State of the Marine Environment and associated Economies in the CLME+ region (CLME+SOMEE)

General State of Selected Marine Fish and Shellfish Status and Associated Economies

FINAL REPORT

By: FREDDY AROCHA, Ph.D.

December 2019

TABLE OF CONTENTS

1. Introduction

The marine fish and shellfish resources selected in these sections which include highly migratory fish species, small pelagic fish species, Penaeid shrimps and coastal fish species occupying various substrata (soft bottom and/or reefs), are described in detail because they correspond to stocks that have a high regional importance.

The selected resources are predominantly caught by pelagic fisheries, soft-bottom fisheries, and by hard-bottom fisheries that operate in the region. Therefore, the resources caught by pelagic fisheries which can be categorized as coastal and oceanic fish species, will be reviewed under the pelagic fisheries section. Subsequently, the resources caught by soft-bottom fisheries within the continental shelf that inhabit mudflats off and around river deltas, like those encountered in the North Brazil shelf LME (NBSLME), will be reviewed under the section on soft-bottom fisheries. Finally, the fin-fish resources that inhabit hard-bottom substrates which are mostly associated to coral reefs and are targeted by local fisheries will be reviewed under the section of similar name.

The reviews for the selected resources within each fishery section will include the most recent information on stock status and current exploitation trends. The information related to the associated social and economic aspects available in the published literature, the drivers and pressures that are likely causing changes in the stock and likely the marine environment, and what responses are in place region-wide to ensure responsible management of the resources and governance will be treated in general because detailed information of the fisheries treated in this review, due to its complexities, is incomplete and in most cases non-existent. Efforts were made where it was possible to present the information as specific as possible.

2. Pelagic fisheries

2.1. Highly migratory fish species

The species in this group are distributed throughout the WECAFC area. Many of the WECAFC large pelagic fisheries target stocks that are not confined to the EEZs of the countries within the region. Some of these stocks are distributed widely throughout the WECAFC area while others are distributed over the Atlantic Ocean. In many cases, only a portion of the stock will inhabit certain areas of the WECAFC area, for only a part of the time. The stocks considered in this section fall under the requirements of the UN Fish Stocks Agreement for shared, highly migratory, or straddling stocks, and therefore international cooperation is required for their management, which in this case falls under the International Commission for the Conservation of Atlantic Tunas (ICCAT) which has a mandate over tunas and tuna-like species fished throughout the Atlantic Ocean (including the Caribbean Sea and Gulf of Mexico) and the Mediterranean Sea. The primary gears used to catch highly migratory fish species in the WECAFC area include purse seine, pelagic longline and pole-and-line gear; in cases in which coastal pelagic species are targeted by coastal fisheries, drift-gillnets and hook and line associated to anchored Fish Aggregating Devices are also used as fishing gears.

2.1.1. Species of interest

The selection of species was done on the basis of major volume in landings, economic importance, and historical fish landings. The selection resulted in two species of major tunas, Yellowfin tuna (*Thunnus albacares*), Skipjack tuna (*Katsuwonus pelamis*); three species of billfish, Blue marlin (*Makaira nigricans*), Atlantic sailfish (*Istiophorus platypterus*), Swordfish, (*Xiphias gladius*); one major shark species, Blue shark (*Prionace glauca*); and four species of small tunas (ICCAT 2006-2016) also considered as coastal pelagics, Blackfin tuna (*Thunnus atlanticus*), King mackerel (*Scomberomorus cavalla*), Serra-Spanish mackerel (*Scomberorus brasiliensis*), and Common dolphinfish (*Coryphaena hippurus*) (**Table 1**).

2.1.2. Geographic distribution and ecology

Yellowfin tuna (*Thunnus albacares*). Yellowfin tuna is a cosmopolitan open-water pelagic and oceanic species occurring above and below the thermocline to depths of at least 400 m. It feeds on fishes, crustaceans and squids. It is sensitive to low concentrations of oxygen and therefore, it is not usually caught below 250m 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 WECAFC area, particularly in the Caribbean Sea, Yellowfin tuna is associated with whale sharks and whales, with a certain seasonality that mainly depends of the appearance of these mammals in waters of the Caribbean Sea (Gaertner and Medina-Gaertner 1999).

Noting that the primary spawning grounds in the Atlantic occur in the Gulf of Guinea, within the WECAFC area spawning consistently takes place in the Gulf of Mexico and to a lesser extent in the southeastern Caribbean Sea (Arocha et al. 2000). Spawning occurs from May through November in the WECAFC areas of the distribution, apparently at sea surface temperatures above 24°C. The spatial-temporal distribution of active reproductive females in the Gulf of Mexico and the southeastern Caribbean Sea suggests the existence of two reproductive groups in the central area of the western Atlantic. According to Arocha et al. (2001), these groups are different in fish size and in their spawning period; in which fish smaller than 150 cm spawns in the Gulf of Mexico in the months of May to August and a second group of fish, with sizes from 150 cm to 170 cm, spawn in the Caribbean Sea in the months of July to November. The females spawn by dispersion with an average of 46 spawning events per spawning period (Arocha et al. 2000, 2001). In general terms and under a controlled environment, major spawning events occurs between 1800 hrs and 2200 hrs (Margulies et al. 2007).

Movements and recruitment information within the WECAFC area is incomplete. The available information on recruitment is limited to the intensive sampling in the US Gulf of Mexico for the collection of tuna larvae during the ichthyoplankton surveys from SEAMAP data (Brenner and McNulty 2018), where eggs and larvae, as well as juvenile fish are found in the northern/central Gulf of Mexico. However, seasonal Yellowfin tuna larvae distribution is limited. Migratory movements of Yellowfin tuna within the WECAFC area are limited to tag-recapture data, are restricted to the Gulf of Mexico and the southern Caribbean Sea, although several trajectories indicate movements from the Gulf of Mexico to the Gulf of Guinea (ICCAT 2006-2016).

Skipjack tuna (*Katsuwonus pelamis*). Skipjack tuna is another cosmopolitan open-water pelagic and oceanic species occurring in offshore waters to depths of 260 m and is normally found in highly oxygenated waters between 20°C and 30°C (ICCAT 2006-2016). Aggregations of this species, like in most tunas, tend to be associated with convergences, boundaries between cold and warm water masses, and other hydrographic discontinuities associated with their reproduction and feeding regime (Sharp 2001). Like other tunas, this species feeds on fish, crustaceans, cephalopods, and mollusks. Skipjack tuna exhibits a strong tendency to school in surface waters in association with birds, drifting objects, sharks, and whales (Gaertner and Medina-Gaertner 1999); in the WECAFC area it is commonly found in mixed schools with Yellowfin tuna (*T. albacares*), and Blackfin tuna (*T. atlanticus*). Highly migratory fish species like billfishes, large tunas, sharks, and Swordfish, prey on skipjack tuna.

Skipjack tuna is a species showing an early maturity (around first year of life), and spawns opportunistically and seasonally throughout the year in warm waters above 25º C (Cayré and Farrugio 1986; Andrade and Santos 2004), it is also considered to be a faster-maturing and shorter lived species than Yellowfin tuna (Maunder, 2001). The primary spawning grounds in the western Atlantic appear to occur in the Gulf of Mexico, southeastern Caribbean Sea, and northern Brazil (ICCAT 2006-2016). In the WECAFC area spawning consistently takes place in the Gulf of Mexico and the southeastern Caribbean Sea (Brenner and McNulty 2018; Pagavino et al. 1997). Spawning appear to occur from March/April through August/September in both of these areas based on gonad indices and egg size distributions (southeastern Caribbean Sea), and eggs and larval surveys (Gulf of Mexico). Little is known of the spawning ground north of Brazil, at the southern boundary of the WECAFC area.

The available information on recruitment, like in Yellowfin tuna, is limited to the intensive sampling in the US Gulf of Mexico for the collection of tuna larvae during the ichthyoplankton surveys from SEAMAP data (Brenner and McNulty 2018), where eggs and larvae, as well as juvenile fish are found in the northern/central Gulf of Mexico and off Florida in the U.S., in addition to juveniles occurring in the southeastern Caribbean Sea between August and October (Pagavino 1997). As in most tunas, information on migratory movements of skipjack tuna within the WECAFC area is restricted to very limited tag-recapture data (ICCAT 2006-2016). There is information of movement from off Guyana to the area between Dominica and Martinique (Rinaldo et al. 1981), and a conceptual movement model has been proposed between the Gulf of Mexico and the southeastern U.S. and the southeastern Caribbean and northern Brazil (Fontenau 2015); therefore, suggesting that there may be two movement routes in the WECAFC area, one that goes from northern Brazil into the Caribbean Sea and onto the Gulf of Mexico, and another that moves north along the Leeward Islands and to the southeastern U.S.

Blackfin tuna (*Thunnus atlanticus*). Blackfin tuna has a relatively limited range; it occurs only in the western Atlantic Ocean from Massachusetts (US) south to Rio de Janeiro (Brazil), including the Gulf of Mexico and Caribbean Sea (Collette and Nauen 1983). Occurring in oceanic waters in close proximity to the coastline, Blackfin tuna prefer clean water and warm temperatures, usually seaward from the continental shelf. It is abundant in tropical regions, during the summer months, migrating to temperate waters remaining above 21°C. It is a strongly schooling, migratory fish, often forming large mixed schools with Skipjack and Yellowfin tunas (ICCAT 2006-2016). Blackfin tuna competes directly with Skipjack tuna for prey and is occasionally preyed upon by it; various fish, squid, amphipods, shrimp, crabs, and stomatopods constitute its diet (Headley et al. 2009).

Spawning occurs in April through December, with a spawning peak in May and June, throughout the area of distribution preferring temperatures of 27°C between 10 and 35 m off Puerto Rico, where larvae have been collected and spawning fish have been analyzed (ICCAT 2006 -2016, Hare et al. 2001, Cornic and Rooker 2018).

Proposed Blackfin tuna movements in the WECAFC area (excluding the north Brazilian shelf) consists of a north-south migration between feeding areas during the first quarter of the year off Bermuda, and spawning areas off several Caribbean Islands (e.g., Cuba, Virgin Islands, Puerto Rico, and Martinique) during the second and third quarter (ICCAT 2006-2016). Movement of Blackfin tuna in the eastern Caribbean Islands has been reported from conventional tag experiments (Renton and Renton 2007), where a total of 787 Blackfin tuna released in the EEZ of St. Vincent and the Grenadines, of which 11 recaptures were reported, and 6 were at liberty for >100 d. In all cases, the distance between point of release and recapture was <100 km.

Swordfish (*Xiphias gladius*). Swordfish are considered meso-pelagic fishes widely distributed throughout tropical and temperate waters between 45° N and 45° S, and in large enclosed basins such as the Gulf of Mexico and the Caribbean Sea (Palko et al. 1981, Nakamura 1985). Unlike most tuna species, this is an oceanic species that does not form schools or dense aggregations (Ward et al 2000), but sometimes is found in coastal waters; generally, above the thermocline, preferring temperatures of 18–22°C. It is primarily a warm-water species that migrates towards temperate or cold waters for feeding in the summer and back to warm waters in winter for spawning and overwintering. Adults are opportunistic feeders, known to forage for their food from the surface to the bottom over a wide depth range (Nakamura 1985). Swordfish typically forage in deep water during the day and stay in the mixed layer at night (Abascal *et al*. 2010). Based on records of forage organisms taken by Swordfish, its depth distribution ranges normally from the surface to a depth of about 550 m but there are depth records down to 2,878 m, it feeds mainly on fishes but also on squids and crustaceans.

Swordfish in the WECAFC area spawns at different time periods in several located areas between 13°N and 35°N, correlated with sea surface temperatures (SST) of 23°-24°C in tropical and subtropical waters and the displacement of the 24°C isotherm at 50 m or deeper (Arocha 2007, Mejuto 2007, Neilson et al. 2013). Spawning grounds are located in three areas distributed in the fringe of the southwestern Sargasso Sea, the Gulf of Mexico and the Windward Passage, and the Straits of Florida and the southeastern U.S. (Arocha 2007). Swordfish are reproductively active throughout the year, but peak spawning events occurs from late December to May in the southwestern Sargasso Sea area, from late December to March in the Gulf of Mexico and the Windward Passage area, and from April through July in the Straits of Florida and the southeastern U.S. (Arocha 2007, Neilson et al. 2013).

Recruitment of juvenile Swordfish in the WECAFC area can be observed in several and persistent nursery areas, like the southern Caribbean Sea in which the majority of the catch consists of small fish (<130 cm Lower-Jaw-Fork-Length (LJFL)), as well as in the Gulf of Mexico and the Charleston Bump off the southeast coast of the U.S. (Arocha and Marcano 2005, Cramer 1996, Neilson et al. 2013). Northern and southern migratory movements have been proposed for Swordfish in the northwestern Atlantic, in which Swordfish moves between spawning nursery grounds in the tropical and subtropical areas (WECAFC area) and major feeding grounds off New England (US) and Grand Banks (Canada), based on pop-up satellite archival tag information (Neilson et al. 2009), in addition there seems to be site fidelity for adult fish in the feeding grounds (Stone 2000, Neilson et al. 2013) as well as juvenile fish in the nursery grounds in the southern Caribbean Sea (Arocha and Prince 1999, unpubl. data NOAA-SEFSC tag#SW00030) 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.

Blue marlin (*Makaira nigricans*). Blue marlin is an epipelagic oceanic species often found in wide open blue waters with surface temperatures between 22-31°C. In the Atlantic Ocean, adults are commonly found in the tropics within the 24°C isotherm spending most of its time in water temperatures of 26°C-30°C, but making dives >300 m and to temperatures of 15°C, and sometimes associated with lunar cycles in some regions of the WECAFC area (Kraus and Rooker 2007, Kraus et al. 2011), it has been suggested that the combination of light intensity and limiting oxygen levels is likely to define the range of depths utilization by this species (Goodyear et al. 2008). Like Swordfish, adults of this species do not form schools or dense aggregations, but juvenile fish tend to form aggregations (Nakamura 1985). Blue marlins are apex predators that feed near the surface and are known to feed in deeper water than other billfish. They opportunistically prey on schooling flying fishes, small tunas, common dolphinfish, and squids (Garcia de los Salmones et al. 1989, ICCAT 2006-2016).

Blue marlin is thought to spawn in the Gulf of Mexico from May to September based upon gonad development and larval occurrence (Kraus et al. 2011), but also in the Mona Passage (Dominican Republic), north of Puerto Rico, and southern Bahamas; therefore, in general terms spawning grounds are most likely located between 17°N and 32°N west of 60°W, during warm months with sea surface temperatures of 27-30°C (Arocha et al. 2012, ICCAT 2006-2016).

Recruitment information based on larval surveys reveal that it takes place in the northern Gulf of Mexico, Mona Passage (Dominican Republic), southern Bahamas, and the Straits of Florida, between the months of May through October (Rooker et al. 2012, Prince et al. 2005, Serafy et al. 2003, Richardson et al. 2009a). Migratory movements of Blue marlin in the WECAFC area can be derived from recent pop-up satellite archival tag technology and conventional tags; conventional tags show strong horizontal displacement within and between the Gulf of Mexico and southern Caribbean Sea, and between the southern Caribbean and the Straits of Florida (ICCAT 2006-2016). However, pop-up satellite archival tag technology indicates that Blue marlin show residency in the Gulf of Mexico and the western Caribbean Sea over long periods of time (Kraus et al. 2011, http://ghriresearch.org/). However, Blue marlin tagged outside the Gulf of Mexico and the Caribbean Sea (e.g., Puerto Rico, Bahamas, Bermuda) show that the majority 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.

Atlantic sailfish (*Istiophorus platypterus*). Atlantic sailfish is an epipelagic and coastal to oceanic species, often found above the thermocline. It is the least oceanic of the Atlantic billfishes, displaying a strong tendency to approach continental coasts, islands and reefs (de Sylva 1974; Nakamura 1985). In the WECAFC area, Atlantic sailfish are found in schools, at least when feeding (Kurvers et al. 2017), in "hot spots" like Isla Mujeres-Mexico from December through March (Lam et al. 2016). Atlantic sailfish in the Straits of Florida and eastern Gulf of Mexico are primarily associated with the upper surface waters within the top 20 m and around 27°C derived from pop-up satellite archival tag technology, but undertake numerous short-duration dives below the local mixed layer to depths of 50–150 m in waters of 21°-25°C (Kerstetter et al. 2012), presumably to feed. Atlantic sailfish feed on either available or abundant prey, like bait balls formed of sardine (Kurvers et al. 2017), however, due to their high prey diversity Atlantic sailfish are considered opportunistic and specialized predators (Arizmendi-Rodríguez et al. 2006).

Atlantic sailfish in the WECAFC area 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 indicated that Atlantic sailfish spawn in the Gulf of Mexico and the Florida Straits between May and September with a peak in July in the northern Gulf of Mexico. Spawning fish have been encountered in the southeast coast of Florida-USA during the summer months (de Sylva and Breder 1997), and in the southeastern Caribbean Sea between March and September with peak spawning in March and April in a localized area known as a billfish hot spot (Arocha et al. 2016). However, occasional spawning of Atlantic sailfish takes place off the North Brazil shelf LME (NBSLME) between June and October (Mourato et al. 2018).

Atlantic sailfish recruitment is based on larval surveys and point studies conducted in the northern Gulf of Mexico and the Straits of Florida (Rooker et al. 2012, Richardson et al. 2009b). This research has indicated that the northern Gulf serves as an important spawning and nursery habitat for western Atlantic sailfish. However, this may be a factor of intensive larval surveys as well as larval research. There are other areas in the Caribbean Sea (*F. Arocha-Univ. de Oriente, pers. comm.*) as well as the area off the North Brazil shelf LME (NBSLME) (around 9°45'N-59°45'W; B. Marin-Univ.de Oriente, *pers. comm.*), where Atlantic sailfish juveniles and larvae have been collected, that may contribute to Atlantic sailfish recruitment in the WECAFC area. Migratory movements of Atlantic sailfish in the WECAFC area, like most billfish species, can be derived from recent pop-up satellite archival tag technology and conventional tags (Lam et al. 2016); research revealed that Atlantic sailfish tagged off Isla Mujeres-Mexico, a known Atlantic sailfish hot spot, displayed a predominantly shelf associated activity, a site fidelity up to 5 months, and subsequent dispersals to productive areas of the Gulf of Mexico, the southeastern Caribbean Sea, and off the North Brazil shelf LME (NBSLME), as well as a strong connection between wintering (Isla Mujeres-Mexico) and reproductive (Placer de La Guaira-Venezuela) hot-spots (Lam et al. 2016, Arocha et al. 2016).

