connectivity of both active fluxes is for feeding, suggesting that the deep pelagic zone is a fundamental element of the ecology of many large epipelagic fishes (like several of the straddling species reviewed in Section 4), and the epipelagic zone is certainly integral to the ecology of nearly all mesopelagic fishes. A recent study in the tropical South Atlantic (Ascension Island offshore waters) showed that several top pelagic predators, like Swordfish, Bigeye tuna and Blue shark make extensive use of the epipelagic and mesopelagic biomes; while other pelagic predators, like Tiger shark, Oceanic whitetip shark, Yellowfin tuna, and Wahoo, can make limited use of the mesopelagic biome (Madigan *et al.* 2021). Consequently, it appears that there is considerable vertical connectivity between the species in the epipelagic and mesopelagic biomes by an active (migration) and passive (ontogenetic descent, and/or oceanographic processes) movement. Aspects that need consideration when reviewing the ecological connectivity between the EZZs of the WECAFC region and the ABNJ, particularly if much of that connectivity is linked to straddling and highly migratory species that has important commercial and food security value to the countries of the region.

Fisheries are typically managed at the scale of national EEZs; however, many fish populations are connected beyond EEZ boundaries (Popova *et al.* 2019). Generally, pelagic species can be tracked across international borders as adults (e.g. Block *et al*. 2005, Luckhurst 2007). In the WECAFC region, the straddling species would likely represent a good example of migratory connectivity of adult species between the ABNJ and the EEZ´s in the region.

Information from Section 4 on straddling species geographical distribution and catch areas were used to map the distribution and/or movement of the most relevant straddling species in the western central

Atlantic within the WECAFC region (**Figures 6.4, 6.5, 6.6**). It is evident that the tuna, billfishes, and other large pelagic resources are distributed throughout the WECAFC region; and span within the ABNJ and the EEZ's of all countries in the region. It is also noticeable that most of the major tuna catches are distributed across the southeastern Caribbean Sea and along the northern part of South America up to the lesser Antilles covering several EEZ´s and parts of the ABNJ (**Figure 6.4**). In contrast, major billfish catches are distributed in the southern part of the region (FAO area 41), in the central and eastern Caribbean and east of the Lesser Antilles, and in the GOM and northern part of the region (**Figure 6.5**). While the three large pelagic species are mostly caught in the central and eastern Caribbean and east of the Lesser Antilles including in the vicinity of the ABNJ; notwithstanding, the presence of important localized areas across the region for individual species, with the exception off Brazil (**Figure 6.6**). Most of these species undertake much of their life-cycle within the WECAFC region and beyond into the ABNJ (within and outside WECAFC region), migrating between spawning and feeding grounds, for example Yellowfin tuna, Albacore tuna (ICCAT 2006-2016, Arocha 2020), Swordfish (ICCAT 2006-2016, Arocha 2007), Atlantic white marlin (ICCAT 2006-2016), Atlantic sailfish (ICCAT 2006-2016, Mourato *et al.* 2018), and dolphinfish (Merten *et al.* 2016, Schlenker *et al.* 2021).

The major tunas, billfishes and large pelagics, like Common dolphinfish and Blackfin tuna, are an important resource for many people regionally, both as a food source with nutritional importance, and as an important economic income (Guillotreau *et al.* 2017, Oxenford and Monnereau 2018). This is particularly the case in several developing countries and SIDS throughout the Caribbean Sea and NBSLME, where tuna (and other large pelagic fishes) fishing provides food, employment and income for artisanal fishers, as well as commercial and recreational fishers (Gentner 2016, Gentner and Whitehead 2018). The presence of these large pelagic fishes also presents the potential for growth in terms of recreational fisheries. Several developing countries in the area have recognized recreational fisheries as a growing industry with the potential to contribute to economic growth, especially with regards to the associated growth of local tourism (CRFM 2016).

Larval connectivity patterns have been analyzed at both the regional (Cowen and Sponaugle 2009) and global levels and have been used to suggest changes for spatial management and conservation (O'Leary and Roberts 2018). However, studies of demographic connectivity have largely focused on species with short pelagic larval duration, like reef fishes, that have a pelagic larval state and a demersal settlement, and on invertebrates (e.g. queen conch) that have also a pelagic larval state but a benthic settlement (Grober and Keller 2008). Demographic connectivity among distant populations between distant marine ecosystems is undetectable given current tagging methods and genetic techniques, which undermines our understanding of connectivity at the larger spatial scales for the management of important fishery resources (e.g., tunas, billfishes, large pelagic fishes, and lobster).

In the case of the Caribbean spiny lobster (*Panulirus argus*), with a long pelagic larval duration time (5-9 months), that matures in the open sea engaging in diurnal and vertical ontogenetic migration during dispersal before returning to coastal nursery areas (Yeung and Lee 2002); Caribbean spiny lobster larval connectivity and dispersal pathways throughout the Caribbean were identified by using multi-scale biophysical modeling techniques coupled with empirical estimates of larval behavior and gamete production (Kough *et al*. 2013). The study was able to predict and empirically verify spatio-temporal patterns of larval supply and describe the Caribbean-wide pattern of larval connectivity for the Caribbean spiny lobster.

However, demographic connectivity between distant marine ecosystems of large pelagic fishes (like straddling species) have not been explored in a similar way as for the Caribbean spiny lobster (Kough *et al.* 2013). The migratory connectivity of large pelagic fishes has been based on inferences of the biology and ecology of the spawning population and its connection to the oceanographic processes and conditions occurring on the spawning grounds (i.e. Serafy *et al.* 2003, Luckhurst and Arocha 2016, Duncan 2017). The available information on some large pelagic fishes spawning grounds (with presence of larval fish) located in the boundaries of several EEZs and the ABNJ of the WECAFC region would warrant future studies with similar tools (multi-scale biophysical modeling techniques coupled with empirical estimates of larval behavior and gamete production), like the one used for species with long pelagic larval duration (e.g. Caribbean spiny lobster). Given the prior knowledge on spawning adults and larval concentration of Albacore tuna, Swordfish, Atlantic blue marlin, and Atlantic white marlin occuring within the boundary of EEZs and the ABN; that pre-juvenile or young of the year (YOY) of most those species inhabit specific areas within the WECAFC region before migrating outside the region as adult fish to feed on more productive waters and noting that a connection exists between these two distant marine ecosystems. The likely use of high resolution, three-dimensional oceanographic circulation models and larval behavior can contribute to understand the migration connectivity between larval areas and YOY nursery areas of those species in the WECAFC region. Presently, the connection is evident, but is undefined how it works and how it affects the countries in the region.

Ecological connectivity between distant marine ecosystems can also be explored as the dependance of coastal nations on their neighbors for recruitment. That is, the risk of losing part of their catch if the fisheries in the source EEZs outside their jurisdiction are poorly managed. A recent study examined the international connectivity of more than 700 species by building a global network of fish larval dispersal (Ramesh *et al.* 2019). The study combined oceanographic and life history data of commercially harvested fish to estimate their connectivity across several hundred (249) EEZs and constructed a network representing the larval flows between nations. Economic risks were quantified, and regional “hotspots” of risk were identified for catch, fishery employment, and food security. The study showed that for the area called the Caribbean (from the southern WECAFC region limit through to northern Cuba 24°N), the NBC flows northwestward along the South American coast, and consequently many of the EEZs lying along this current act as sources for the Lesser Antilles (**Figure 6.3**). Within the Lesser Antilles, the density of small EEZs gives rise to a highly interconnected, complex network structure (**Figure 6.7**). The effect of the northward flow along this island chain can be inferred from the larger node sizes among the EEZs lying in its southern portion. The study showed that the most vulnerable countries that depend the most on the spawning grounds of neighbors in terms of their total catch, gross domestic product (GDP), number of jobs in the fishery industry, and a fishery food security dependence index are concentrated in the hotspot area of the Caribbean islands (Ramesh *et al.* 2019). In summary, the study highlights the role of larval connectivity across international boundaries and the need for multilateral cooperation for sustainable management of shared resources. Nonetheless, the role of adult fish migration in driving international connectivity remains unclear.