King mackerel (*Scomberomorus cavalla*). King mackerel is an epipelagic, neritic species, often found in outer reef areas, and its distribution range goes from Massachusetts-United Sates of America to Rio de Janeiro, Brazil, including the Gulf of Mexico and the Caribbean Sea, but it only inhabits subtropical areas during the warmer months (Clardy et al. 2008). In the rest of the areas, it appears to be present throughout the year, particularly, from off Louisiana and off the state of Ceará in northeastern Brazil (Strum and Salter 1989). There also seems to be some resident populations in South Florida waters, as fish are available to the recreational fishery all year.

Spawning takes place from January through September in the southwestern Gulf of Mexico, particularly in September at depths between 35 m and 180 m over the middle and outer continental shelf (Grimes et al 1990, Gledhill and Lyczkowski-Schultz 2000), peaks in July and August in the northeastern Caribbean, and in Trinidad waters spawning appears to take place all year but with peak spawning from October through March (Strum and Salter 1989). Larvae are encountered in surface waters of 26°C to 31°C (McEachran et al. 1980).

King mackerel movements appear to be restricted to localized areas of the southeastern U.S., the Gulf of Mexico with apparent mixing around Florida (Clardy et al 2008), the waters around Trinidad (Strum and Salter 1989) and northeastern Brazil (Nobrega and Lessa 2009).

Serra-Spanish mackerel (*Scomberorus brasiliensis*). Serra-Spanish mackerel is an epipelagic, neritic species, found up to 130 m depths, most commonly found on a depth range from 20–60 m (Collette and Nauen 1983). It concentrates on coastal areas, and is common on rocky coasts, open beaches and islands. It does not migrate extensively, although some seasonal movement appears to occur off Trinidad (Strum 1978, Strum et al. 1984). It tends to form schools and enters tidal estuaries. It feeds largely on fishes, with smaller quantities of Penaeid shrimps and loliginid cephalopods.

This species peak spawning occurs between October and April in low salinity waters in the Gulf of Paria, over the continental shelf, probably between 15 and 36 m of depth (Strum 1974). It has been suggested that movement of this species corresponds to a clockwise northward feeding migration around the island of Trinidad. However, there is some indication that this species displays migratory movements along the coast in distinct areas, like those observed in northern Brazil (Batista and Fabré 2001), and in Trinidad (Strum et al. 1978).

Common Dolphinfish (*Coryphaena hippurus*). Common dolphinfish is a highly migratory pelagic species that inhabits tropical and subtropical surface oceanic waters worldwide and are reported to be bounded in the North and South Atlantic by the 20°C isotherm (Palko et al. 1982). The distribution range in the western Atlantic is from Nova Scotia-Canada to Rio de Janeiro, Brazil. However, it is generally considered to be common from North Carolina-U.S. 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). Common dolphinfish is found offshore under floating objects, like *Sargasso* mats, logs and Fish Aggregating Devices (FADs). Vertical movements based on pop-up satellite archival transmitter data revealed a diel activity pattern within the mixed surface layer with dives below the thermocline (Merten et al. 2014). The fish tracked reached depths >200 m, and temperatures ranging from 16° to 30°C, which suggests that Common dolphinfish vertically shift between surface and at-depth feeding strategies to exploit aggregating epipelagic and mesopelagic prey items. Like other highly migratory pelagic species, Common dolphinfish are considered opportunistic and specialized predators, due to their high prey diversity. They are known to feed during the day on small oceanic fishes, juveniles of large pelagic fish, pelagic larvae of benthic fish, and invertebrates (Oxenford 1999).

Common dolphinfish displays a protracted spawning behavior, with multiple spawns during the spawning period (Arocha et al. 1999, Oxenford 1999). The peak spawning seasonality varies across the WECAFC area, where peak spawning occurs in May-June in North Carolina-US waters, from January to March in the Straits of Florida, from March to June off Puerto Rico, in Barbados in May-June, although females have ripe ovaries throughout the fishery season (November to June), and off the Venezuelan coast in May and from October to November.

The available information on recruitment, like in tuna species, is limited to the intensive sampling in the US Gulf of Mexico for the collection of large pelagic fish species larvae during ichthyoplankton surveys in the northern/central Gulf of Mexico (Rooker et al. 2013); in which the highest predicted concentration of larvae where estimated during June across the central area of the northern Gulf of Mexico (~26°N). Migratory movements of Common dolphinfish in the WECAFC area have been recently derived from recent pop-up satellite archival tag technology and conventional tags (Merten et al. 2016). Movements between Puerto Rico and South Carolina-U.S. were recorded, indicating a migration movement between the Atlantic and the northern Caribbean Sea (Mona Passage).

Blue shark (*Prionace glauca*). Blue shark is one of the widest ranging oceanic sharks, which are found in all oceans, in tropical, subtropical and temperate waters, from 60ºN to 50ºS (Nakano and Stevens 2008). In the western Atlantic its distribution is from Newfoundland to Argentina, including the Gulf of Mexico and Caribbean Sea. It is oceanic and pelagic, 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 (Nakano and Stevens 2008). 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.

The Blue shark is a placental live-bearing shark that produces litters averaging ~35 pups (maximum recorded 135 pups) after a gestation period of nine to 12 months. At birth, the pups are 35–50 cm Total-Length (TL). Reproduction has been reported as seasonal in most areas, with the young often born in spring or summer although the periods of ovulation and parturition may be extended (ICCAT 2006-2016).

In the northwest Atlantic, where the population consists mainly of juveniles of both sexes, sub-adult females and adult males, the sharks move along the Gulf current towards the Caribbean and South America at the end of the summer, autumn and spring. Juvenile and sub-adult females, the majority of which have recently mated, go deeper into the ocean; some of these probably migrate towards the east. In summer, they gather in large numbers to the south of New England, Georges Bank, Nova Scotia and Grand Banks (Nakano and Stevens 2008, Kohler and Turner 2008). 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).

2.2. Status and trends of highly migratory fish fisheries

Several stocks of highly migratory fish species (*e.g*., major tunas, billfishes, Swordfish, large pelagic sharks, and small tunas) are exploited by many countries of the WECAFC area; and all of those stocks fall under the mandate of the International Commission for the Conservation of Atlantic Tunas (ICCAT). Although in some coastal migratory species, like the mackerels (*Scomberomorus spp*.), management usually falls under the country's jurisdiction due to their coastal nature. Common dolphinfish, considered a highly migratory species, has been managed by some WECAFC states. As of 2011, Common dolphinfish was included as part of ICCAT´s species of interest and since 2011 falls under ICCAT's mandate (ICCAT 2011, ICCAT 2012).

2.2.1. Stock definitions

Of the major tunas stocks occurring in the WECAFC area, the Yellowfin tuna stock and the skipjack western Atlantic stock are the two stocks of major interest in the WECAFC area.

Yellowfin tuna. The Yellowfin tuna stock is considered a single Atlantic-wide stock, and as such is managed by ICCAT (ICCAT 2006-2016). Although separate spawning areas might imply separate stocks or substantial heterogeneity in the distribution of Yellowfin tuna, a single stock for the entire Atlantic is assumed as a working hypothesis by ICCAT, taking into account the transatlantic migration (from west to east) indicated by tagging, a 40-year time series of longline catch data that indicates Yellowfin are distributed continuously throughout the entire tropical Atlantic Ocean, and other information (ICCAT 2006-2016). However, a recent study on population genomics of Yellowfin tuna at 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. The results presented in the recent study encourages a re-assessment of the Atlantic-wide Yellowfin tuna stock by ICCAT, by using a multi-disciplinary approach that takes advantage of modern genetic technologies and incorporates other techniques to detect adaptive divergence in stocks.

Skipjack tuna. Based on the results of the International Skipjack Year, a research program ran by ICCAT (ICCAT 1986), and to the lack of transatlantic skipjack recoveries, it has been assumed and maintained by ICCAT that there are two independent stocks of skipjack in the Atlantic (ICCAT 2015): an eastern and a western stock with a border at 30°W on the basis of the western boundary of the eastern Atlantic Skipjack fisheries. However, in a recent review based on movement patterns of Skipjack tuna in the Atlantic and the low and limited north-south movements on both sides of the Atlantic (Fonteneau 2015), it was suggested that because of the large distances between fishing zones and the environmental heterogeneities; the mixing rates between the remote fractions of each skipjack stock fished in the most northern and southern areas were probably very low or absent, like the case for the west Atlantic between Gulf of Mexico/Caribbean Sea and southern Brazil. Thus, suggesting that due to the low north-south mixing, current stock structure is not a fully valid one for assessments and management of the resource.

Swordfish. Atlantic Swordfish is managed based on a three stock structure by ICCAT (ICCAT 2006-2016). The Swordfish population that inhabits the WECAFC area is part of the North Atlantic Swordfish stock managed by the said tuna Regional Fisheries Management Organization (RFMO). A recent review concluded that although there is compelling evidence of a north-south separation, it is not clear where the boundary between the two stocks is situated (Neilson et al. 2013).

The billfishes commonly caught in the WECAFC area consists of five species, Blue marlin, Atlantic sailfish, white marlin (*Tetrapturus albidus*), longbill spearfish (*Tetrapturus pfluegeri*), and roundscale spearfish (*Tetrapturus georgii*). Among these, only Blue marlin and Atlantic sailfish are considered due to their importance in the local fisheries within the region (commercial and/or recreational).

Blue marlin. The Atlantic Blue marlin is considered a single Atlantic-wide stock, and as such is managed by ICCAT (ICCAT 2006-2016). Genetic analysis of Blue marlin from samples taken throughout their Atlantic range showed no evidence of structuring among locations (McDowell et al. 2007). This corroborates earlier results of previous studies of Blue marlin demonstrating a lack of detectable structure within the Atlantic (Graves and McDowell 2003). Consequently, Blue marlin in the WECAFC area is part of a single Atlantic-wide stock.

Atlantic sailfish. ICCAT has managed Atlantic sailfish as separate eastern and western stocks with an arbitrary line drawn at 30°W between the two management units. This model is based on both morphological and tag and recapture data, specifically, eastern Atlantic sailfish tend to be larger than western Atlantic sailfish (ICCAT 2006-2016). However, there is some concern on the current stock structure used by ICCAT to manage Atlantic sailfish, mostly because the apparent genetic homogeneity on the distribution of Atlantic sailfish across the Atlantic calls to question the current application of eastern and western Atlantic stocks (McDowell and Graves 2002).

The Small Tunas Species Group of the Standing Committee on Research and Statistics (SCRS) in ICCAT is responsible for fulfilling ICCAT's mandate on Blackfin tuna, the *Scomberomorus spp*. and Common dolphinfish, as well as other small tuna species, like bonito (*Sarda sarda*), frigate tuna (*Auxis thazard*), little tunny (*Euthynnus allerattus*), wahoo (*Acanthocybium solandri*) among other species in the Atlantic (ICCAT 2012). In the WECAFC area, four species of this Group are of great importance in the region's local fisheries, among them are: Blackfin tuna, King mackerel, Serra-Spanish mackerel, and Common dolphinfish.

Blackfin Tuna. Blackfin tuna exist only in the western Atlantic and is limited to most of the WECAFC area. An early study on the genetic basis for stock structure indicated that there is some finer-scale population structuring within the region (Saxton 2009); the analysis used adult and larvae samples from the Gulf of Mexico and off the southeastern U.S. and Bermuda in which there was evidence of significant population differentiation between Blackfin tuna from the two locations. However, a recent study on the genetic structure of Blackfin tuna in the western Atlantic developed homologous microsatellite markers to study the population structure of Blackfin tuna from six locations including North Carolina-U.S., the Florida Keys, the northern Gulf of Mexico, Martinique, Venezuela and northern Brazil; results indicated that the preliminary analyses suggest occurrence of a weak pattern of isolation by distance where genetic distance increases as a function of geographic distance (Saillant et al. 2016).

King mackerel. The stock structure of King mackerel in the WECAFC area appears to display four stock units on the basis of tagging efforts, where three migratory groups of King mackerel exist in United States waters: a western Gulf of Mexico, Eastern Gulf of Mexico, and Atlantic (Johnson et al. 1994). However, there are no genetic differences between the two Gulf of Mexico populations therefore the species is managed by the U.S. as two migratory stocks: Gulf of Mexico and the southeastern US coast (Gold et al. 2002). The other potential stock unit is located off northeastern Venezuela and Trinidad through Suriname, where an important fishery developed since 1950 (in Venezuela) (Marcano et al. 1998, Hogarth and Martin 2006). Last, the most southern stock unit in the WECAFC area is located in northern Brazil (Nobrega and Lessa 2009a).

Serra-Spanish mackerel. The stock structure of Serra-Spanish mackerel in the southeastern Caribbean (off Venezuela and Trinidad), where important fisheries for this species coexists, consists of two stocks on the basis of genetic analyses (Gold et al. 2010). Further analyses indicate that there may be a number of spawning stock of this species in the southeastern Caribbean Sea, due to several genetic differentiations between Serra-Spanish mackerel in two localities off Venezuela, and between northern and southern Trinidad waters. The other known stock is the one off north and northeastern Brazil (Nobrega and Lessa 2009b).

Common dolphinfish. There is some evidence of multiple populations based on biological and morphological characteristics (Oxenford and Hunt 1986, Lessa et al. 2008, Duarte-Neto et al. 2008); however it appears that genetic connectivity between migratory groups in the central western Atlantic, Caribbean and Gulf of Mexico is plausible. The Caribbean Regional Fisheries Mechanism (CRFM) 2010 stock assessment analyzed data from the Caribbean, Venezuela, Brazil and the U.S. that corroborates that this species migrates from northern Brazil to the eastern Caribbean and may also enter the southeastern Caribbean Sea (CRFM 2010). In Brazil there is evidence of at least two stocks, one in northern Brazil (shared with the Caribbean) and one in the northeastern Brazilian coast (Lessa et al. 2008). In the northern part of the WECAFC area, the Common dolphinfish from the Gulf of Mexico and southeastern U.S. is considered part of what is referred to as the northern stock, although there is recognition that a strong connectivity exists with the northern Caribbean Sea islands (Farrell et al. 2014). Finally, a study on genetic structure and dispersal capabilities of dolphinfish in the western central Atlantic revealed a low population differentiation of Common dolphinfish throughout the region (Merten et al. 2015). Therefore, if Common dolphinfish in the WECAFC area is considered a single panmictic population, future stock assessments will need to incorporate the movement of the species through 30 EEZs and its catch and effort data in each location (Merten et al. 2015).

Blue shark. ICCAT has managed Atlantic Blue shark as separate north and south stocks with an arbitrary line drawn at 5°N between the two management units, and Blue shark in the Mediterranean Sea is considered to be a different management unit (ICCAT 2006-2016). However, a recent genetic survey (Veríssimo et al. 2017) using a data set consisting of young-of-year and <2 years juveniles collected from nurseries areas in the north central Atlantic, north eastern Atlantic, eastern South Africa, and southern Brazil, showed a lack of spatio-temporal genetic differentiation, suggesting the presence of a panmictic population in the whole Atlantic. Therefore, genetically Blue shark in the WECAFC area likely belongs to an Atlantic-wide population, although it is managed under the North Atlantic stock unit by ICCAT.

2.2.2. Exploitation status

Yellowfin tuna. The most recent stock assessment conducted for Yellowfin tuna conducted on July 2019 applied two production models and one age-structured model to the available catch data through 2018 (ICCAT 2019a). 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. 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 (17,996 tonnes) were well below the estimated maximum sustainable yield estimates (30,000 tonnes-32,000 tonnes).

Swordfish. The last assessment for Swordfish in the North Atlantic was conducted in 2013 (ICCAT 2014). The population of Swordfish in the North Atlantic is estimated to be at or above levels needed to produce the maximum sustainable yield (B/B_{MSY}=1.14) and the population is not overfished (F/F_{MSY}=0.82). Fishing mortality of Swordfish in the North Atlantic has been below levels needed to produce the maximum sustainable yield (F_{MSY}) since 2000 and overfishing is not currently occurring. Current management advice is a TAC of 13,700 tonnes, in which several WECAFC countries have a specific TAC, as well as a minimum size limit.

Blue marlin. A full stock assessment was conducted for Blue marlin in 2018, using the available data through 2016, and applying both surplus production and age-structured models (ICCAT 2019a). 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. The probability of being in the red quadrant of the Kobe plot was estimated to be 54%; while the probability of the being in the yellow quadrants of the Kobe plot was estimated to be 42% and that of being in the green quadrant only 4%. However, the Committee recognizes the high uncertainty with regard to data and the productivity of the stock. Current management advice is a TAC of 2 000 tonnes, in which several WECAFC 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 2017b). 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 advice 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.

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). For the North Atlantic stock, all scenarios considered with both models indicated that the stock was not overfished and that overfishing was not occurring. However, ICCAT recognizes that there still 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.

Blackfin tuna. ICCAT's SCRS-Small Tunas 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 on 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 analysis 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 2017c). 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 (Saint Lucia, Grenada, Dominica, and St. Vincent and the Grenadines) indicated a general increasing trend (CRFM 2013a). Strong caution is warranted on the basis of 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.

King mackerel. In 2017, ICCAT updated the Ecological Risk Analysis (ERA) for the small tuna caught by longline and purse seine fisheries in the Atlantic. The study found that King mackerel was one of top 3 stocks at risk in the Atlantic Ocean that should deserve most of the managers' attention (ICCAT 2017d, Fredou et al. 2017). For the stock units under U.S. management, according to the most recent stock assessment (SEDAR 2014a, b), the King mackerel stocks in the Atlantic (Gulf of Mexico and Southeastern U.S.) are not overfished and are not subject to overfishing. The stock status assessment for the potential southern Caribbean stock unit (off Venezuela, Trinidad, and Guyana) conducted in 2006 and 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 suggested that the participation at CRFM assessment meetings of scientists from other countries that harvest the same stock should be encouraged for the purpose of contributing with additional assessment data which would significantly reduce the uncertainty in the evaluation of stock status.