The straddling species included in this review cross many EEZ boundaries and move into ABNJ (ICCAT 2006-2016). As such, there is the need to increase efforts across the WECAFC region to collect and report fishery data on these straddling species to the responsible RFMO and other RFB can contribute to reduce the uncertainties on stock assessments and will increase multilateral cooperation for the sustainable management of these shared resources.

7. DISCUSSION AND CONCLUSIONS

Fisheries targeting resources that straddle political boundaries are likely to complicate fisheries management and potentially reduce the effectiveness of policies to achieve conservation and sustainability objectives. Therefore, having an accurate understanding of the distribution and scale of transboundary and straddling fish stocks as well as associated fisheries is important to apprise their sustainable management.

This review shows that shared fisheries in the WECAFC region involve fish that are caught in waters of more than one country and in the high seas. These shared fisheries are economically and biologically significant, making their management and conservation a priority for the sustainability of region's fisheries (Acosta *et al.* 2020).

In the review of the species, 38 were classified as transboundary and 31 as straddling/highly migratory species. Within the group of species that were classified as transboundary, one species that is very important to the region, the queen conch, appears that its classification into a transboundary species is not supported by current research in the region. A couple of studies on the potential replenishment of nursery areas in the Mexican Caribbean and the southern GOM and its connection to the Florida Keys have proven that is weak (Delgado *et al.* 2008, Paris *et al*. 2008). One study showed that the small fraction of larval dispersal of queen conch reaching the Florida Keys might not be sufficient to replenish downstream populations. However, there are other areas in the Caribbean where queen conch is commonly fished and no known studies on the connectivity of larval dispersal are known to science. For example, the potential connectivity between queen conch in the Antillean Islands and that of the populations off Jamaica and Nicaragua; are these concentrations of queen conch selfsustained or a connectivity between them exists? The possibility that due to the nature of queen conch larvae, ocean currents could cause panmixis over relatively large spatial scales and prevent isolation of populations continues to be an option. It is evident that queen conch has been severely over-exploited in the region for centuries, thus it is likely that due to this exploitation the potential panmixis has been reduced over time. Nonetheless, queen conch in the Caribbean should be considered a shared stock with transboundary issues, if not a transboundary species.

The rest of the species classified as transboundary show no relevant discrepancies. One characteristic is that several groups of species show clear relevance within and between the LMEs in the region. The spiny lobster is widely distributed and exploited across all LMEs in the region. Although, the population off Yucatan in the GOM appears to be undefined. It is evident that management of the Caribbean spiny lobster will require cooperation of all countries exploiting the resource.

The group of groundfish stocks is most intensively exploited in the NBSLME and parts of the southern coast of the CLME, with the exception of the Whitemouth croaker (*Micropogonias furnieri*) that is widely distributed in the coastal areas of the southern GMLME, CLME, and NBSLME. Management effort would likely be focused in this area by countries that share these transboundary stocks.

The transboundary species of reef and slope species selected in this review include some critically overexploited and endangered species that are shared by several countries in the region. Of the eleven reef and slope species selected, five are distributed across all EEZs of the region, while the rest are limited to two or three LMEs. Noting that many of this species aggregate to spawn, the need to protect these spawning aggregations is critical for the conservation and sustainability of these resources in the region. Therefore, all effort to support the Regional Fish Spawning Aggregation Fishery Management Plan for the WECAFC region should be a priority for these stocks.

The transboundary stocks of shelf shrimps can be separated into two groups, those corresponding to the GMLME and SEUSALME, and those of the CLME and NBSLME, with a couple of species that are broadly distributed across all LMEs of the region (Redspotted shrimp, *Farfantepenaues brasiliensis* and Atlantic seabob, *Xiphopenaeus kroyeri*). Although classified as transboundary species, in most cases these stocks are managed as stock units by individual countries across the region and not as shared stocks. However, some recent progress has been made in looking at the possibility of collaborating over some shared stocks between countries operating in the NBSLME that exploit these southern stocks. Even though, some countries have established individual management actions for specific stocks. More advances are needed for species specific reporting to enhance future collaboration in the conservation and sustainability of these shrimp resources in the area.

The four pelagic fish species classified as transboundary species are under the mandate of the only Regional Fishery Management Organization operating in the region (ICCAT) and are to be reviewed and assessed by the Small Tuna Species Working Group. However, due to data limitations ICCAT has not been able to conduct any formal assessments on any of these species. Responsibility lies on ICCAT member states to provide catch and effort data regularly and contribute with the biological information necessary for the assessments. Noting that two species (King mackerel, *Scomberomorus cavalla* and Serra Spanish mackerel, *Scomberomorus brasiliensis*) are of great importance to many countries in the region, regional ICCAT members and non-ICCAT members should be encouraged to make efforts to report catch and effort data to ICCAT, with the aim of supporting regional ICCAT members in their efforts to conduct formal stock assessments of these shared resources to contribute to CMM region wide.

Of the seven transboundary shark species, only one (Blacktip shark, *Carcharhinus limbatus*) is distributed across all the EEZs of the region and is probably one of the most heavily fished. One of the major issues associated to these elasmobranchs is the misidentification of shark species in the catches, with few exceptions like in the case of small coastal hammerhead sharks (Smalleye hammerhead, *Sphyrna tudes* and Bonnethead shark, *Sphyrna tiburo*) where they are commonly fished and relatively easily identified. Most of the shark species are landed dressed at sea and grouped, this practice hinders proper identification and reporting of the catches. The review showed that most of the shark catches come from multi-specific fisheries and SSF off the NBSLME and southern coasts of the CLME, except for *S. tiburo* that seems to be more common in the GMLME. Noting that small individuals of several shark species are common in areas of the NBSLME, the potential of that area being a nursery area for some shark species is high, and thus the need for enhanced efforts in identifying which species may be using the area as nursing grounds becomes a critical issue in the conservation of shark species in the region.

Of the 31 species classified as straddling/highly migratory stocks, two are not under the mandate of the only Regional Fishery Management Organization operating in the western central Atlantic (ICCAT), the Fourwing flyingfish, *Hirundichthys affinis* and the Common dolphinfish, *Coryphaena hippurus*. The flyingfish species complex that consists of mainly *Hirundichthys affinis* is mostly caught at the boundary between the high seas in the Atlantic EEZs waters of the southeastern Caribbean islands. The fishery for this species complex is localized within the WECAFC region but supports several island's social, economic, and traditional values. It is considered to be managed under the CRFM. In contrast, the Common dolphinfish, which in some cases is also mixed with the Pompano dolphinfish, *Coryphaena equiselis*, is widely distributed across the region, targeted by many countries, is also part of the commercial bycatch of the tuna fisheries in the region. For a brief period in recent years, and under the petition of ICCAT's SCRS, the Common dolphinfish was placed under ICCAT's species of interest and efforts were made to create and construct historical catch and effort data sets for the species. Several countries in the region contributed to that data set that made possible the fisheries mapping for Common dolphinfish provided in this review. Noting that as of 2021, the Common dolphinfish was dropped out of ICCAT's species of interest and is not under ICCAT's mandate, it would be in the region's best interest to build on the existing regional data base in ICCAT for future regional assessment to ensure the conservation and management of a highly important pelagic resource like the Common dolphinfish in the WECAFC region.

Within the straddling stocks of the region that are under ICCAT's mandate, two species are of particular interest in the region's SSF pelagic fisheries and are not fully assessed by ICCAT: Blackfin tuna (*Thunnus atlanticus*) and Wahoo (*Acanthocybium solandri*). These two stocks are under the responsibility of the SCRS's Small Tuna Species Working Group and the scientists of the member countries. Therefore, if interested parties have provided data to revise the state of the stocks, it is within this working group that a decision to conduct a stock assessment is considered based on the data available to the working group. It is in the benefit of the region's member countries with interest in these two species or any other species under ICCAT's mandate that are not regularly assessed, to contribute with the minimum data requirements by ICCAT to help regional ICCAT members to request the needed data review and potential assessments in species of interest to all members in the WECAFC region. Without the regional input in ICCAT scientific meetings, it would be unlikely that specific assessments would be conducted.