Serra-Spanish mackerel. In 2017, ICCAT updated the Ecological Risk Analysis (ERA) for the small tuna caught by longline and purse seine fisheries in the Atlantic. The study found that for Serra-Spanish mackerel from the stock off north-northeastern Brazil was considered to be 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' (Fredou et al. 2017). In the other two potential stocks (Trinidad and Venezuela), only Trinidad 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 F_{MSY}. 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 was to continue fishing at current levels.

Common dolphinfish. The Caribbean Regional Fisheries Mechanism (CRFM) 2010 stock assessment analyzed data from the eastern Caribbean Islands, Venezuela, northeastern Brazil and the U.S. (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 U.S. waters, produced highly uncertain results due to absence of reliable data in many sectors for many years (Prager 2000).

2.2.3. Trends in fishery landings

In this section, the trends in fishery landings will be treated as groups of species, in the case of major tunas (Yellowfin and Skipjack) will be discussed jointly, the next group will be billfishes and will include Swordfish with the two istiophorid species, and finally the small tuna group will include Common dolphinfish as well as the rest of the scombrid species. The historical landings represented in this section are those reported to FAO on a yearly basis, through 2017, by member countries included in FAO Area 31.

Major tunas (Yellowfin tuna, Skipjack tuna). Historical landings of Yellowfin tuna show two periods of high landings, one in the early 1960's, and another in the early 1980's likely due to the incorporation of a purse seine fleet from Venezuela; landings remained high (around 25,000 tonnes) through the mid 1990's, thereafter landings dropped and stabilized to levels of around 15,000 tonnes for the last five years (**Fig.1A**). Historical landings have been reported by reported by Japan, Venezuela, Mexico, United States, Korea, Taiwan, and St. Vincent and the Grenadines; these countries are responsible for more than 82% of the Yellowfin tuna caught in the region (**Fig.1B**). During the last five years, landings of Yellowfin tuna representing over 75% of the total have remained stable around 1,000-2,000 tonnes for countries like Suriname, Mexico, Grenada, Trinidad and Tobago, the United States, and Panama, the exception being Venezuela that showed landings varying between 3,000 to 5,000 tonnes (**Fig.1C**). Skipjack tuna historical landings show a slow increasing trend through the early 1980's when landings peaked over 20,000 tonnes, likely due to the development of the Venezuelan surface fleet (purse seine and bait boat/pole&line), thereafter landings declined to levels around 5,000 tonnes and above, in recent years total landings have remained relatively stable around 3,000 tonnes (**Fig.2A**). Historical landings have been reported mainly by Cuba during the early period (1950-1980), thereafter most of the landings were reported by Venezuela and Cuba, and a small fraction of the landings are mainly from St. Lucia and Dominican Republic among other (**Fig.2B**). During the last five years, landings of skipjack tuna representing over 75% of the total have had a high level of variation, from low landings (< 1,000 tonnes) from countries like Suriname, Panama, and St. Lucia to higher landings (> 1,000 tonnes) for countries like Venezuela (**Fig.2C**).

Billfishes (Blue marlin, Atlantic sailfish, Swordfish). Historical landings of Blue marlin in the area (FAO Area 31) have remained somewhat stable after the historical peak in the mid 1960´s, thereafter landings have remained around 1,000 tonnes (**Fig.3A**). Historical landings have been reported by Japan, Venezuela, Barbados, Cuba, France, and Taiwan, who are responsible for more than 82% of the Blue marlin landings taken in the region (**Fig.3B**). During the last five years, landings of Blue marlin representing over 75% of the total have remained relatively stable around 100-150 tonnes for countries like St Lucia, Dominican Republic, Mexico and Venezuela, the exception being France that showed landings varying between 100 to 400 tonnes (**Fig.3C**). Atlantic sailfish historical landings show a steady increase after the 1980's until its historical high in 2006 and more recently in 2016 of over 16,000 tonnes (**Fig.4A**). Historical landings have been reported by reported by Japan, Venezuela, Barbados, Cuba, Dominican Republic, and Grenada; these countries are responsible for more than 77% of the Atlantic sailfish landings (**Fig.4B**). During the last five years, Atlantic sailfish landings representing over 75% have varied between reporting countries at different levels, where Grenada, Barbados and Dominican Republic show relatively stable landings; while Venezuela and Suriname show variable high landings ranging from around 200 tonnes to 500 tonnes (**Fig.4C**).

Swordfish reached an all-time high of 5,255 tonnes in 1990, thereafter dropped to levels around 3,000 but soon returned to landings around 4,000 tonnes, until 2013 when landings have stabilized around 2,500 tonnes in the most recent years (**Fig.5A**). Historical landings have been reported by Japan, Venezuela, Cuba, the United States, and Spain, which are responsible for more than 92% of the Swordfish landings taken in the region (**Fig.5B**). During the last five years, landings of Swordfish representing over 75% of the total have remained relatively stable around 100 tonnes for countries like Grenada, Saint Vincent and The Grenadines, Japan, Belize, and Venezuela, the exception being the United States, and Spain that showed landings varying between 600 tonnes and 1,000 tonnes from the United States and around 1,600 tonnes reported by Spain (**Fig.5C**).

Small tunas (Blackfin tuna, King mackerel, Serra-Spanish mackerel, Common dolphinfish). Historical landings of Blackfin tuna show two periods of high landings, one in the early 1970's, and another in the early 1990's showing reported landings of over 5,000 tonnes; thereafter landings commenced to drop through 2000, after which landings have relatively stabilized to levels of around 1,300 tonnes for the most recent years (**Fig.6A**). Historical landings have been reported by reported by Cuba, Venezuela, Martinique, Guadalupe, and Dominican Republic, of which these countries are responsible for more than 84% of the Blackfin tuna caught in the region (**Fig.6B**). During the last five years, landings of Blackfin tuna representing over 75% have remained stable around 100-200 tonnes for countries like Saint Lucia, Grenada, and Venezuela, the exception being Cuba that showed landings varying between 600 tonnes to 900 tonnes; while Dominican Republic with reported landings of 600 tonnes for the first two years dropped to below 50 tonnes the last three years of the time series (**Fig.6C**).

King mackerel historical landings increased steadily until 1997 (12,716 tonnes), thereafter landings dropped slightly until 2000. After 2000, recovery in the landings was observed and reached 12,820 tonnes in 2004 (**Fig.7A**); afterwards landings dropped to around 10,000 tonnes. Historical landings reported by Trinidad and Tobago, Venezuela, United States, Mexico, and Dominican Republic represent over 98% of the King mackerel caught in the region (**Fig.7B**). King mackerel landings in the last five years have remained stable around 2,000 tonnes for countries like Guyana, Trinidad and Tobago and the United States, the exceptions being Mexico that showed an increasing trend in landings varying from about 4,000 tonnes to slightly under 7,000 tonnes, and Venezuela that showed a continued decreasing trend in the landings (**Fig.7C**). Historical landings of Serra-Spanish mackerel increased to an all-time peak of 7,207 tonnes in 1993; thereafter high landings remained until 2006 after which landings began to drop steadily to around 2,000 tonnes by the end of the time series. Historical landings of Serra-Spanish mackerel come mainly from Trinidad and Tobago, and Venezuelan fisheries, but in recent years from Guyana as well (**Fig.8A**). Serra-Spanish mackerel landings in the last five years have remained relatively stable with landings below 1,000 tonnes for the countries reporting 99% of the total catch (**Fig.8B**), where landings for Trinidad and Tobago have remained stable across all years, while for Venezuela landings varied from about 1,000 tonnes in 2013 down to 747 tonnes in 2015, and up to 900 tonnes by 2017 (**Fig.8C**).

Common dolphinfish historical landings have increased steadily and peaked in 2013 when the highest landings of 6,478 tonnes was reported, thereafter landings dropped to almost half in the last couple of years of the historical time series (**Fig.9A**). Over 84% of the historical total catch of Common dolphinfish are reported by Barbados, Guadalupe, Martinique, United States, Venezuela, Dominican Republic, and Saint Lucia, of which Barbados, Guadalupe, and Martinique were responsible for the most of the landings through the early 1990's; thereafter landings from these countries dropped to almost half by 2003, but after 2003 Venezuela's landings increased notably through the end of the historical time series (**Fig.9B**). Landings during the last five years have remained relatively stable for most countries landing over 75% of the total Common dolphinfish, which include Saint Lucia, Barbados, Guadalupe and Martinique, and Dominican Republic, but Venezuela's landings have been reduced from about 1,500 tonnes to around 1,100 tonnes at the end of the time series (**Fig.9C**). Conversely, landings from France show a substantial drop after 2015, from about 1,500 tonnes (2013-2015) to almost nothing in the last two years of the time series. Noting that France and Martinique and Guadalupe are in principle one fishing nation (i.e., EU France), it is not clear if there is potential for double reporting or that for some large pelagic species, reporting is partitioned by over-seas territories.

Sharks. Landings of sharks have been commonly grouped due to the lack of taxonomic resolution in the historical landings; however, in recent years, landings of sharks have started to be separated by species and reported. Blue shark (*P. glauca*) is one of the most common sharks landed; reported historical landings show an all-time high of about 11,000 tonnes in 2011 and 2013, and in most recent years landings have been around or below 2,000 tonnes (**Fig.10A**). Historical landings have been reported by Venezuela, Korea, Suriname, Belize, Panama, and Spain, who are responsible for more than 98% of the Blue shark landings taken in the region (**Fig. 10B**). During the last five years, landings of Blue shark representing over 75% of the total have remained relatively stable blow 1000 tonnes for countries like Belize and Suriname, the exception being Spain that showed landings leveling at 2,000 tonnes, after a strong drop from 9,000 tonnes at the beginning of the period, to finally drop to under 1000 tonnes in the last year of the series (**Fig. 10C**).

2.2.4. Impact

Impact is considered in terms of the achievement of specific societal goals and targets. While individual countries and sub regional political bodies may have their own goals and targets, for this regional report the relevant Sustainable Development Goals (SDGs), particularly SDG 14, and Aichi Targets are considered in the context of the large pelagic fish fisheries:

SDG 14, Target 14.4 (By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics);

Indicator 14.4.1: Proportion of fish stocks within biologically sustainable levels

Aichi Target 6: By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

Determining whether or not the large pelagic fish fishery is biologically sustainable will require further analyses based on reliable data and more detailed information, particularly for some of the stocks considered in the section. For stocks that are under Regional Fisheries Management Organization like ICCAT, two stocks, Skipjack tuna (the West Atlantic stock) and Swordfish (the North Atlantic stock), can be considered to be within biologically sustainable levels. Although, Atlantic sailfish (the West Atlantic stock) and Blue shark (the North Atlantic stock) are not overfished nor undergoing overfishing, the uncertainties in the model estimations have cautioned on the stock status, whether these stocks are at biologically sustainable levels is unknown. However, several management actions implemented by ICCAT have been set in place to correct the situation. The recent Yellowfin tuna assessment indicated that is not overfished and not experiencing overfishing, but the stock assessment group cautioned that the differences between the 2016 and 2019 assessment results are not due to stock recovery, considering that the 2019 assessment models indicated that the stock biomass declined between 2014 and 2018. The rest of the species reviewed in this section which is part of the ICCAT Small Tuna species group, *i.e.*, Blackfin tuna, King mackerel, Serra-Spanish mackerel and Common dolphinfish, the assessments indicated that there was not sufficient information that would indicate if they are within biologically sustainable levels. Within this group, in order to achieve biologically sustainable levels, Blackfin tuna and Common dolphinfish, will likely need to be managed at region-wide level due to the possibility of each being a single genetic stock within the WECAFC area. While in the case of the two mackerel species, sub-regional management should be encouraged for each potential stock unit within the WECAFC area, which in cases like this, reliable data and more detailed information is highly required and should be a priority for the countries involved in those fisheries.

2.3. Small pelagic fish species

The species selected in this group are distributed throughout the WECAFC area, but mostly in the Gulf of Mexico, southern Caribbean Sea, and off the leeward Caribbean Islands. In general context, some of these stocks can be considered to have a local distribution within the WECAFC area, in which two of the most important stocks are located in the north/central Gulf of Mexico and in the southeastern Caribbean Sea. In contrast, the other important species considered in this group appears to belong to a stock that clearly crosses boundaries of EZZ's in the region, thus international cooperation is required for its management; to date some steps have been initiated in that direction. The primary gears used to catch small pelagic fish species in the WECAFC area include purse seines, beach seines, gill nets, dip nets and hook and line.

2.3.1. Species of interest

The selection of species was done on the basis of major volume in landings, regional economic importance and historical fish landings. The species include: Gulf menhaden (*Brevoortia patronus*), Round sardinella (*Sardinella aurita*) and Four-wing flyingfish (*Hirundichthys affinis*).

2.3.2. Geographic distribution and ecology

Gulf menhaden (*Brevoortia patronus*). Gulf menhaden is an estuarine-dependent species, and use these environments as nursery and feeding areas, where food abundance and warm temperatures promote rapid growth and development (Castillo-Rivera and Kobelkowsky 2000). Gulf menhaden range from the Yucatan Peninsula in Mexico, across the western and northern Gulf of Mexico to Tampa Bay, Florida (VanderKooy and Smith 2015). It occurs inshore in summer, with some individuals migrating to deeper waters in October (Mississippi Delta area). It feeds in dense schools on phytoplankton, but probably also feeds at the bottom. The species spawns offshore during the months of October to February, with a peak in January (VanderKooy and Smith 2015). Juveniles and adults are typically found in open water with non-vegetated bottoms, while larvae and early juveniles are associated with estuarine marsh edges where adequate forage and protection from predators can be found. This species reaches a maximum age of 6 yrs; however, individuals older than 4 yrs are uncommon in landings (SEDAR 2013).

Round sardinella (*Sardinella aurita*). Round sardinella is a pelagic species that schools in subtropical coastal waters from inshore to the shelf edge (Freon and Mendoza 2003). This species is distributed across the Atlantic Ocean. In the western Atlantic it is known from Cape Cod, Massachusetts south along the U.S., Bermuda, the Bahamas, throughout the Gulf of Mexico and Caribbean Sea, and along the South American coast to Argentina (Munroe et al. 2015). It is highly associated with upwelling and highly productive waters. Adults feed mainly on zooplankton, especially copepods; while juveniles feed on phytoplankton. Round sardinella is known to display a vertical migration, forming dense schools at mid water or above the sea bottom during daylight hours and often rising to surface at night and dispersing. In some areas there are two main spawning periods. However, Round sardinella off Venezuela display a reproduction strategy in which spawning occurs mainly from November through March, showing a short spawning time with a peak in December in the southern range, and a more protracted spawning in the northern area with two close peaks (November and February) (Freon et al. 1997). For the Gulf of Mexico, conflicting results suggest that spawning occurs either year-round with less spawning during May to September, or with peak spawning during April to September (Munroe et al. 2015). Juveniles tend to stay in nursery areas, but upon maturity they rejoin adults offshore, displaying a possible inshore/offshore migration off Florida and off Venezuela, where adults live on the shelf and migrate along the shelf.

Four-wing flyingfish (*Hirundichthys affinis*). The Four-wing flyingfish is a neritic species that occurs in open water and amongst pelagic *Sargasso*. It is considered a migratory species confirmed by the north–south migratory distribution of flying fish from Dominica to Tobago (Oxenford 1994). Considered a short-lived species (~18 months) with very strong inter-annual variability in cohort size is normally encountered in a depth range of 0-20 m (Oxenford et al. 2007). It breeds throughout the year with two spawning peaks, one in December-January and another in April-May (Oxenford et al.1994, Khokiattiwong et al. 2000). This species diet comprises zooplankton and fish larvae (Lewis *et al.* 1962), but it 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).

2.4. Status and trends of small pelagic fisheries

2.4.1. Stock definitions

Gulf menhaden. The biology of Gulf menhaden, in particular the presence of an offshore egg—larval stage and the potential for a considerable migration at both the larval and adult life stages, suggests a predisposition for this species to conform to the expectation of genetic homogeneity over the range of the species (SEDAR 2013, VanderKooy and Smith 2015). Genetic studies have confirmed a basin-wide genetic homogeneity in the Gulf of Mexico and strongly support a single-stock hypothesis for *B. patronus* in the U.S. Gulf of Mexico (Anderson and Torres 2016).

Round sardinella. The stock structure of Round sardinella in the WECAFC area is poorly known, the major fishery in the region occurs off the coast in northeastern Venezuela, a well-known highly productive area, thus it is likely that a unit stock may be warranted for that part of the WECAFC area for management purposes (Freon and Mendoza 2003). The other area of commercial exploitation is off the Florida Gulf of Mexico coast and is managed as a single unit stock by the U.S. and is considered to be a single population due to the absence of genetic evidence for geographic population structuring (Kinsey et al. 1994).

Four-wing flyingfish. A genetic study on the Four-wing flyingfish (*Hirundichthys affinis*) indicated a lack of gene flow between three areas under study 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 unit stocks of *H. affinis* in the central western Atlantic (Gomes et al. 1999). Therefore to date, these three genetically discrete sub-regional stocks have been identified and acknowledged within the WECAFC area.

2.4.2. Exploitation status

The Gulf menhaden fishery is completely managed by the U.S. Overall the stock appears to be in good shape, with SSB (measured as fecundity) increasing since a low in the early 1990's to currently well over any potential reference points examined (SEDAR 2018). Fishing mortality has also been decreasing since the early 1990's and, while variable, is currently is well below any potential reference points. Landings have been quite variable but are much lower now than the peak reached in the mid-1980s. Recently, total removals have declined over the last three years and are below the time series average (SEDAR 2018). While recruitment in 2017 was lower than average, recruitment in 2016 was at a time series maximum (SEDAR 2018).