Of the all the species that appear in the WECAFC Reference list of aquatic species presented in the iDCRF (Version 2021.0.7, Appendix 3.1), a group of 26 fish and crustacean species that were considered as "High Seas and Deep Sea species falling under a possible mandate of WECAFC as a Regional Fisheries Management Entity or Arrangement (RFME/RFMA)" were not included in the present review due to several factors, the most relevant was the limited reported catches in the FAO catch statistics, with few exceptions like in the USA and Mexico for the Vermelion snapper (*Rhomboplites aurorubens*), which can be considered transboundary. The rest of the species were either grouped with other species or have not been reported. It becomes important that if any of the species listed in this group are to be the focus of a Regional Fisheries Management Entity or Arrangement in the WECAFC region, efforts should be maximized by nations targeting (like Vermelion snapper) or willing to exploit any of the fish resources listed to record and collect fishery data for future CMM.

Data describing fisheries (what, where and how much is caught, and how fisheries are conducted including effort by gear type) is the fundamental underpinning of fishery management. Such data is needed for scientific assessments of the state of fish stocks and to estimate sustainable yields. The present review showed that information on reported catches and fishing effort across the region's fisheries is unbalanced, incomplete and outdated. Regardless of the country's development status, the level of fishery data relevant to the WECAFC region is incomplete at least. The most notorious is the limited information on basic fishing effort data, i.e. fleet characteristics, number of vessels dedicated to an important fishery, number of fishers, gear type by fleet(s), among other issues.

The review of the most recent reported catches (2015-2019) by countries showed two outstanding issues; the first, in species-specific reported catches there were discrepancies between those reported to FAO and those reported in other official databases (National or ICCAT) for the same species and year. The second was the use of carry-over catch values over several years in some species-specific reported catches. There are other specific issues noted, like the reporting of catches for the same species by overseas territories in the WECAFC region and the country that oversees those territories, which raises the question if double reporting is occurring. Another issue is the claim of member country that no pelagic fishing is occurring in its Caribbean waters, yet catches are reported of such species being caught in the Caribbean, which raises the question if those catches are misreported from other oceans. These types of misreporting will have unwanted effects in the catch matrix for a given species when trying to conduct a stock assessment, and members should make its best effort to review and update them accordingly.

Regarding the basic information on fishing effort, it was clear that in least developed countries with large coastal areas and multiple fisheries, the information on fishing effort is limited, aggregated and most of the time not up to date with very few exceptions. In contrast, countries with small and limited coastal areas tend to be more organized. Nonetheless, in either case the fishing effort information is limited and unbalanced at best. It became also evident that relatively complete and detailed fishing effort information is available from fisheries targeting most of the straddling stocks reviewed that is reported by WECAFC member countries to ICCAT, either because they are ICCAT members (Contracting Parties and Cooperating Non-Contracting Parties) and by non-member countries that abide by the United Nations Fish Stocks Agreement. This information made it possible to produce detailed fishery maps specifically for the WECAFC region. The limited information on catch and effort data in the region is due to the absence of a regional Data Collection Reference Framework. The 17th WECACFC session convened in 2019 adopted a recommendation on the iDCRF, which would be the first instrument to establish the foundation for comprehensive fisheries data and statistics collection in the WECAFC region. This is an ongoing process that may take years to put in place. Efforts should be made to develop a basic and simple structure in order to capture the needed basic information across the region for the main species of interest that need constant monitoring, surveillance, and compliance to effectively manage those fishery resources.

Noting that most countries in the region are targeting or have interest in expanding their large pelagic fisheries towards tuna species and or tuna-like species. It would be in their best interest to get involved in the ICCAT process for reviewing the state of a resource that is under its mandate. The process would basically involve the participation of national scientists to the Species Working Group meetings where fishery data is revised and updated, and relevant biological and ecological information for a species of interest are discussed and updated in order to move towards the analysis of the state of a particular stock. This would be a starting point in getting regional scientists from WECAFC countries involved in the stock assessment process in the immediate future.