A hydroacoustic survey report on the status and perspectives of Round sardinella was prepared by several Venezuelan scientific institutions (Fundación La Salle, The Nature Conservancy, Instituto Oceanográfico-Universidad de Oriente) led by the Instituto Socialista de la Pesca y Acuicultura (INSOPESCA) in 2010 (Gassman et al. 2012). The stock status for 2010 on the basis of size frequency analysis and biomass dynamic models, and total biomass derived from the hydroacoustic survey for Round sardinella in 2009, indicated that in the worst case scenario the stock of round sardinella collapsed and in the best case scenario the stock was overfished. However, it was also recognized that there was a high level of uncertainty in the estimates. Later in 2016 at the request of the official fishery administration (INSOPESCA), an update on the state of the stock was conducted using catch data through 2015, and applying two catch-only methods (Vasconcellos and Cochran 2005, Martell and Froese 2012); results indicated that benchmark reference points continued to show that Round sardinella in northeastern Venezuela was overfished and was undergoing overfishing.

The Four-wing 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 Four-wing 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. 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 Four-wing flyingfish (CRFM 2014), a catch trigger point of 5 000 tonnes was to be established to ensure the stock does not become overfished.

2.4.3. Trends in fishery landings

Historical landings of Gulf menhaden show an upward trend in landings from 1946 through 1984 when landings peaked at 982 800 tonnes, thereafter landings have fluctuated on a decreasing trend stabilizing around 400 000 tonnes during the recent period of the time series (**Fig.11A**). This species, mainly reported by the United States, during the last five years showed a sinusoid trend in the landings from 450 000 tonnes in 2013 to a peak in 2016 of over 600 000 tonnes, to 400 000 tonnes in 2017 (**Fig.11B**).

Landings of Round sardinella show an increasing trend in landings through 1998 when landings reached 186 060 tonnes, fluctuating around 100 000 tonnes until 2004 when landings peaked at 200 232 tonnes; thereafter the landings dropped to levels of about 50 000 tonnes in two years. Landings remained stable at low levels until 2015 and then increased to 126 400 tonnes in 2017 (**Fig.12A**). Historical landings show that over 95% of landings are reported by Venezuela, the rest include the United States and Mexico (**Fig.12B**), although landings are around 500 tonnes annually for the United States. Recently, Venezuelan landings have doubled over a period of four years (**Fig.12C**).

Historical landings of Flyingfishes nei (in which *H. affininis* is the dominant species in the reported landings) fluctuate throughout the time series around 2 000 and 3 000 tonnes 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 to 500 tonnes (**Fig.13A**), largely due to the decrease of the landings in Barbados (**Fig.13C**). Historical landings show that over 70% of flyingfish have been mainly caught by Barbados, in addition to Martinique, Grenada, St Lucia, and Saint Kitts and Nevis in recent years (**Fig.13B**).

2.4.4. Impact

Impact is considered in terms of the achievement of specific societal goals and targets, which were detailed in section 2.2.4. of this report.

Like in most fisheries discussed in this report, determining whether or not the fishery is biologically sustainable will likely require further analyses based on reliable data and more detailed information. In the context of the small pelagic fish fisheries considered here; the Gulf menhaden fishery is considered to be biologically sustainable within current management action. It is uncertain for the Four-wing Flyingfish and Round sardinella; considering that these are short lived recruitment dependent fisheries that require regular monitoring and assessment. For example, in the case of Four-wing flyingfish, *Sargasso* influx and related changes in catchability has been advanced as an explanation for reduced catch levels in recent years (CRFM 2014). In the case of Round sardinella, if it is assumed that landing statistics are reliable, it is likely that the abundance has increased, but there is no indication of how much if so. Because of the socioeconomic importance of Four-wing flyingfish around the Eastern Caribbean countries and Round sardinella stock off Venezuela, improving its stock status should be a priority for regional fisheries, not only because of local food security, but because these are likely the basic natural and most important bait for all large pelagic fishes occurring in the area and that some of them are subject to important fisheries in the region.

3. Associated Social and Economic Aspects

In the Pelagic fisheries, information regarding social and economic aspects is limited at the fishery level and mostly nonexistent at the species level. Consequently, the information presented in this section will be limited to the available information for some species.

3.1. Benefits

During 2017, total WECAFC landings were 2.504.018 tonnes (excluding mollusks), of which 662,340 tonnes consists of pelagic species, and 629,736 tonnes represent the group of species selected in this report. The pelagic species selected accounted for 23.5% of the small pelagic landings and 1.65% of the large pelagic landings (**Table 2**).

- Food security: Although there is exportation in place for several of the species (Flyingfish in Trinidad and Tobago, FAO 2018b). In the case of some large pelagic species (e.g., billfishes), are considered by several coastal communities in the WECAFC area to be a major source of relatively inexpensive protein in important quantities due to the large size of the fish captured. In the case of small pelagics, Round sardinella is considered to be an strategic food resource reserved to be captured exclusively by artisanal fisheries (Gaceta Oficial de la República Bolivariana de Venezuela 2017). In contrast, the single largest fishery in the WECAFC area is the Gulf menhaden fishery and most of the catch is for reduction (VanderKooy and Smith 2015).
- Employment: Fisheries of all the previously named species are an important source of employment, especially for some small coastal communities with no other source of livelihood (*e.g.*, Round sardinella in Guaca, a small village of Venezuela –Freon & Mendoza, 2003). In the case of the Gulf menhaden, the number of vessels in the reduction fisheries has been 35-40 since 2000 (VanderKooy and Smith 2015). As the fishing fleet modernized and technology allowed the purse boats to become more efficient, the size of the traditional fishing crew declined. At the height of the fishery, a typical crew aboard a reduction vessel was about 20 men - not including the captain, mate, or pilot. Since 2000, the crew is integrated by 14-15 men. The number of plants operating in the Gulf fishery has stabilized since 1999 at four. In 2012, 35 steamers and one run boat participated in the Gulf menhaden fishery. In a survey of the Gulf menhaden fishery, 49% of respondents claimed all their income comes from menhaden fishing only.

- Recreation: There is an important activity related to recreational fisheries in the area such as the one for billfishes in the Caribbean Sea (WECAFC 2018). Within the Caribbean, recreational fisheries currently represent a largely untapped resource for valuable data capture. This fishery subsector is very capable of providing invaluable data to genuinely inform effective fisheries management. However, national fishery authorities tend to either not recognize the opportunity, or struggle to engage effectively with this fishery sector for data capture. The Caribbean Billfish Project (CBP), a component of the GEF-funded, World Bank-implemented had as overall project's long-term goal to, "recapture lost wealth and contribute to sustainable livelihoods in the Western Central Atlantic region through investment in economically, technically and ecologically feasible billfish fisheries management and conservation" (WECAFC 2018). The specific objective is, "to develop business plans for one or more long-term pilot projects aimed at the sustainable management and conservation of billfish within the Western Central Atlantic Ocean". Along these lines, an economic impact analysis on two pilot countries (Dominican Republic and Grenada) revealed the basic shortcomings in enabling conditions found in both pilot countries (Gentner and Obregon 2018). However, in the Dominican Republic, the recreational fishery sector is much more economically important, generating $36.3 million USD in annual cash flows, compared to the commercial fishing sector, which generates less than $0.75 million USD annually. To reduce some of the shortcomings it may be possible, given the willingness of recreational anglers to pay for access, to generate funds to pay for additional enabling conditions in the case of FAD access in the Dominican Republic. In the United States, the recreational fishing sector supported 472,000 jobs across the United States in 2016 and generated about $67.9 billion in sales impacts, $24.3 billion in income impacts, and $38.7 billion in value-added impacts; where recreational anglers in west Florida took the most trips (13.2 million trips) and spent the most on trips ($646.3 million), and North Carolina spent the second most on trips ($446.7 million) (https://www.fisheries.noaa.gov/resource/document/fisheries-economics-united-states-report-2016). West Florida also had the most recreational anglers participate in fishing in their state, with 3.7 million anglers. In terms of employment, the greatest impacts were generated in West Florida, followed by East Florida in the WECAFC area of the United States, as well as the highest sales impacts.
- Culture and tradition: Some of the artisanal fisheries in the coastal areas have a traditional importance in the region, including being regarded as icons during cultural activities (*e.g.*, flyingfish is considered as a cultural icon of the Caribbean island of Barbados (Nyman, 2012).

3.2. Production and value

The species of interest sustain economically important fisheries in the area, as illustrated by its landings compared to the total landings of species by similar groups for the area (excluding mollusks) in the western central Atlantic-FAO area 31 (**Fig.28**).

In terms of value in pelagic fisheries, the Gulf menhaden was the species with the highest value followed by Tuna and billfishes (Pauly and Zeller 2015) (**Fig.29**). In the WECAFC area of the United States (South Atlantic and Gulf of Mexico), Gulf menhaden provided the highest landing revenues but the lowest annual price compared to the rest of the other pelagic species (**Table 3**); whereas King mackerel provided the highest landing revenues but lower average annual prices compared to swordfish which had the highest value in the U.S. South Atlantic (https://www.fisheries.noaa.gov/resource/document/fisheries-economics-united-states-report-2016).

Regarding the countries in the WECAFC area that represent over 98% of the total landings in 2017 (excluding mollusks), the United States of America has the major accumulated percentage (70.89%) of catches for all pelagic species followed by Venezuela with 20.93% and Mexico with 3.08% (**Fig. 30A**). Similarly, the total landings of the selected pelagic species, the three countries continued to lead the major accumulated percentage for all pelagic species (**Fig. 30B**). In the case of the United States and Venezuela, the largest proportion of the landings are attributed to Gulf menhaden (USA) and Round sardinella (Venezuela).

Considering catches of the most recent year available (2017), large pelagic fishery had more catch landed by Venezuela followed by Mexico and United States of America (**Fig.30C**). The main countries with catches in the small pelagic group were United States of America (Gulf Menhaden primarily), Venezuela (primarily Round sardinella) and Barbados (primarily Flyingfish) (**Fig.30D**).

In most countries of WECAFC area, the available information refers to the contribution of the entire agriculture, forestry, and fishing sector, which is between less than 1% and 5% (World Bank, 2019).

3.3. Employment

Target species of this section support artisanal, industrial and recreational fisheries. In some cases they include subsistence fishery especially for coastal communities. Some of these communities have as main mean of livelihood the fisheries of small pelagics, such as the example of the artisanal fishery *Sardinella aurita* (Round sardinella) in Guaca, a small village in northeastern Venezuela (Freon and Mendoza 2003).

3.4. Human well-being and social justice

An assessment of the six human well-being indicators of the Governance Effectiveness Assessment Framework is not available for the fisheries nor the species of interest in the area evaluated. It is recommended to join efforts on this matter to apply it in each country, possibly by following the holistic framework proposed by Biedenweg *et al*. (2016).

3.5. Impact

Improvements in human well-being and social justice are implicit in many societal goals and targets, particularly the Sustainable Development Goals (SDGs). In most fisher communities, there are conditions that could be improved regarding to human well-being and social justice such as health status, environmental quality, personal security, housing, income and among other issues relevant to each community.

In addition, overfishing of any of the species previously mentioned is likely to have significant adverse economic consequences for the communities and countries that exploit those resources. Considering that all stocks exploited in the WECAFC area that had some form of stock assessments, 56.8% of them are fully exploited, 37.8% are over-exploited, and 5.4% in which current stock status could not be determined (WECAFC 2019b). The present report revealed that five stocks of highly migratory species were not over-exploited, only one was considered to be over-exploited, and the remaining four their current stock status could not be determined due to the uncertainties associated to its assessments. While for three small pelagic stocks, only one was over-exploited and the other two stocks were not. This last point has a direct relation to the SDG 14, target 14.1 "By 2020, effectively regulate harvesting and end overfishing (…) in which indicator 14.4.1 is the proportion of fish stocks within biological sustainable levels".

4. Drivers and Pressures

4.1. Drivers

Drivers are the economic, social, cultural and political factors that motivate human activities and satisfy basic human needs such as food and employment. They increase or mitigate pressures on the populations of highly migratory fish species, small pelagic fish species, Penaeid shrimps and coastal fish species occupying various substrata (soft bottom and/or reefs), being the drivers for the fisheries reviewed:

Economic Value: High or competitive prices along the value chain and high market demand for export and local consumption sector and people with purchasing power represent the main drivers (Lappo et al. 2015). High demand, high quality and reduced supply can significantly increase the prices paid for any of the high value products like, Yellowfin tuna, Swordfish, Common dolphinfish, King mackerel, for the fresh market, and have promoted further overcapitalization (excessive fishing effort) in large pelagic migratory finfish, Even in fisheries with no high value but with a strong demand in some countries because of its low value, represents food security for communities with very limited resources, such is the case of small pelagic fisheries (like, Round sardinella in Venezuela, and possibly Four-wing flyingfish in some Eastern Caribbean countries) which represent in some cases high volume at low prices, in which an increase in demand due to population growth and low income, will likely result in excessive fishing effort and overexploitation, and sometimes the collapse of a fishery.

Employment: Pelagic fisheries can be one of the most viable work options for many Caribbean nations. In developing nation cities where important ports with fishing operations exist as well as in remote fishing communities where economic development is low, fishing of high value resources like lobster, queen conch, octopus, crab, and/or sea cucumber fishing have always been a very attractive source of income. However, in many cases throughout the Caribbean developing nations, employment in the fishery sector can be a last resort, including for pelagic fisheries.

Consumer awareness: Consumer awareness can be a road to sustainability by demanding traceability, supporting consumption of local resources, and eco-labeling for assurance of fish resources been caught in a sustainable way (Lappo et al. 2015). In the WECAFC area steps have been taken towards sustainability in some countries where awareness was low, like the Marine Stewardship Council (MSC) certification. In a study on economic impact analysis on recreational and commercial billfish fisheries in Dominican Republic and Grenada (Gentner and Obregon 2018) indicated that there was sufficient awareness from consumers to find ways to enhance cooperation between both sectors to satisfy each other needs in order that each sector could fulfill their respective goals.

4.2. Pressures

Pressures are factors (natural and/or anthropogenic) that result in unsustainable fishing of the shellfish and finfish resources reviewed or induce negative changes in its health or its populations. The open-access nature of some of the fisheries targeting shellfish and finfish resources in the region can exacerbate its unsustainable exploitation. Among the key pressures that may affect these resources are:

Fishing effort: Excessive fishing effort (*e.g*., number of vessels/boats, number or length/size of the gear, and fishing days that exceed the level required for optimum sustainable catch) has contributed to overfishing of some resources in some countries (*e.g*., billfishes, Round sardinella,). However, excessive fishing effort in highly migratory species is measured as relative fishing mortality (F/F_{MSY}) like in the case of Blue marlin stock assessments, whereas the number of registered vessels in ICCAT cannot be used as indicative of excessive fishing effort due to incompleteness of records. One major concern in pelagic fisheries of highly migratory species in the WECAFC area, is the increasing use of Fish Aggregating Devices (FADs) by various artisanal and sport fisheries is causing greater vulnerability in some of the large pelagic migratory stocks (Ehrhardt et al. 2017, Gentner et al. 2018). For example, over the last fifteen years, Antillean artisanal fleets have increased the use of Moored Fish Aggregating Devices (mFADs) to capture large pelagic fishes. Catches of Blue marlin caught around mFADs are known to be significant but reports on these catches made to ICCAT are very incomplete (ICCAT 2006). In the case of small pelagic fisheries, like that of Round sardinella in Venezuela, in which high effort levels and increased catchability due to reduced upwelling which explained record landings in 1998 and 2004, resulted in the collapse of the fishery thereafter due to the abrupt decline in subsequent years (Rueda-Roa et al. 2017). However, environmental conditions in the area were also responsible for the apparent stock's recovery.

Illegal, unreported and unregulated fishing: Like for most fisheries, IUU fishing has not been systematically and reliably quantified in the region. In the WECAFC area, illegal fishing is fishing conducted by national or foreign vessels in the waters of a State without permission of that State, examples exists of plundering neighboring fleets, mostly small scale and semi industrial in national inshore waters and offshore banks, like those fleets fishing for highly migratory species,. There are six nations that share sea boundaries in the North Brazil shelf LME (NBSLME) (Trinidad and Tobago, Venezuela, Guyana, Suriname, French Guiana, and Brazil), it has been known, but not quantified, the number of artisanal/small scale and semi industrial vessels that fish in neighboring waters without permission, and in some cases do not report landings. This practice directly affects the sustainability of coastal highly migratory species (like, Common dolphinfish, King and Serra-Spanish mackerels) Another practice of illegal fishing in the region is the operations of industrial scale tuna fleets in national offshore waters (EEZ). Unreported fishing occurs when a vessel does not report or misreports its catches in contravention of national law or the reporting procedures of an RFMO. This is another common practice in the region (Mendoza 2015, Hornby et al. 2015, Zeller et al. 2011), particularly in highly migratory species caught in small scale fisheries. A common example is not reporting species-specific catches of large pelagic migratory species, like, sharks, billfishes, and small (and juvenile) tunas. The non-reporting or misreporting catches can generate uncertainties in the assessments in some large pelagic migratory species; a recent example is the last west-Atlantic sailfish assessment in which concerns exists on reported catches that are incomplete, likely from the Caribbean region (ICCAT 2017b). Likewise, in sharks it is a common practice, as most sharks are grouped in reported landings and this will clearly affect any form of conservation and sustainability of the different shark populations fished in the region.

Destructive/ghost fishing: 'Ghost fishing' by lost or abandoned driftnets, and even mFADs gear can be destructive. One important concern is the abandoned or lost mFADs that aggregate tunas or other large pelagic fishes (like Common dolphinfish) from surrounding waters and possibly act as 'ecological traps' of pelagic species by altering their natural spatial and temporal distributions, habitat associations, migration patterns and residence times (Hallier and Gaertner 2008, Ehrhardt et al. 2017). Gillnet gear causes incidental mortality on non-target species; the obvious result of not investing in retrieving fishing gear, mortality may be substantial and its effect on stock productivity could be significant.

Habitat degradation: In pelagic fisheries can be summarized in two major events occurring across the tropical Atlantic which are the massive influx of Sargasso into the WECAFC area (Wang et al. 2019) and the increasing hypoxia levels that can influence in the habitat compression of istiophorid billfishes in the Atlantic (Prince et al. 2010). Although both events can be considered a consequence to climate changes in the area, they do contribute to habitat degradation of the pelagic habitat that affects highly migratory species subject to important fisheries in the region. The degradation consists on potential altering of migration routes of migratory fish due to dense Sargasso beds, and the expansion of the oxygen minimum zones (OMZs) that will likely reduce suitable habitats for some pelagic species.

Predation: The extent of mortality caused by predation on juvenile species of large pelagic fishes, small pelagic species, is largely unknown. There are studies of juveniles of the species reviewed here that are part of the diet of adult fish species.

Climate change: Several climate change stressors have been identified and its implications for marine resources and fisheries of the WECAFC area (WECAFC 2019c), which include increasing sea surface temperature (SST), ocean acidification (OA), sea level rise (SLR) and increased frequency of extreme weather events (e.g. storms, hurricanes, precipitation anomalies). A regime shift in the southeastern Caribbean Sea has been documented (Taylor et al. 2012). The regime shift with reduced upwelling, associated water column nutrient enrichment and changes in the planktonic community on which *Sardinella aurita* feeds, have likely affected recruitment levels and carrying capacity of Round sardinella in the northeastern Venezuelan shelf (Mendoza 2015). Also, the recurrent Great Atlantic *Sargassum* Belt (GASB) (Wang et al. 2019) may become an pressing issue to pelagic fish species, considered an Essential Fish Habitat by the U.S. because the algae, which create rafts that can be 100s of kilometers long and several meters deep, provide refuge and food for a large diversity of animals such as small shrimps, crabs, juvenile sea turtles, dolphinfish, jacks, marine birds and other species (Casazza and Ross 2008). However, once currents and winds move it close to shore, the algae start to break-down, sink, and decay, creating an environment poor in oxygen (van Tussenbroek et al. 2017). Also, it has been noted that some *Sargasso* blooms in the region are dominated by a rare *Sargassum* form (*Sargssum natans VIII*) that has a lower value as a nursery and foraging habitat for macrofauna including fishes (Schell et al. 2015). There is no clear understanding how the recurring GASB affects fish populations in the region, clearly future research is critically needed. A shallowing of the oxygen minimum layer (representing a hypoxic habitat boundary for high oxygen demand species) has already been observed in the tropical Atlantic, diminished upwelling and increased stratification have been recorded in the southern Caribbean off northeastern Venezuela commented earlier.

In Oceanic pelagic species (billfishes, large tunas, dolphinfish, wahoo, mackerels, small tunas) will likely be less impacted by climate change, at least in the short-term, than other species groups. However, increases in SST will affect the productivity and distribution of many species, as they will likely move to areas with more favorable temperatures. Therefore, reductions in productivity of the oceanic pelagic species are expected over the medium- to long-term, affecting fisheries production across the Western Central Atlantic (WECAFC 2019c). However, shallowing of the OMZ will likely increase over-exploitation on some species due to their increased vulnerability to higher levels of exploitation by surface gears (Prince et al. 2010).

Fisheries Impact: Bycatch constitutes an important issue in all fisheries. Bycatch can negatively affect species all fish species, sea turtles, protected fish, marine mammals, and sea birds by harming animals, contributing to population declines, and impeding population recovery. Other impacts of fisheries may include removal of preferred prey and sometimes habitat damage. In large pelagic fisheries, the bycatch of juvenile tunas and unmarketable species and/or sizes of other fish in purse seine fisheries, and juvenile Swordfish in longline fisheries, contribute to the overexploitation of some stocks, and is an allocation issue among gear types and fishing nations (Gilman and Lundin, 2010).
However, concern over juvenile classes of target species in baitfish fisheries that supply live bait to pole-and-line fisheries has been raised, as have other ecological issues (ecosystem effects of removal of baitfish species, overexploitation of target baitfish species, habitat degradation) and socioeconomic issues (food security impacts with coastal communities) (Gillett, 2011).

4.3. Impact of pelagic fisheries on marine habitats and biodiversity

An ecosystem approach to fisheries requires that the fishery's impact on other components of the ecosystem is considered in decision-making. Pelagic fisheries, as reviewed here, have the potential to affect habitats and biodiversity through various means, like:

Pelagic fisheries. Bycatch, is by far one of the greatest impacts that large pelagic fisheries have on biodiversity. In tuna and *tuna-like* (as defined by ICCAT) fisheries, which is where most of the bycatch occurs in these fisheries, it includes a number of different groups such as under sized tuna (*e.g.*, Yellowfin and Bigeye tunas) and other ICCAT species like swordfish, billfishes, pelagic sharks than can be part of the commercial bycatch, and non-commercial bycatch like sea turtles, marine mammals (*e.g.*, dolphins), and sea birds (Hall and Roman 2013). Quantification of the bycatch is not available for the region; one of the major reasons is that an important number of small-scale fisheries that target tuna and *tuna-like* species most of the

time the incidental catch become part of the commercial catch in these fisheries (Gillett 2011). However, incidental catches of turtles may occur in these fisheries, but most are released. Also, bycatch of live marlins are to be released, but not all countries in the region do it because they are part of their food security supply of fish protein.
In small pelagic fisheries, the amount of bycatch is likely negligible, only in Gulf menhaden there is some evidence of the bycatch that is less than 5% (VanderKooy et al. 2002). In the other two species (Round sardinella and Four-wing flyingfish), unwanted incidental catch is negligible.

Further specific investigations are needed to assess the impact of these fisheries on marine habitats and biodiversity.

5. Responses

Responses include measures and actions taken by stakeholders to ensure that shellfish and finfish fisheries are sustainable. They also include the institutional, policy and legal frameworks and processes that are relevant to shellfish and finfish fisheries management. Responses are divided into 'governance' and 'management' (including stress-reduction measures). Governance covers architecture/arrangements and processes.

5.1. Governance architecture

In the fisheries reviewed in this section the main groups and organizations involved in governance of fisheries in the area include three Regional Fishery Advisory Bodies (WECAFC, CRFM and OSPESCA) and one Regional Fishery Management Organization (ICCAT). CRFM is a Regional Fishery Advisory Body for the CARICOM member countries, while OSPESCA works with the Spanish speaking Central American countries and Dominican Republic (**Table 6**). WECAFC covers additional countries and has thus a mandate of creating cohesion and involvement in its working area.

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 two Fishery Management Plans have been developed and adopted by the Commission, The Sub-regional Fisheries Management Plan for Flyingfish in the Eastern Caribbean (CRFM 2014, WECAFC 2016

Level of application of fishery policy by the fisheries mechanisms: Unlike other policy arrangements in the region, for species other than large pelagic migratory fish species that are under a binding mandate, the rest of the resources reviewed are dependent on specific National Management and Conservation measures of each country within the region; the exception being the Flyingfish fishery in the Eastern Caribbean (CRFM 2014).

In the case of highly migratory pelagic fish species, ICCAT issues a set of recommendations towards the recovery of any species that is considered overfished and undergoing overfishing, or is at high risk of overexploitation by tuna fisheries, these set of recommendations are binding for all Contracting Parties and Cooperating non-contracting parties. ICCAT states that all Contracting Parties and non-contracting Parties, Entities or Fishing that seriously undermine the ICCAT conservation and management measures are subject to non-discriminatory trade sanctions (www.iccat.int).

5.2. Governance processes

A range of initiatives undertaken in the WECAFC area to improve management of the shellfish and finfish fisheries include:

ICCAT Recommendations: ICCAT has issued a series of recommendations for the recovery and/or sustainability of several highly migratory species, like, Yellowfin tuna, Swordfish, Blue marlin, Atlantic sailfish, and Blue shark, some of which have overall or specific TAC allocations among contracting parties, also recommendations towards bycatch reductions and limitations in some key species like, sharks, sea turtles, and sea birds (https://www.iccat.int/en/RecRes.asp). In addition to recommendation on compliance measures on several species groups (https://www.iccat.int/en/RecRes.asp).

Sub regional processes: CRFM , promoted the management and conservations measures of the Sub-regional Fisheries Management Plan for Flyingfish in the Eastern Caribbean (CRFM 2014), those that appear to limit exploitation in a controlled and sustainable manner are: (1) the establishment of an authorized national entry (license/permit) system for flyingfish, to enter in each fishing season; (2) to conduct of an assessment to estimate stock abundance of flyingfish prior to any significant development in the fishery; (3) the adoption of a precautionary sub-regional total annual catch trigger point of 5,000 tonnes; (4) the implementation of a precautionary sub-regional freeze on expansion of flyingfish fishing effort and/or fishing capacity applied to all authorized vessel types, should the agreed catch trigger point be realized, to be followed by reassessment of resource status and adaptive management; (5) to strengthen current national data collection systems to facilitate improved assessment and management of the resource as well as monitoring and evaluation of implementation of national and sub-regional fisheries management plan. However, it is expected that the implementation of the flyingfish subproject be completed by mid-2019, when a review of the management performance, management strategies and sharing of lessons learned will be carried out (WECAFC 2019d).

WECAFC promoted The Caribbean Billfish Management and Conservation Plan in which its objective is to outline and guide the implementation of a suite of billfish management measures over a five-year period at regional and sub-regional scales to help secure the potential future benefits that can accrue from billfish stocks in the Caribbean. However, the plan recognizes the mandate of the International Commission for the Conservation of Atlantic Tunas (ICCAT) over the billfish stocks, and supports the implementation of the ICCAT binding recommendations in the region. In which one of its goals is to increase coordination and collaboration between nations through a regional governance framework better suited to effectively address the Caribbean region billfish management and conservation issues (Bealey et al. 2019).

5.3. Stress-reduction measures

Several stress-reduction measures have been adopted by the countries that exploit pelagic resources in the WECAFC area. These measures aim to control fishing pressure on the stocks so that the stocks can be restored to sustainable levels.

TAC allocations and other measures (ICCAT): In highly migratory fish species Total Allowable Catch (TAC) quotas for Blue marlin have been allocated to several Caribbean countries in the WECAFC area. In addition, effort limitation is in force for tuna fishing vessels >24 m, and minimum size limits exists for tropical tunas, and Swordfish (https://www.iccat.int/en/RecRes.asp). All contracting and cooperating non-contracting parties are obligated to comply, and non-contracting parties are encouraged to report to ICCAT their catches of large pelagic fish associated to tuna fisheries under the UN Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks.

Minimum size limits and closed season: Minimum size limits for highly migratory fish species have been implemented by ICCAT for Yellowfin tuna (69 cm curved fork length, CFL), and Swordfish (125 cm LJFL with 15% tolerance, and 119 cm LJFL with zero tolerance) (ICCAT 2019c). There are several closed seasonal areas for pelagic longline gear targeting highly migratory species in the U.S. southeastern Atlantic and U.S. GOM (NOAA 2011). In Venezuela, Round sardinella minimum size limits exists for the commercial fishery (19 cm TL) and the bait fishery (between 15 cm and 18 cm TL) with a 10% tolerance, in addition to a closed season from December 15th to March 15th (Gaceta Oficial 2017).

Limited entry/Exclusion areas: For highly migratory species Venezuela and the U.S. have limited oceanic waters (off shore and close to shore) that have prohibition year round for commercial longline gear to operate in a specific area (the U.S. off Florida's east coast and Venezuela off La Guaira) (NOAA 2011, Gaceta Oficial 2003). For Round sardinella, Venezuela has imposed limited entry by restricting the number of permits, gear restrictions, as well as number of days of fishing and a limited weekly quota allocation to specific gears (Gaceta Oficial 2017).

5.4. Recommendations for action

Pelagic fisheries:

1. Encourage the International Commission for the Conservation of Atlantic Tunas (ICCAT) and individual member countries to adopt precautionary and ecosystem-based management measures. Demand that member countries comply with all ICCATs Conservation and Management Measures.
2. Explore implementation of control documents to ensure supplier compliance with ICCAT conservation and management measures (CMM's) (*e.g.*, around bycatch) such as: recording and reporting interactions, use of de-hooking devices and line cutters for sea turtles, sea bird mitigation measures and prohibition on retaining silky (*Carcharhinus falciformis*), oceanic whitetip (*C. longimanus*), hammerhead (*Sphyrna spp.*) and thresher (*Alopias spp.*) sharks.
3. Encourage the ICCAT and member countries to conduct studies, increase monitoring and publish information to assess longline interactions with protected, endangered and threatened and other bycatch species.
4. Noting the regional increase and unregulated use of mFADs, it is critical that a sub-regional management plan for fish aggregating devices be adopted. A draft of such plan has been proposed by CRFM (2015), aiming at strengthening the mFAD fishery, with special attention to licensing (in limiting the number of FADs), construction methods to avoid ghost fishing, marine debris, to encourage the use of biodegradable materials, and bycatch mitigation practices (release of juvenile fish).
5. It is essential to undertake genetic studies to have the appropriate certainty for the shared coastal large pelagic stocks of indicator finfish species (*e.g.*, Common dolphinfish, King and Serra-Spanish mackerels, Blackfin tuna).
6. The urgent implementation of the Sub-regional Fisheries Management Plan for Flyingfish in the Eastern Caribbean (CRFM 2014).
7. The urgent update on the stock status of Round sardinella (*Sardinella aurita*) off northeastern Venezuela, noting that is a key prey species in the southeastern Caribbean Sea as well as a food security issue in Venezuela.

6. Soft-Bottom (Continental shelf) fisheries

The two most important fisheries in the region that target shrimp and also catch groundfishes as part of the shrimp bycatch or as a commercial byproduct of the shrimp fishery will be discussed in this section. One of them is the Gulf of Mexico (GOM) shrimp fishery that targets three species of Penaeid shrimps. The other, is the North Brazil shelf LME (NBSLME) shrimp and groundfish fishery targets four species of Penaeid shrimps as well as associated groundfish species (mostly weakfishes and snappers). The preferred gear of operation for these fisheries is the otter or demersal bottom trawl. In addition, there are important directed commercial and recreational fisheries for Red snapper caught with hook and line, bottom/drop lines, and traps. Other gears like gill nets, in addition to hook and line are also used in the capture of groundfishes.

6.1. Species of interest

The species of interest in this section are those considered to be the main target species of the soft-bottom fisheries in both regions considered, as well as those species with commercial interest for the countries in which bottom trawl fisheries take place in their waters. The selection was on the basis of major volume in landings, economic importance, and historical landings which resulted for the GOM shrimp fishery in: northern brown shrimp (*Farfantepenaeus aztecus*), which is the primary species, northern white shrimp (*Litopenaeus setiferus*), which is the secondary species and northern pink shrimp (*Farfantepenaeus duorarum*), as well as bycatch groundfish, mainly northern red snapper (*Lutjanus campechanus*) and Atlantic croaker (*Micropogonias undulatus*); although in the case of Northern red snapper, its relevance is due to its importance in the commercial longline fishery as well as the recreational fishery in the GOM, where the species is targeted by both fisheries. For the NBSLME shrimp and groundfish fishery the selected species were: southern brown shrimp (*Farfantepenaeus subtilis*), which is the primary species, southern pink shrimp (*Farfantepenaeus notialis*), which is the secondary species, spotted shrimp (*Farfantepenaeus brasiliensis*), and Atlantic seabob (*Xiphopenaeus kroyeri*) which is part of a targeted fishery in Guyana and Suriname. In addition, the groundfish species considered as part of the commercial byproduct of the NBSLME shrimp fishery and directed industrial and artisanal fisheries included: Whitemouth croaker (*Micropogonias furnieri*), Jamaica weakfish (*Cynoscion jamaicensis*), Green weakfish (*Cynoscion virescens*), King weakfish (*Macrodon ancylodon*), Southern red snapper (*Lutjanus purpureus*), and Lane snapper (*Lutjanus synagris*) (**Table 1**).

6.2. Geographic distribution and ecology

Northern brown shrimp (*Farfantepenaeus aztecus*). Northern brown shrimp is distributed along the Atlantic coast of U.S.A. from Massachusetts to Texas; east coast of Mexico from Tamaulipas to Campeche (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). Juvenile and adult shrimp feed on the bottom at night. They are omnivorous, and feed on worms, algae, microscopic animals, and various types of organic debris. Off North Carolina this is the most important *Penaeus* species. Also along the north and east coast of the Gulf of Mexico it is of great commercial value, although sometimes surpassed by *L. setiferus*; the grounds off Texas are by far the most important.

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 (Holthuis 1980). They're 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. Juvenile and adult shrimp are omnivorous and feed on the bottom on detritus, plants, microorganisms, macro-invertebrates, and small fish. Cannibalism is also common among adult white shrimp. White shrimp spawn when offshore ocean bottom water temperatures increase, generally from May through September in the Carolinas, 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 species is fished along the Atlantic coast of U.S.A. from North Carolina to Florida and in the Gulf of Mexico. It is of great economic importance in the United States and Mexico.

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 (Holthuis 1980). They're 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. The species is fished along the Atlantic coast of U.S.A. from North Carolina to Florida and in the Gulf of Mexico. It is of great economic importance in the United States and Mexico.

Northern red snapper (*Lutjanus campechanus*). Red snapper are 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 (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).

Atlantic croaker (*Micropogonias undulatus*). This species is distributed in the western Atlantic from the Gulf of Maine to Argentina. Along the U.S. Atlantic coast is abundant from Florida to Chesapeake Bay where it supports an important commercial and recreational fishery (Able et al. 2017). Atlantic croaker are generally found over mud and sandy mud bottoms in coastal waters to about 200 m depth. Nursery and feeding grounds are located in estuaries. It is dependent on estuaries during early juvenile stages. It spawns pelagic eggs in coastal waters during late summer, fall and winter. Late larvae enter estuaries after 30–60 days in the plankton, and juveniles spend their first winter in estuarine nursery habitats (Hare et al. 2010). Off North Carolina, it spawns in the ocean between September-February (Chao and Espinosa-Perez 2015).

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. The biology and ecology of this species is similar to 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).

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. 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 Leon et al. 2016).

Spotted shrimp (*Farfantepenaeus brasiliensis*). Spotted shrimp is distributed along the Atlantic coast of U.S.A. from North Carolina to Rio Grande do Sul in Brazil, including Bermuda and the Gulf of Mexico and the Caribbean Sea. 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).

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. 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).

Whitemouth croaker (*Micropogonias furnieri*).This species is distributed in the western Atlantic in the Gulf of Mexico from Veracruz, Mexico to northwestern Cuba, in the Caribbean Sea from Cuba, Jamaica to St. Croix, and along Central and South America from southern Belize to Bahia San Blas, Argentina (Aguilera et al. 2015). Whitemouth croaker are generally found over mud and sandy mud bottoms in coastal waters to about 80 m depth. Nursery and feeding grounds are located 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).