The ecological connectivity between the high seas and the region’s EEZs is largely dominated upstream by the NBC and NBCR and by the NEC downstream which seem to have inferred influence in some of the straddling stocks (tuna and tuna-like species) exploited in the region. Without direct empirical evidence on this potential connectivity between the two distant ecosystems it precludes any assertion that poor management around the boundary of either side of the ecosystems will result in the loss of catches downstream (i.e. within the WECAFC region). However, the results of the study by Ramesh *et al.* (2019) revealed that that the most vulnerable countries that depend the most on the spawning grounds of neighbors are concentrated in the Caribbean islands; although the study did not specify the species that were responsible for that effect in the Caribbean region.

Concluding remarks

1. 69 species have been examined: one mollusk, nine crustaceans, six groundfish species, 11 reef and slope fish species, 23 pelagic species, and 19 elasmobranch species. 38 were classified as transboundary and 31 as straddling/highly migratory. Only one, the queen conch, appears to have transboundary issues and its classification as a transboundary species remains unclear.
2. Fisheries mapping by species with spatial distribution information on fishing effort and catch by gear type was possible for most of the straddling/highly migratory stocks that are targeted or part of the commercial bycatch from the tuna fisheries operating in the WECAFC region. The fisheries mapping information for the transboundary species was possible only for the spatial distribution of catch areas. Large-scale spatial effort data for the transboundary species reviewed is very limited in the WECAFC region.
3. The absence of a regional DCRF for the WECAFC region represents a handicap when evaluating the state of the stocks at the regional level. For several stocks, mostly transboundary, localized fishery information may be available to conduct stock assessments but for most straddling/highly migratory stocks (whether under ICCAT or not) is not sufficient. For several straddling/highly migratory stocks in region, the limited information of fishery data has had an adverse effect in some of the stock assessments results for species of interest in the region (e.g. marlin species).
4. Data on social and economic aspects of fisheries is rarely collected in a systematic and comprehensive manner in the region. Effort to address the issue of social and economic data collection is under development by the iDCRF for which specific tasks are defined, along with the characterization of the scale of fishing units for the characterization of Small Scale Fisheries to assist national/regional management, which is led by FAO Coordinating Working Party on Fishery Statistics (CPW-IS/2019/11). The approach uses a matrix scoring approach to address the multi-character complexity and inter-regional diversity of small-scale fishing operations. Several countries in the WECAFC region have conducted survey trials in some of their fisheries with interesting results. The use of this instrument for valuable regional resources would provide benefits towards policy development as well as providing a common framework of inter-comparability of fishing units between countries and regions. It would also enable greater clarity and objectivity over the scope of management or policy measures that are applied to large or small scale fishing units.
5. Stock status of the straddling/highly migratory stocks that were reviewed indicated that flying fish is not overfished; of the major tunas, only one stock is overfished (Bigeye tuna); of the

tuna-like species Atlantic blue marlin and Atlantic white marlin are under strict conservation and recovery measures; and the stock status of two spearfishes and dolphinfish are unknown. Of the elasmobranch species caught by tuna fisheries, Shortfin mako is overfished and experiencing overfishing. The rest are in a relatively stable condition; although there are several recommendations to reduce fishing mortality on several oceanic shark species.

6. The ecological connectivity between the high seas and the region's EEZs is largely dominated upstream by the NBC system and the NEC downstream, these two major currents are largely responsible for the connection of the straddling/highly migratory stocks (tuna and tuna-like species) exploited in the region. However, for some transboundary species is less evident. Although, for slope stocks in the NBSLME, and reef stocks in the eastern CLME the possibility of a connection may exist, but no empirical studies are available to discern that possibility.
7. The information presented in this review will serve as the basis for an actionable process for helping the decisions that will require the transformation process of WECAFC into a Regional Fisheries Management Entity or Arrangement in the region. There are several ways that an actionable process can be approached that would help the decisions that need to be addressed by WECAFC. Some of them are highlighted in Appendix A as reference.