Jamaica weakfish (*Cynoscion jamaicensis*). This species is distributed in the western Atlantic from Hispaniola to Puerto Rico and along Central and South America from Guatemala to western Honduras, and Costa Rica to southern Brazil (Fredou and Villwock de Miranda 2015a). This species increases in abundance in the southern portions of its range, like the NBSLME area. It is generally found over mud and sandy mud bottoms off the coastline between 5 m and 100 m depth. Nursery and feeding grounds are located in river estuaries (Fredou and Villwock de Miranda 2015a).

Green weakfish (*Cynoscion virescens*). This species is distributed in the western Atlantic along Central and South America from Laguna de Caratasca, Honduras to Tubarao, Brazil, it is very common and abundant in the Guianas and common in Brazil (Fredou and Villwock de Miranda 2015b). It is generally found over mud and sandy mud bottoms off the coastline between 6 and 70 m of depth, especially near river mouths. Juveniles inhabit estuaries during summer and adults are also known to inhabit estuaries off French Guiana. It is mostly demersal during the day and moves toward the surface at night. It feeds mainly on shrimps and occasionally on fish (Fredou and Villwock de Miranda 2015b).

King weakfish (*Macrodon ancylodon*). This species is distributed in the western Atlantic from Barranquilla, Colombia to Bahia Blanca, Argentina. Its depth range is from 0 m to 60 m. This species is common and abundant in Venezuela, Guyana, Suriname, French Guiana, and scarce in northeastern Brazil where there are few estuaries and the bottom is mostly constituted of rocks. This species occurs over mud or sandy bottoms in coastal waters (Fredou et al. 2015). Juveniles inhabit estuaries and coastal lagoons. It feeds mainly on shrimps and small fish. Upon sexual maturation, it migrates to the 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 (Fredou et al. 2015).

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. It is most abundant on the continental shelf off Honduras and in the Guaianas-Brazil 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 and 120 m. Spawning occurs mainly during spring and summer. Adults feed mainly on fishes, shrimps, crabs, and cephalopods. Spawning occurs mainly during spring and summer (Allen 1985).

Lane snapper (*Lutjanus synagris*).This western Atlantic species is distributed from North Carolina south along the U.S. coast, Bermuda, the Bahamas, throughout the Gulf of Mexico and Caribbean Sea, and along the South American coast to Santa Catarina, Brazil (Lindeman et al. 2016a). 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 also near shore 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. 2016a).

6.3. Status and trends of Soft-bottom (Continental shelf) fisheries

6.3.1. Stock definitions

Northern brown shrimp. The population structure of the species is not clear but there are indications that the Northern Gulf of Mexico and North west Atlantic distributions may constitute a single contiguous population (McMillen-Jackson and Bert 2003) that are currently assessed and managed independently in the US region. Brown shrimp is caught along with pink and white shrimp along its distribution range. In Mexico is caught in the estuaries of Tamaulipas and Veracruz (Carta Nacional Pesquera 2012). It is unclear if the population caught in Mexico is part of the same population in the northern GOM and the U.S. southeast Atlantic.

Northern white shrimp. Samples from North Carolina (USA) to Campeche (Mexico) indicated that there is some evidence of genetic separation of a population of northern white shrimp from the U.S. Atlantic coast from a population in the Gulf of Mexico (Ball and Chapman, 2003).

Northern pink shrimp. Like northern brown shrimp, the population structure of this species is not clear but there are indications that the Northern Gulf of Mexico and the U.S. southeast Atlantic distributions may constitute a single contiguous population (McMillen-Jackson and Bert 2003) that are currently assessed and managed independently in the US region. Pink shrimp is caught along with Brown and White shrimp throughout the area.

Northern red snapper. This snapper species may not show significant genetic variation between the specimens of northern Gulf of Mexico and those of southern Gulf of Mexico, but it is believed they are unlikely to be part of the same population (Gold and Richardson, 1998). The northern red snapper caught in the U.S. southeastern Atlantic and the same species caught in Mexican waters are managed as separate stock units by the U.S. and Mexican fishing authorities (SEDAR 2017a, Carta Nacional Pesquera 2017).

Atlantic croaker. This croaker species was previously split into North (USA) and South (South America) stocks, but the Atlantic coastal stock is now considered a single stock from Gulf of Maine to mid-Argentina (http://www.asmfc.org/species/atlantic-croaker). However, removals of this species in the U.S. Atlantic coastal waters are discards of the shrimp trawl fishery and commercial landings caught with gillnets and entangling gear mostly occurring in the U.S. southeastern Atlantic (Able et al. 2017).

The stocks of shrimp and fish species caught in the soft-bottom fisheries off the NBSLME, by default have been defined by species and country based on management units rather than biological populations (CLME 2013).

Weakfish. Little is known about the stock structure of the sciaenid species in the region, with the exception of Whitemouth croaker *(Micropogonias furnieri)* from southern Brazil.

King weakfish. A molecular study using ribosomal DNA and mitochondrial genes to analyze genetic differentiation of *M. ancylodon* along its distribution was performed by Santos et al. (2003), revealed two distinct evolutionary lineages which broadly represented tropical and subtropical groups, in which the northern tropical group includes populations from Venezuela to Pernambuco (northeast of Brazil), whereas the southern subtropical group includes populations from São Paulo (southeast of Brazil) to Argentina. A more recent study (Santos et al. 2006), supports the tropical and subtropical separation, although the analyses indicated a deep phylogenetic separation indicating that there are different species under the phylogenetic species concept.

Southern red snapper. The stock structure is not totally understood. A distinct population of southern red snapper – Brazil exists (Gomes et al. 2012) but there is not sufficient information available in the Caribbean region.

Lane snapper. Genetic studies in the Gulf of Mexico (Karlsson et al. 2009) and the Caribbean (Gold et al. 2011) found significant differences in microsatellites and mtDNA between subpopulations. In particular, in the Gulf of Mexico there appear to be two subpopulations: one in the western Gulf and one in the eastern Gulf, with the western GOM subpopulation providing more migrants to the eastern subpopulation than the reverse.

6.3.2. Exploitation status

The current stock status of Northern brown shrimp in the Gulf of Mexico (GOM) is healthy; for the stock in the U.S. southeastern Atlantic is that it is not overfished and overfishing is not occurring (NOAA 2013). GOM Northern brown shrimp fishing mortality was estimated to be 1.55. Spawning biomass and recruitment at the end of the 2015 fishing season were 74.4 million pounds and 25.8 billion individuals respectively. Using these results, there is no evidence that the Gulf of Mexico brown shrimp stocks are overfished or undergoing overfishing (Hart 2016a).

The stock of GOM Northern white shrimp is healthy. Fishing mortality had been decreasing in recent years, with annual weighted F of 1.74 being estimated for the 2015 fishing season. Spawning biomass and recruitment for the 2015 fishing season were 467.9 million pounds and 18.8 billion individuals respectively (Hart 2016b); therefore, the Gulf of Mexico white shrimp stock is not overfished nor undergoing overfishing. U.S. southeastern Atlantic white shrimp stock is not overfished and overfishing is not occurring (NOAA 2013).

According to the latest stock assessment of the Northern pink shrimp (Hart 2017), the stock is not overfished nor undergoing overfishing. The stock had been showing a slight increase in spawning biomass, decrease in recruitment, and a decrease in fishing mortality, over the last year.

The Northern red snapper 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 U.S. 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. However, the projections assume future recruitment at the mean recruitment between 1984 and 2011 and continued sustainable levels of fishing mortality in the directed fishery (assuming quotas will not be exceeded, which has not been the case in the recreational fishery) and non-directed fishery (shrimp bycatch) (SSC 2013). Shrimp fishing effort has declined substantially which has positive impact on juvenile red snapper survival. In Mexico, the species is fished at maximum sustainable level at Tabasco, but in the rest of the fishing areas catches have deteriorated, likely overexploited (Carta Nacional Pesquera 2017).

The most recent assessment of Atlantic croaker for the southeastern Atlantic stock indicated significant declines in harvest and adult abundance in the Mid-Atlantic (north of Virginia-North Carolina border) region (Able et al. 2017). It also indicated that current stock status of Atlantic croaker could not be determined because the assessment results were sensitive to certain modeling assumptions, particularly those regarding fishery and survey gear selectivity. The Gulf of Mexico is a separate stock but there are no assessments.

On the basis of the last stock assessments, Southern brown shrimp, Southern pink shrimp, and Spotted shrimp are at medium risk of having the biomass below the limit reference point (CLME 2013). However, the exploitation is at medium risk for most of the species, but at high risk for Spotted shrimp. Thus, is likely that southern brown shrimp, and southern pink shrimp are fully exploited, but spotted shrimp is at risk of overexploitation (CLME 2013). Generally, stock status is difficult to determine in many species of *Penaeus* shrimp due to the lack of data and recurring stock assessments.

The last reported stock assessment of Atlantic seabob took place in 2009, which used data up to 2008 (CRFM 2009, 2011). The existing stock assessment has gaps due to absence of data on discards, artisanal catches for the dried seabob market in Suriname and IUU catches by foreign fleets from neighboring countries (CRFM 2011). Current status indicates that the stock is not overfished and overfishing is not occurring (Derrell et al. 2009), this status continues to the current time for Suriname and Guyana based on monitoring of the key stock indicator, the annual catch per unit effort (CPUE) since the implementation of Harvest Control Rules (HCRs) (Southall et al. 2017, 2019).

Whitemouth croaker *(Micropogonias furnieri),* Jamaica weakfish *(Cynoscion jamaicensis),* and Sea trout *(Cynoscion virescens)*, are commonly caught off the NBSLME fisheries with trawls and gillnets. Recent assessments indicate that all three 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. $L_{infinity}$) warns caution (McManus 2018).

King weakfish stock assessment in 1999 indicated that the stock was overfished from both growth and recruitment perspectives, but the assessment in the 2004 using a longer time series of data found no clear indication as to the state of the stock and could not confirm the findings in 1999 assessment (CRFM 2004). There were no trends in CPUE and fishing mortality estimates were not large relative to likely natural mortality. This may be partly because there is no directed fishery at this species and the species should be relatively robust to fishing. However, noting that recruitment overfishing is most likely not occurring, growth overfishing seems more likely, given the bycatch and discarding of small King weakfish. Current status is at medium risk of biomass falling below optimum levels and increasing exploitation levels (CLME 2013). Recent work on King weakfish (McManus 2018) suggests targeting appears to be at the optimal length and the MSY reference point met, but the use of inappropriate LBI values (e.g. $L_{infinity}$) warns caution as analyses will likely be compromised.

Southern red snapper stock assessment carried out in Guyana suggested that the stock was most likely under- to fully-exploited; while the stock status in Trinidad and Tobago was likely underexploited in 2006 (CLME 2013). Thus, on balance the stock is not overfished.

Lane snapper stock assessments conducted in several countries fishing in the NBSLME fisheries concluded from the preliminary results that the stock in that area may be overfished (CRFM 2004; CRFM 2006). From a yield per recruit perspective, the fishery appears to be operating near the optimum, but this assumes that future recruitment will continue at current levels.

6.3.3. Trends in fishery landings

Northern brown shrimp has been fluctuating around 50 000 tonnes since 2000 and showed an increase to 59 913 tonnes in 2017 after a recent peak in 2015 (**Fig.14A**). The historical catch was almost entirely from the U.S., until 2005 when Mexico has increased its fraction in the total landings of northern brown shrimp (**Fig.14B**).

After three years (2013-2015) of stable landings around 42 000 tonnes, Northern white shrimp landings reached 55 250 tonnes in 2017 (**Fig.15A**). In a similar way, the historical catch was almost entirely from the U.S., until 2005 when Mexico increased its fraction in the total landings of Northern white shrimp but at a much smaller fraction of the total catch than in northern brown shrimp (**Fig.15B**).

Northern pink shrimp landings showed a notable increase to 13 258 tonnes in 2017, after 3 years of landings between 7 000 and 9 000 tonnes, mostly attributed to increases in the landings from Mexico and the U.S. in the past five years (**Fig.16A,C**). The historical catch was almost entirely from the U.S. and Cuba through 2005, thereafter Mexico increased its fraction in the total landings of Northern pink shrimp (**Fig.16B**).

Northern red snapper, reported by Mexico and the United States of America peaked 8 711 tonnes in 1993 then landings dropped to low levels of 2 535 tonnes in 2010, since landings have shown a sustained recovery to over 7 000 tonnes (**Fig.17A**). The historical catch was almost entirely from the U.S and Mexico since 1970 (**Fig.17B**). Recent landings show a stable increasing trend led by Mexico (**Fig.17C**).

Historical landings of Atlantic croaker have been reported mostly by the United States, after high catches in the early period (1970´s) landings have remained fluctuating below 100 tonnes through 2017 (**Fig.18**) of which most of the U.S. landing come from the U.S. southern Mid-Atlantic.

Penaeus shrimps nei, reported mainly by Mexico, Venezuela, Nicaragua and Honduras, stopped a long declining trend in 2016, when in 2017 a small recovery to 8 825 tonnes is observed (**Fig.19A**). Historical landings of *Penaeus* shrimp nei from the countries of the NBSLME fisheries (*i.e*., Venezuela, Trinidad and Tobago, Suriname, Guyana, and French Guyana) show Venezuela as a major contributor that disappears in the last two years of the series, which is attributed to separating *P. schmitti* landings from *Penaeu*s shrimp nei reporting (**Fig.20A**). In recent years, *Penaeus* shrimp nei landings have been relatively stable above 500 tonnes, for most countries in the sub-region, with the exception of Suriname for which reported landings show a slow decreasing trend between 2013 and 2017 (**Fig.20B**).

Atlantic seabob overall landings increased in 2017 and reached 30 697 tonnes (**Fig.21**). Historical landings are reported to FAO mainly by Guyana, Suriname, the United States of America and Mexico, but after 2000, Guyana and Suriname have been the major contributors to the total Atlantic seabob landings (**Fig.21B,C**).

Historical landings of sciaenid species, with the exception of Whitemouth croaker are reported as Weakfish nei to FAO, likely including King weakfish *(Macrodon ancylodon)* as well. However, noting that only Venezuela reports Whitemouth croaker separately, it is likely that other countries in the WECAFC area have reported it within Weakfish nei group. Landings of Whitemouth croaker increased in the last two years to 3 015 tonnes after a decreasing trend since the early 2000s (**Fig.22A, C**). Weakfishes nei, mainly from Mexico, Venezuela and French Guiana, show a steady decreasing trend since 2005 to 5 998 tonnes in 2017 (**Fig.22B**), although in recent years a relative stable trend is observed for Mexico and Venezuela, less so for French Guiana (**Fig.22D**).

Southern red snapper landings show two recent peaks of 2 800 tonnes in 2010 and 2014, thereafter landings dropped to levels close to 2 000 tonnes, and in recent years a small recovery to over 2 000 tonnes is observed in 2016 and 2017 (Fig.23A), mostly caused by reported landings from Guyana (**Fig.23B**). Recent historical landings indicated that the major proportion is reported by Guyana (**Fig.23C**).

Lane snapper landings have fluctuated around 1 300 tonnes and 2 000 tonnes after the major drop of around 1 200 tonnes in 2005(**Fig.24A**). In recent years Cuba´s reported landings have shown a decrease, while small increases are reported by Mexico and Venezuela (**Fig.24C**).

6.3.4. Impact

Impact is considered in terms of the achievement of specific societal goals and targets, which were detailed in section 2.2.4. of this report.

Like in most fisheries discussed in this report, determining whether or not the fishery is biologically sustainable will likely require further analyses based on reliable data and more detailed information. The northern Penaeid shrimp stocks are healthy and are considered biologically sustainable. In the case of the Northern red snapper, it is likely to be recovering and the fishery is likely to be biologically sustainable but is unknown for the Atlantic croaker due to the absence of current stock status. The southern Penaeid shrimps, and in most of the groundfish species considered here, the stocks are at least fully exploited and likely overexploited, thus biological sustainability is unlikely. Major issues are the uncertainties associated to more detailed fishery information, *e.g.*, in groundfish one of them is the species-specific landed catch.

7. Associated Social and Economic Aspects

In most cases, information regarding social and economic aspects is limited at the fishery level and mostly nonexistent at the species level. Consequently, the information presented in this section will be limited to the available data for some species in specific countries in which the information is readily available.

7.1. Benefits

During 2017, total WECAFC landings were 2.504.018 tonnes (excluding mollusks), of which 203,848 tonnes consists of shrimp and groundfish species (excluding snappers), and 195,885 tonnes represent the group of species selected in this report. The shrimp and groundfish (excluding snappers) species selected accounted for 6,82% of the shrimp landings and 1.01% of the groundfish landings (**Table 2**).

- Income: The estimated annual value of total landings in the FAO area 31 in 2014 was more than 1 000 million US$ (Pauly and Zeller 2015). In a couple of countries from the NBSLME area, GDP in 2017 for Suriname was $USD 3324 million and for Guyana it was $USD 3676 million, with 8.74% and 12.68% corresponding to the Agriculture, forestry, and fishing, value added, respectively (WorldBank, 2017).
- Food security: Fish plays an important part in food supply, with a per capita consumption of 17.7 kg in 2017 in Suriname, about double the South American average Also this sector plays an important role in rural development, especially in the coastal areas (Fishery and Aquaculture Country Profiles: Suriname, 2019). In some communities, such as the ones belonging to region of Salgado Paraense (north of Brasil), shrimps from artisanal fisheries are the basic food for many families (Ravena-Cañete, 2018). In addition, Shrimps and Southern red snapper are high valued products for export for most countries in the NBSLME area.
- Recreation: In the United States, the recreational fishing sector in the GOM show an important increase (up 78% since 2015) in captures of Northern red snapper (https://www.fisheries.noaa.gov/resource/document/fisheries-economics-united-states-report-2016). Generating important revenues from recreational fisheries in the area.

7.2. Production and value

The species of interest sustain economically important fisheries in the area, as illustrated by its landings compared to the total landings of species by similar groups for the area (excluding mollusks) in the western central Atlantic-FAO area 31 (**Fig.28**).