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APENDIX A.

FUTURE CONSIDERATIONS

From the ensuing discussions during the first WECAFC preparatory meeting for the transformation into a RFMO there appeared to be a general agreement on the creation of an entity/arrangement having a mandate within the ABNJ, and a possible extension to stocks within the EEZ of the coastal states concerned. The approach would be short, medium and long term, starting with the ABNJ where binding measures can be implemented, and perhaps including as well selected straddling and transboundary stocks, or highly migratory stocks within the EEZ without prejudice of the sovereign rights of WECAFC Members.

The present review revealed that most of the economically important and food security resources within the ABNJ of the WECAFC region for which there are directed fisheries are straddling/highly migratory stocks under the mandate of the existing Regional Fisheries Management Organization in the region (ICCAT), except for two species, flyingfish and the Common dolphinfish. In the case of transboundary stocks, the review showed that most of them occur within the EEZs of neighboring states.

In the case of the straddling/highly migratory stocks not under the ICCAT mandate (Flyingfish and Dolphinfish), the Fourwing flyingfish (*Hirundichthys affinis*) resource exploitation is mostly limited to an area that is under a Regional Advisory Body (CRFM) that can contribute in moving forward with biding CMMs among coastal states that target the resource in the area of interest. However, there may be other elements that may affect the stock status of the Fourwing flyingfish resource in the area that may not be attributed to fishing mortality, but rather to environmental variations in their critical habitat. Considering Fourwing flyingfish prefer floating objects to spawn, there is the lack of knowledge weather the Sargassum influx into the fishing areas have an adverse effect on future recruitment, nor if there is a strong existing connectivity between the Sargassum and the population dynamics of the Fourwing flyingfish. Therefore, to understand the ecosystem-level impacts of pelagic Sargassum in the population dynamics of numerous species (possibly including Fourwing flyingfish) that depend upon it as habitat is mostly addressed at a broad regional level.

Common dolphinfish (*C. hippurus*) is a straddling/highly migratory stock widely fished across the region by commercial (SSF, semi-industrial, and industrial) and recreational fisheries. It would be an excellent candidate to explore region-wide CMM, noting that dolphinfish in the WECAFC region is considered a single panmictic population. Therefore, it would require that states take the necessary measures to collect, record and report the necessary fishery statistics to a regional entity with a regional mandate that would analyze and report on the stock status of dolphinfish region wide.

Almost all the transboundary species reviewed are shared resources within the EEZ of several neighboring states apparent regional patterns. Shelf shrimps and groundfish resources in the southern part of the WECAFC region, which includes the Gulf of Paria (with similar ecosystem characteristics to the NBSLME) and the NBSLME, are shared by six states that are responsible for the collection and reporting fishery statistics to determine stock status of several species caught by the fisheries operating in the area. Not having clear stock definition/delimitation of the species of interest would not guarantee the health of the shared stocks regardless of state-specific CMMs. In addition to the need to estimate unbiased indices of abundance for the species of interest.

The transboundary species in the northern part of WECAFC are shared stocks within two neighboring states. For northern shelf shrimp stocks, most are managed as state specific stock units.

However, transboundary species within the group of reef and slope species (groupers and snappers) would require defining a series of indicators that would help the discrimination of stock units for each species of interest. For these stocks there appear to be sub-areas of groups of reef and slope species that would require clear stock definition/delimitation. There is the group of species in the northern and eastern GOM and southeastern USA managed as stock units by the USA. Another subarea is off the Yucatan Peninsula and the western Caribbean (the Mesoamerican reef area and the Nicaragua shelf area). A better understanding of the connectivity between different subareas of the western Caribbean LME and Yucatan Peninsula would be required. This can provide a better understanding of stock definition/delimitation of the species of interest to guarantee the health of the shared stocks in cooperation with state-specific CMMs. Similarly, another subarea that require similar studies would be the Caribbean Islands (Greater and Lesser Antilles). Finally, the slope resources of the NBSLME would also require similar studies, but it would likely need to be extended to the Lesser Antilles and the southern Caribbean as reef and slope resources in those two subareas are downstream of the major ocean currents that are responsible for the connection of several stocks in the region.

A final major step would be to advance in a multiple-scale approach to enhance our understanding of the interaction between the key physical and biological processes driving the connectivity and/or isolation between habitats and populations of key species or groups of species in the region. The effort would require validated biophysical models that consider ocean circulation and larval dispersal.

Deep-sea fishing in the ABNJ of the WECAFC region is very limited. Seven years have passed since the first meeting of the Working Group on the Management of Deep- sea fisheries of the Western Central Atlantic Fishery Commission (FAO WECAFC 2015). The compiled available information on the high seas fisheries in the WECAFC area noted that deep-sea fisheries in the High Seas had been and were occurring, and that they were likely to increase in the future. However, it was noted that there were few deep-sea fisheries being undertaken by the countries represented at the workshop, and the deep-sea fisheries known to occur were normally an extension of shallower-water fisheries into deeper waters, typically within the EEZ of the country operating them.

In 2016 WECAFC issued a recommendation "On the management of deep-sea fisheries in the high seas" (Recommendation WECAFC/16/2016/4) that, among other issues, asked members to develop data and information collection programmes and research projects to assess current practice and scope for socially and economically viable and ecologically sustainable investments in Deep Sea Fisheries in the WECAFC mandate area; also asked members and non-members of WECAFC involved in experimental, exploratory and established Deep Sea Fisheries in the high seas of the WECAFC area to report annually to the WECAFC Secretariat on their activities; and also asked members and non-members of WECAFC submit to the WECAFC Secretariat any plans to engage in Deep Sea Fisheries, including exploratory fishing and/or research on deep-sea resources, in the high seas areas of the WECAFC area prior to implementation (FAO WECAFC 2016).

Presently, no published literature nor reports indicate the existence of deep-sea fishing operations in the ABNJ area of WECAFC in the past decade. The available published information showed that there were deep-sea fishing operations targeting Alfonsino (*Beryx splendens*, *B. decadactylus*), a species common in temperate and sub-tropical, in FAO area 31 and 41 during the late 1990s and mid 2000 by a couple of foreign fleets (FAO WECAFC 2014, Shotton 2016). It seems that those catches were made during the same time around Corner Rise Seamounts which are located at the northern limit of the WECAFC region and overlapping with FAO area 21 (Shotton 2016).

Potential deep-sea fishing in the ABNJ of the WECAFC region is likely to be conducted by bottom and mid-water trawl, and squid jigger fleets. Available published information reveals that bottom trawl fishing in the WECAFC region is limited mainly to the USA and French Guyana EEZs, based on Automatic Identification System (AIS) data and Global Fishing Watch (GFW) algorithms (Kroodsma et al., 2018); although there are other nations operating bottom trawls within their EEZs, but not recorded by AIS in the WECAFC region (Arrizabalaga et al. 2019a). There are operations of squid jigger fleets in FAO area 41, but its operations appear to be outside WECAFC (Arrizabalaga et al. 2019b). A recent study on the economics of fishing in the high seas showed that most of the fishing effort by gear type likely operating in deep-sea fisheries (i.e. Trawlers and squid jiggers) is outside the WECAFC region (Sala et al. 2018). Some squid jigging experimental fishery was conducted in Grenada with poor results due to high costs of fishing gear and limited market (Anon. 2009), no other off-shore/high-seas squid jigging experimental or commercial fishery are known for the WECAFC region in the past decade.

There were several vulnerable marine ecosystems (VMEs) identified in the first meeting of the Working Group on the Management of Deep-sea fisheries of the Western Central Atlantic Fishery Commission were included in WECAFC recommendation "On the management of deep-sea fisheries in the high seas". It appears that a way forward in all aspects of deep-sea fisheries in the ABNJ of the WECAFC region would be to act on the Commission's recommendation (WECAFC/16/2016/4) which would likely be possible if there are bidding agreements on Conservation and Management Measures only possible through a Regional Fisheries Management Organization.

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MAPS & FIGURES (see separate file)