In terms of value in groundfish fisheries, the Northern white shrimp was the species with the highest value (221,88 million US$), followed by Weakfishes, Atlantic croaker, Snappers, and Northern red snapper (Pauly and Zeller, 2015) (**Fig.29**). In the WECAFC area of the United States (South Atlantic and Gulf of Mexico), Shrimps provided the highest landing revenues but the lowest annual average price compared to Snappers of which Red snapper had the highest annual average price (**Table 3**).

Regarding the countries in the WECAFC area that represent over 98% of the total landings in 2017 (excluding mollusks), the United States of America has the major accumulated percentage (62.95%) of catches for all shrimp species followed by Mexico with 68.81% and Guyana with 13.54% (**Fig. 31A**). While, the total landings of the selected shrimp species, the three countries to lead the major accumulated percentage were Mexico, Guyana and Suriname (**Fig. 31B**). In the case of Guyana and Suriname, the largest proportion of the landings are attributed to Atlantic seabob. In the case of the groundfish (excluding snappers) species, Mexico, Venezuela and United States of America accumulated the highest percentages of the total groundfish landings (**Fig. 31C**); while for the selected species of groundfish (excluding snappers) it was Mexico, Venezuela and French Guiana the countries that accumulated the highest percentages of the landings (**Fig. 31D**).

Considering catches of the most recent year available (2017), the fishery of shrimps and groundfish had more landed catch by the United States of America, Mexico and Guyana (**Fig.32A**).

The contribution of the fisheries targeting the species evaluated to the national gross domestic product (GDP) is clearly unknown. In most countries of WECAFC area, the available information refers to the contribution of the entire agriculture, forestry, and fishing sector, which is between less than 1% and 5% (World Bank, 2019). However, in many countries of the region (like Guyana, Trinidad and Tobago, Suriname and French Guiana) fisheries such as the ones of shrimps, weakfishes and others are of major economic importance to commercial and artisanal fishers, for example, GDP in 2017 for Suriname was $USD 3324 million and for Guyana it was $USD 3676 million, with 8.74% and 12.68% corresponding to the Agriculture, forestry, and fishing, value added, respectively (World Bank 2017). The best available information is the one provided by WECAFC (2019a), in which says that countries are encouraged to collaborate with FAO to increase the availability and/or precision of their data, by providing otherwise unavailable inputs for the calculation of the indicator. Data could be received through existing processes (*i.e.*, FAO questionnaires of capture and aquaculture production) or others planned to be established. Consequently, a proportion of fisheries and aquaculture to GDP available for 23 countries according the SDG 14.7.1 methodology is presented in **Table 4**.

7.3. Employment

Target species of this section support artisanal, industrial and recreational fisheries. In some cases they include subsistence fishery especially for coastal communities.

Data regarding to the number of fisher refers to the total number of fishers by country, is not disaggregated by fisheries or by the species considered in this report; however, in countries like Suriname, the fishing industry provided employment for approximately 6,324 people in 2010, of which 175 belong to Shrimp boat category and 140 to the Seabob boats (Ministry of Agriculture, Animal Husbandry and Fisheries, 2013). In Guyana, the fishing industry employs some 8,400 people in harvesting and 5,000 in processing and marketing, so more than 10,000 livelihoods depend directly on fishery, and many more benefit indirectly from fishing-related occupations such as boat building, gear supply and repair (Fishery and Aquaculture Country Profiles: Guyana, 2019). In some cases there is participation of women in the harvesting, such as the case of artisanal shrimp fishery in the Para region of north Brasil, where 15.5% of fishers are women (Ravena-Cañete, 2018).

According to FAO data, for the countries with the higher production levels of the main groups studied the number of fishers go from 6.66 thousand (Surinam in 2014) to 238 thousand (Mexico in 2017). Information on employment by gender for the species of interest is not available either. However, according to WECAFC (2019a), based on the available FAO Fisheries and Aquaculture Profiles and on some country publications such as the NOAA publication on economic importance of fisheries in the United States of America (https://www.fisheries.noaa.gov/resource/document/fisheries-economics-united-states-report-2016), an estimate is provided for a group of countries (**Table 5**).

7.4. Human well-being and social justice

The status of the fisheries of the interest species and main groups have a direct bearing on the well-being of the communities that exploit those resources as their major source of income and livelihoods.

An assessment of the six human well-being indicators of the Governance Effectiveness Assessment Framework is not available for the fisheries nor the species of interest in the area evaluated. It is recommended to join efforts on this matter to apply it in each country, possibly by following the holistic framework proposed by Biedenweg *et al*. (2016).

An example is presented for the community of fishers dedicated to the artisanal shrimp fishery in the Salgado Paraense region (North of Brasil) which have a low scholarity; this is a factor who certainly contributed to the inefficiency of taking advantage of public policies (Ravena-Cañete, 2018). In Suriname, as compared to people from Paramaribo and other urban areas, the inhabitants of most fishing and plantation communities have relatively poor access to health care facilities, government institutions, information and educational facilities. (Ministry of Agriculture, Animal Husbandry and Fisheries, 2013). In isolated fishing communities of the same country (i.e. Braamspunt, Bigi Santi, Pomona), living conditions can be characterized as very poor (Duijves & Heemskerk, 2011).

7.5. Impact

Improvements in human well-being and social justice are implicit in many societal goals and targets, particularly the Sustainable Development Goals (SDGs). In most fisher communities, there are conditions that could be improved regarding to human well-being and social justice such as health status, environmental quality, personal security, housing, income and among other issues relevant to each community.

In addition, overfishing of any of the species previously mentioned is likely to have significant adverse economic consequences for the communities and countries that exploit those resources. Considering that all stocks exploited in the WECAFC area that had some form of stock assessments, 56.8% of them are fully exploited, 37.8% are over-exploited, and 5.4% in which current stock status could not be determined (WECAFC 2019b). This last point has a direct relation to the SDG 14, target 14.1 "By 2020, effectively regulate harvesting and end overfishing (…) in which indicator 14.4.1 is the proportion of fish stocks within biological sustainable levels". Of the species included in this section, like it was presented in section 6.3.4, indicated that the northern Penaeid shrimp stocks are healthy and are considered biologically sustainable in contrast to the Penaeid shrimps of which the stocks are at least fully exploited and likely overexploited, thus biological sustainability is unlikely. In the case of the Snappers all stock are likely overexploited and towards recovering and in the case of the Weakfish species its stock status are at least fully exploited and likely overexploited. Therefore, biological sustainability is unlikely in some stocks. Major issues are the uncertainties associated to more detailed fishery information, *e.g.*, in groundfish one of them is the species-specific landed catch.

8. Drivers and Pressures

8.1. Drivers

Drivers are the economic, social, cultural and political factors that motivate human activities and satisfy basic human needs such as food and employment. They increase or mitigate pressures on the populations Penaeid shrimps and coastal fish species occupying various substrata (soft bottom being the drivers for the fisheries reviewed:

Economic Value: High or competitive prices along the value chain and high market demand for export and local consumption sector and people with purchasing power represent the main drivers (Lappo et al. 2015). High demand, high quality and reduced supply can significantly increase the prices paid for any of the high value finfish and/or shellfish products like, Penaeid shrimps and snappers which have promoted further overcapitalization (excessive fishing effort) in groundfish fisheries, which have contributed to overfishing in some countries.

Employment: Shellfish and finfish fisheries are one of the most viable work options for many Caribbean nations. In developing nation cities where important ports with fishing operations exist as well as in remote fishing communities where economic development is low, fishing of shellfish and finfish resources as well as other associated resources such as octopus, crab, and/or sea cucumber fishing have always been a very attractive source of income. However, in many cases throughout the Caribbean developing nations, employment in the fishery sector is a last resort.

Consumer awareness: In the WECAFC area steps have been taken towards sustainability in some countries where awareness was low, like the Marine Stewardship Council (MSC) certification process in Guyana and Suriname for the Atlantic seabob industrial fishery (Southall et al. 2017, 2019).

8.2. **Pressures**

Pressures are factors (natural and/or anthropogenic) that result in unsustainable fishing of the shellfish and finfish resources reviewed or induce negative changes in its health or its populations. The open-access nature of some of the fisheries targeting shellfish and finfish resources in the region can exacerbate its unsustainable exploitation. Among the key pressures that may affect these resources are:

Fishing effort: Excessive fishing effort (e.g., number of vessels/boats and fishing days that exceed the level required for optimum sustainable catch) has contributed to overfishing of some resources in some countries. However, in recent years several countries have limited fishing effort in their shrimp and groundfish fleets, mostly by limiting the number of licenses per type of fishery or by banning industrial shrimp and groundfish trawling in national waters (e.g., Venezuela) (Arocha and Mendoza 2015). Countries like Suriname and Guyana have introduced Fisheries Management Plans for their Atlantic seabob fisheries that has established a limit on licensing (Ministry of Agriculture, Animal Husbandry and Fisheries. 2013, Government of Guyana Ministry of Agriculture 2019), the United States has moratorium on Permits and a plan to reduce the number of permits (GMFMC-NOAA 2017); while Mexico has a placed a limit on number of vessels and permits (Carta Nacional Pesquera 2012).

Illegal, unreported and unregulated fishing: Illegal fishing is fishing conducted by national or foreign vessels in the waters of a State without permission of that State, examples exists of neighboring fleets exploiting resources from other country's waters, mostly small scale and semi industrial in national inshore waters and offshore banks, like some fleets fishing for shrimp and groundfish resources. There are six nations that share sea boundaries in the NBSLME area (Trinidad and Tobago, Venezuela, Guyana, Suriname, French Guiana, and Brazil), it has been known, but not quantified, the number of artisanal/small scale and semi industrial vessels that fish in neighboring waters without permission, and in some cases do not report landings. Some countries in the area, like Guyana and Suriname, have recently enhanced their monitor, surveillance and control systems to reduce IUU practices (Southall et al. 2017, 2019), other countries in the area have lagged behind in their efforts to control it. This practice directly affects the sustainability of the shrimp and groundfish resources of the area. Unreported fishing occurs when a vessel does not report or misreports its catches in contravention of national law or the reporting procedures of an RFMO, another common practice in the NBSLME for groundfish resources that are not the primary target species, which also contributes to the potential depletion of non-target species.

Destructive/ghost fishing:
Gillnet gear causes incidental mortality on nontarget species; the obvious result of not investing in retrieving fishing gear, mortality may be substantial and its effect on stock productivity could be significant.
Catching and discarding juvenile fish in bottom trawl fisheries (for shrimp and groundfish fisheries) throughout the region has contributed to population decline for some snapper species that are caught in these fisheries, like *Lutjanus analis, L. campechanus, L. synagris,* and most likely *L. purpureus*.

Habitat degradation:
In demersal fisheries, bottom trawling has been a source of potential habitat degradation by disturbing or destroying seagrass beds, coral reefs or rock gardens where fish hide from predators (NRC 2002). Bottom trawling flattens any upright structure on the seafloor destroying coral reefs and other places where juvenile fish hide. Hard-bottom areas away from the reef are also likely to be vulnerable to bottom trawling (NRC 2002). The extent to which habitat degradation has affected the weakfish, snapper populations in the region is unknown and requires further investigation.
Groundfishes Weakfish) production and survival are highly dependent on the quality of its preferred marine habitats, particularly shallow-water nursery habitats in estuarine areas (for weakfishes/*Cynoscion spp.*). Coastal development and pollution, particularly from land-based sources and activities, have degraded mangroves, seagrass beds

Climate change: Several climate change stressors have been identified and its implications for marine resources and fisheries of the WECAFC area (WECAFC 2019c), which include increasing sea surface temperature (SST), ocean acidification (OA), sea level rise (SLR) and increased frequency of extreme weather events (e.g. storms, hurricanes, precipitation anomalies). A regime shift in the southeastern Caribbean Sea has been documented (Taylor et al. 2012). However, once currents and winds move it close to shore, the algae start to break-down, sink, and decay, creating an environment poor in oxygen (van Tussenbroek et al. 2017). Animals trapped under or among the dense mats can neither escape nor breathe, and ultimately die. The decomposing mass of several meters in height deprives of oxygen coastal habitats, such as seagrass beds, that support much of the diversity of sea life affecting coastal nursery areas. There is no clear understanding how the recurring GASB affects fish populations in the region, clearly future research is critically needed. However, increases in SST will affect the productivity and distribution of many species, as they will likely move to areas with more favorable temperatures.

In the Penaeid shrimp and groundfish (e.g. weakfishes, croakers) species mostly rely on estuarine nursery areas, and offshore deeper soft bottom areas as adults. The early life stages are expected to be particularly vulnerable to further degradation of estuarine habitats expected under climate change and continuing eutrophication (e.g. changes to salinity, increased hypoxia). The adult habitats will likely be less impacted by climate change and adults could probably move to deeper offshore soft-bottom habitats. However, Penaeid shrimps in the northern Gulf of Mexico where the development of seasonal hypoxic areas is particularly severe and increasing under climate change are expected to suffer significant impacts, since the adults will be unable to pass through the hypoxic zones to spawn in open water. Overall, declining productivity of shrimp and groundfish populations are expected over the near- to medium-term with significant reductions in fisheries production in the North Brazil Shelf, continental countries of the Caribbean, and the Gulf of Mexico (WECAFC 2019c).

Fisheries Impact: Bycatch constitutes an important issue in all fisheries. Bycatch can negatively affect species all fish species, sea turtles, protected fish, marine mammals, and sea birds by harming animals, contributing to population declines, and impeding population recovery. Other impacts of fisheries may include removal of preferred prey and sometimes habitat damage.
Bycatch is also an issue in bottom trawl fisheries that may have contributed to population declines in the stocks of several snapper species in the GOM shrimp fisheries, and in the NBSLME shrimp and groundfish fisheries, by catching and discarding juveniles of snapper and other groundfish species (likely species of Weakfish) (Meeremans et al. 2017).

8.3. Impact of soft-bottom fisheries on marine habitats and biodiversity

An ecosystem approach to fisheries requires that the fishery's impact on other components of the ecosystem is considered in decision-making. Soft-bottom (demersal) fisheries, as reviewed here, have the potential to affect habitats and biodiversity through various means, like:

Soft-bottom (demersal) fisheries. Bycatch and discards of juvenile fish and shellfish in bottom-trawl fisheries is known to have an impact on the marine habitats and biodiversity; particularly, for endangered and threatened species (Sea turtles and elasmobranchs). Damage from fishing gear (including lost and abandoned gear, and impact on seagrass beds) and from bottom-trawling on nursery areas are known to be major stressors on the sea floor. In the area of the NBSLME, it has been noted that despite the relative selectivity, 31%-41% of the catch in the Suriname Atlantic seabob fishery consist of bycatch, and the majority is discarded; while 75% consists bycatch in the shrimp trawl fishery, and in the finfish trawl fishery 45% of the catch was discarded (Meeremans et al. 2017).
Further specific investigations are needed to assess the impact of these fisheries on marine habitats and biodiversity.

9. Responses

Responses include measures and actions taken by stakeholders to ensure that shellfish and finfish fisheries are sustainable. They also include the institutional, policy and legal frameworks and processes that are relevant to shellfish and finfish fisheries management.
Responses are divided into 'governance' and 'management' (including stress-reduction measures). Governance covers architecture/arrangements and processes.

9.1. Governance architecture

Existence of arrangements that address the governance of shellfish and finfish fisheries at the regional/ sub regional level: Noting that the fishery resources considered in this section , namely, highly shrimp and groundfishes, WECAFC/CRFM/IFREMER Working Group on Shrimp and Groundfish in the Northern Brazil-Guiana's Shelf; the Recommendation WECAFC/XVII/2016/5 "On the management of shrimp and groundfish resources of the north NBSLME in the WECAFC area" (WECAFC 2016). However, it has been noted that the countries in the WECAFC area have committed themselves to implement the CLME+ Strategic Action Programme (SAP), which calls for a sub-regional management plan for shrimp and groundfish (FAO 2017). Additionally, the development of the Caribbean Management Plan for Spawning Aggregation that was originally introduced in 2012, it has not been approved.

Level of application of fishery policy by the fisheries mechanisms: In the case of shellfish and finfish fisheries (with exception of highly migratory pelagic species) not having complete set of policies at a specific regional or sub-regional level (CERMES 2018), the stages of application of policy cycles to which attention should be paid, which include management advise, management review, management data and information, policy decision-making, management decision-making, and management implementation. The implications for the different fisheries reviewed that have transboundary and shared stocks is that at ideally the policy cycle stages be sanctioned and implemented by the three Regional Fishery Advisory Bodies in the region (WECAFC, CRFM, OSPESCA), in view of the inexistence of a RFMO for the transboundary and shared stocks that are not under the ICCAT mandate.

9.2. Governance processes

Sub regional processes:

WECAFC has also promoted and adopted Recommendation WECAFC/XVII/2019/11 “On the management of shrimp and groundfish resources of the north North Brazil shelf LME (NBSLME) in the WECAFC area”, in which encourages interested parties to ensure the sustainability of the shrimp and groundfish resources targeted by the nations involved in the fishery. The provisions in the Recommendation include: 1, WECAFC members and partners should ensure Shrimp and Groundfish priority species of the North Brazil-Guianas shelf are included in the Regional WECAFC-FIRMS database. 2, WECAFC, in close collaboration with FAO, CRFM NOAA and IFREMER build capacity in the Brazil-Guianas region for relevant and periodic stock assessment and bioeconomic analysis of priority fisheries to overcome significant knowledge gaps on the status of stocks. 3, WECAFC, in close coordination with CRFM and IFREMER should facilitate the provision of samples and mobilize necessary resources to complete population genetic studies required to properly manage stocks of critical shrimp and groundfish species of the North Brazil-Guianas Shelf. 4, WECAFC members develop and enforce national level shrimp and groundfish fishery management plans and put in place appropriate legislation in support of a sustainable shrimp and groundfish fishery. 5, The Working Group on Shrimp and Groundfish to assist the Regional Working Group on IUU to develop a regional plan of action to combat Illegal, Unreported and Unregulated (IUU) fishing (RPOA-IUU). 6, The Working Group on shrimp and Groundfish to collaborate with the Regional Working Group on Fisheries Data and Statistics to identify training opportunities for initializing the WECAFC-FIRMS regional database and developing FIRMS inventories. 7, WECAFC, in close collaboration with partners and Members to evaluate the impact of sargassum on the shrimp and groundfish fisheries and include these fisheries in regional sargassum prediction model and mitigation initiatives. 8, WECAFC to collaborate with OSPESCA and CRFM to develop a regional strategy for management of bycatch in shrimp/bottom trawl fisheries to be completed in a consultative process with the support of REBYC-II LAC project and presented to the 18th Session of WECAFC for its review and endorsement.

In a review conducted to provide an inventory of legal, administrative and management frameworks in place for managing marine capture fisheries in the Western Central Atlantic Fishery Commission (WECAFC) area, several governance and management issues were identified, like the existence of inadequate legislation, ad hoc management processes and plans, uncoordinated monitoring and enforcement, non-management-driven scientific information, insufficient stakeholder identification and participation, among other issues (Singh-Renton and McIvor 2015).

9.3. Stress-reduction measures

Several stress-reduction measures have been adopted by the countries that exploit shrimp and groundfish resources in the WECAFC area. These measures aim to control fishing pressure on the stocks so that the stocks can be restored to sustainable levels.

Stress-reduction measures in bottom-trawl shrimp and groundfish: In Brazil's shrimp fishery on the Amazon continental shelf a series of measurement have been adopted which include: (1) the mandatory use of sea turtles excluding devices (TED) in fishing trawl nets by the industrial vessels along the Brazilian coast; (2) vessel limitation in the industrial bottom-trawl fleet; (3) Seasonal closure and area restriction to shrimp fishery motorized vessels; (4) Closed areas to trawling by motorized vessels. In Guyana´s Atlantic seabob fishery a reduction of 40% of the elasmobranch catch rate was reduced by modified turtle excluder devices (TEDs) (with a reduced bar spacing and the addition of a brace bar), it also resulted in a virtual elimination of 3 IUCN designated endangered/threatened species (Garstin and Oxenford 2018). Suriname has a Fisheries policy which includes a Licensing policy that will issue number plates (or stickers) with a unique license number on a yearly basis (Ministry of Agriculture, Animal Husbandry and Fisheries 2013). Vessels limited size (max length of 12 m for inland vessels-BV), larger vessels need to apply for a Surinamese Coastal (SK) license number. All SK boats will be required to carry a VMS system. Fishing zones are demarcated between inland waters and the fishery zone. The number of licenses for the large sea shrimp fishery will be limited at 25 for the duration of management plan 2014-2018. Any increase of issuable licenses can only be considered if research (CPUE data) indicates that shrimp stocks have recovered to original levels. The shrimp sector will conduct experiments with several types of BRD (especially Nordmore Grid). The BRD judged to be most effective will be implemented. In the Atlantic seabob bottom trawl fishing, the number of licenses will be fixed to 22 for the duration of this Management Plan. The use of BRD found most effective will be implemented. In Bottom trawl fishing (for demersal species), the number of licenses issuable for the bottom trawl fishery will be fixed at a maximum of 23. The 500 hp maximal permitted engine power will be strictly imposed from January 2019. Since inspection of maximal engine power is technically complicated, the maximum length of replacement vessels has been fixed at 32 m. From 1st January 2017 the use of a TED will also be mandatory in fish trawl fishery. This set date will allow the sector time to develop a workable flexible TED. In the United States of America, stress reduction measures on the shrimp fisheries include, size limits, vessel trip limits, closed seasons or areas and reopening's, quotas (including a quota of zero), gear restrictions (ranging from regulation to complete prohibition), gear markings and identification, vessel markings and identification, rebuilding plans, restrictions relative to conditions of harvested shrimp (maintaining shrimp in whole condition, use as bait), target effort and fishing mortality reduction levels, bycatch reduction criteria, BRD certification and decertification criteria, BRD testing protocol and certified BRD specifications (https://www.federalregister.gov/documents/2015/11/30/2015-30214/fisheries-of-the-caribbean-gulf-of-mexico-and-south-atlantic-shrimp-fishery-of-the-gulf-of-mexico). In GOM shrimp fishery, a nested cylinder bycatch reduction device (NCBRD) tested in shrimp trawls has proven to reduce juvenile Northern red snapper catch rate to about 50% (Parsons and Foster 2015), which suggests that the NCBRD device may find application in other trawl fisheries in the area.

9.4. Recommendations for action

Soft-Bottom (continental shelf) fisheries:

1. Venezuela and Trinidad share shrimp resources caught by several fleets of both countries; although catches have decreased; it was the result of Venezuela´s ban on bottom-trawl on April 2009. In order to prevent a re-expansion of the fishery, if Venezuela lifts its ban on bottom-trawling in the future, it was recommended that Trinidad should implement its own management controls, like closed season for trawling; limitation on the numbers of trawlers with a view to a reduction in fleet size, strictly enforce the current regulations for the trawl fishery, and set appropriate and specific reference points for the fishery (CLME 2013).
2. Activate the existing 1989 Protocol on co-operation in fisheries research between Trinidad and Tobago and Venezuela. The FAO should be approached to provide technical assistance in the following: a. Harmonization of data collection and analysis methods; b. Joint length-based assessments for shrimp and groundfish species; c. Joint bio-economic analyses by fleet for shrimp and groundfish species. Bilateral meetings are considered essential in the inter-sessional periods between regional assessment meetings (CLME 2013).
3. Evaluation and assessment of mandatory use of Turtle Exclusion Devices / Bycatch Reduction Devices (TED/BRD) in bottom-trawl fisheries.

4. Implement management actions that reduce risk to the stocks in Trinidad, Guyana, and Suriname. Actions include reducing susceptibility scores for the stocks, so that the effects of the action on the risk score are clear. For example, limiting the depths where trawling is allowed could reduce the vertical overlap of the fishery with the stocks, altering the risk score (CLME 2013).
5. It is essential to undertake genetic studies to have the appropriate certainty for the shared shrimp stock hypotheses for Brazil and French Guyana on the one hand, and Guyana and Suriname on the other hand. As well as for other groundfish (*e.g.*, Weakfishes, Snappers) species that are potentially shared by the fisheries in the Guiana's-Brazil shelf.
6. Need to implement the CLME Strategic Action Programme (SAP), which calls for a sub-regional management, in which shared stocks or shared fisheries would require joint management, either a bilateral or sub-regional plan for shrimp and groundfish.
7. The use of Vessel Monitoring Systems (VMS) is an effective tool for various management controls on fishing activity, including providing greater safety-at-sea. It should be a requirement for all vessels operation in the fishing area.

10. Hard-Bottom (Coral reef - finfish) fisheries

In this section, hard bottom fisheries will include those fisheries using passive gears like hook and line, bottom longline, or set longline that target reef fishes normally fished around coral reefs or rocky bottoms throughout the WECAFC area. Considering that there is a vast array of fish species from several groups like the Balistidae (Triggerfishes), Carangidae (Jacks), Labridae (Wrasses), Malacanthidae (Tilefishes), Serranidae (Groupers), and Lutjanidae (Snappers) that are likely to be caught by this fishery, for the purpose of the present report the selected species to be reviewed are on the basis of their data availability, high commercial value, the formation of spawning aggregations near or off coral reefs, and that have been subjected to intensive fishery exploitation. The primary gears used to catch hard-bottom indicator finfish species in the WECAFC area include boat seines, beach gill nets, set nets, hooks and lines with electric or manual winches, bottom longlines, traps, and divers using spearfishing.

10.1. Species of interest

The selected species include three species of groupers and one species of snapper (**Table 1**), *i.e.*, *Epinephelus morio* (Red grouper), *Epinephelus striatus* (Nassau grouper), *Mycteroperca microlepis* (Gag grouper), and *Lutjanus analis* (Mutton snapper). Noting that there other species that can be included in this section, like Northern red snapper (*Lutjanus campechanus*), Southern red snapper *(Lutjanus purpureus)*, Lane snapper *(Lutjanus synagris)*, these species have been reviewed in the previous section because they form an important part of the soft-bottom and groundfish fisheries catch, therefore will not be reviewed in this section.

10.2. Geographic distribution and ecology

Red grouper (*Epinephelus morio*). Red grouper is distributed in the western Atlantic from North Carolina, south along the U.S. 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 (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 Atlantic U.S. (Brule et al. 2018).

Nassau grouper (*Epinephelus striatus*). Nassau grouper is naturally abundant in areas with large shelf platform habitat, such as Belize, the Bahamas, 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).

Gag grouper (*Mycteroperca microlepis*). Gag grouper is distributed in the western Atlantic from North Carolina south along the U.S., Bermuda, throughout the Gulf of Mexico except Cuba (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).

Mutton snapper (*Lutjanus analis*). Mutton snapper is distributed from Cape Hatteras, North Carolina south along the U.S. 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 (Lindeman et al. 2016b). 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. 2016b). An important spawning aggregation site at Dry Tortugas, Florida has been subject to management attention.

10.3. Status and Trends of Hard-Bottom (Coral reef - finfish) fisheries

10.3.1. Stock definitions

Red grouper. Genetic analyses of Red grouper have shown low genetic variation across the red grouper's US and Mexican distribution range suggesting 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 management pursposes there are three recognized stock units, the U.S. South Atlantic unit, the U.S. GOM unit and the Mexican GOM unit.

Nassau grouper. Genetic studies show evidence that there is strong genetic differentiation among Nassau Grouper subpopulations in the Caribbean region (Jackson et al. 2014b), proposed genetic barriers separates Bahamas and eastern Caribbean, central Caribbean, and Mesoamerican Reef/Belize.

Gag grouper. Stock structure of Gag grouper is unclear regarding continuity between the Gulf of Mexico and US Atlantic coast distribution of the species (Chapman et al., 1999). However, for management pursposes the recognized stock units are for the U.S. GOM and U.S. South Atlantic.

Mutton snapper. The limits of the biologic stock structure are not completly clear. A recent study of the genetics of specimens from the Florida Keys, Puerto Rico, and the U.S. Virgin Islands (Carson et al. 2011) supports the single stock hypothesis; in the Southeast United States it is considered a single stock that is centered in south Florida.

10.3.2. Exploitation status

Red grouper stock status has been partitioned in three structures, in which the northern Gulf of Mexico stock is not overfished and overfishing is not occurring (SEDAR 2015). The Mexican stock unit is considered to be “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 (Diario Oficial de la Federacion (DOF) 2014). The U.S. south Atlantic stock is overfished and overfishing is occurring (SEDAR 2017b, Carpenter et al. 2015).

There are no recent assessments for Nassau grouper, mostly because of the declining trends in the landings and that the Nassau grouper is classified as threatened under the USA Endangered Species Act and 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.

The most recent benchmark stock assessment for Gag grouper in the Gulf of Mexico provided conflicting evidence regarding abundance, depending on whether Spawning Stock Biomass (SSB) included both males and females (overfished) or females only (not overfished). The 2016 (SEDAR 2016) update assessment indicated that the stock is not experiencing overfishing. Management measures implemented in 2009 have allowed the stock to rebuild. The most recent assessment for the U.S. southeastern Gag grouper stock found that the stock is experiencing overfishing but is not overfished (SEDAR 2014c).

The Puerto Rican and the US Virgin Islands Mutton snapper population managed by the U.S. Caribbean Fishery Management Council (CFMC) considers the stock as not undergoing overfishing, and not overfished (SEDAR 2007). The most recent assessment for the GOM and U.S. southeastern Atlantic stock indicated that is not overfished and overfishing is not occurring (O’Hop et al 2015). Noting tha this species has documented spawning aggregations, in 1992, the GMFMC imposed a two month spawning season closure (May and June), the area off Dry Tortugas, Florida (Lindeman et al. 2016b).

10.3.3. Trends in fishery landings

Landings of Red grouper have been relatively stable for the past 20 years, but have sustained a decreasing trend to 1,872 tonnes in 2017 (**Fig.25**), mostly attributed to the Unites States reported landings in the past four years. It is to note that Mexico shows important catches of “Mero” (Red grouper) in the order of 8,000 tonnes in recent years (2010-2015) (Carta Nacional Pesquera 2017) but is not reported to FAO under the species name, likely is reported under Seabasses nei.

Landings of Nassau grouper have remained low, with a minor peak from Bahamas in 2014 of over 140 tonnes, but afterwards landings fell to levels of around 50 tonnes for the past three years (**Fig.26**).

Mutton snapper, historically one of the most targeted species by commercial and recreational fisheries off Cuba was subject to a major decline in the 1990’s due to reduced commercial effort, intense subsistence fishing, and historical overexploitation of spawning aggregations (Claro et al. 2009). The majority of landings are from the trap and/or pots, and hook and line fisheries. In Venezuela, the species is fished commercially. Landings have remained relatively stable around 90 tonnes between 2008 and 2013; however, in recent years an increasing trend has been observed mostly due to reported landings from Venezuela in 2016 and 2017, when total reported landings reached 279 tonnes in 2017 (**Fig.27**).

10.3.4. Impact

Impact is considered in terms of the achievement of specific societal goals and targets, which were detailed in section 2.1.4. of this report.

Like in most fisheries discussed in this report, determining whether or not the fishery is biologically sustainable will likely require further analyses based on reliable data and more detailed information, in addition to more robust management action. In the context of the hard-bottom coral reef fisheries, and in the indicator finfish species (groupers and snapper) described here; the grouper stocks (Red, Nassau, and Gag groupers) are not considered to be biologically sustainable; Nassau grouper is deemed endangered and threatened by different organizations and the other two (Red and Gag groupers) are overfished and overfishing is occurring in most part of the stocks. In the case of snappers, Mutton snapper has been over exploited, but management action has contributed in the recovery of population in some localized areas of the stock, therefore the fishery is likely to become biologically sustainable.

11. Associated Social and Economic Aspects

In most cases, information regarding social and economic aspects is limited at the fishery level and mostly nonexistent at the species level. Consequently, the report is in terms of fisheries and main groups or commercial groups associated to hard-bottom (coral reef - finfish) fisheries.

11.1. Benefits

During 2017, total WECAFC landings were 2.504.018 tonnes (excluding mollusks), of which 36,950 tonnes consists of snapper and grouper species, and 27,776 tonnes represent the group of species selected in this report. The snapper and grouper species selected accounted for 0.49% of the snapper landings and 0.61% of the grouper landings (**Table 2**).

- Recreation: Recreational fisheries for Gag grouper and Mutton snapper are important in the WECAFC area of the United States. U.S. South Atlantic Gag grouper landing estimates for the period of 2010-2012 varied between 2.10 and 3.28 (x1000) fish and abundance index estimates varied between 0.57 and 1.09 (SEDAR 2014c); while the GOM Gag grouper landings for the period of 2013-2015 varied between 100.2 to 218.7 (x1000) fish (SEDAR 2016). In the case of Mutton snapper, recreational landings accounted for 34 to 52 tonnes in 33000 to 40000 angler-days (O'Hop et al. 2015).

11.2. Production and value

The species of interest sustain economically important fisheries in the area, as illustrated by its landings compared to the total landings of species by similar groups for the area (excluding mollusks) in the western central Atlantic-FAO area 3; although hard-bottom (coral-reef finfish) group of species contribute very little to the overall landed catch (**Fig.28**).

In terms of value, the hard-bottom (coral-reef finfish) group of species had a combined value in 2014 of 195.17 million US$; of which the Snapper group accounted for the highest value (101.68 million US$), followed by the Northern red snapper, and the smallest value was from the Groupers (Pauly and Zeller, 2015) (**Fig.29**). In the WECAFC area of the United States (South Atlantic and Gulf of Mexico), Groupers in the U.S. GOM provided the highest landing revenues but a lower annual average price compared to grouper from the U.S. South Atlantic which was the highest value (2.18 US$/kg) for all the species in this group of species (**Table 3**). Red snapper had the highest annual average price (1.86 US$/kg) compared to the rest of the snappers.

Regarding the countries in the WECAFC area that represent over 98% of the total landings in 2017 (excluding mollusks), the Mexico has the major accumulated percentage (57.71%) of catches for all snapper and grouper species followed by United States of America with 16.56% and Dominican Republic with 6.61% (**Fig. 32B**). While, the total landings of the selected snapper and grouper species, the three countries to lead the major accumulated percentage were Mexico, United States and Venezuela (**Fig. 32C**). The main snapper producing countries were Mexico, United States of America and Venezuela (**Fig.32D**).

11.3. Employment

Target species of this section support subsistence, artisanal, and recreational fisheries. In some cases, they include subsistence fishery especially for coastal communities.

According to FAO data, for the countries with the higher production levels of the main groups studied the number of fishers go from 6.66 thousand (Surinam in 2014) to 238 thousand (Mexico in 2017). Information on employment by gender for the species of interest is not available either. However, according to WECAFC (2019a), based on the available FAO Fisheries and Aquaculture Profiles and on some country publications such as the NOAA publication on economic importance of fisheries in the United States of America (https://www.fisheries.noaa.gov/resource/document/fisheries-economics-united-states-report-2016), an estimate is provided for a group of countries (**Table 5**).

11.4. Human well-being and social justice

The status of the fisheries of the interest species and main groups have a direct bearing on the well-being of the communities that exploit those resources as their major source of income and livelihoods.

An assessment of the six human well-being indicators of the Governance Effectiveness Assessment Framework is not available for the fisheries nor the species of interest in the area evaluated. It is recommended to join efforts on this matter to apply it in each country, possibly by following the holistic framework proposed by Biedenweg *et al*. (2016).

11.5. Impact

Improvements in human well-being and social justice are implicit in many societal goals and targets, particularly the Sustainable Development Goals (SDGs). In most fisher communities, there are conditions that could be improved regarding to human well-being and social justice such as health status, environmental quality, personal security, housing, income and among other issues relevant to each community.

12. Drivers and Pressures

12.1. Drivers

Drivers are the economic, social, cultural and political factors that motivate human activities and satisfy basic human needs such as food and employment. They increase or mitigate pressures on the populations of highly migratory fish species, small pelagic fish species, Penaeid shrimps and coastal fish species occupying various substrata (soft bottom and/or reefs), being the drivers for the fisheries reviewed:

Economic Value: Coral reef-associated fisheries in the Caribbean region provide net annual revenues valued at an estimated 310 million US$ (Burke and Maidens 2004). Nassau grouper is a highly valuable commodity important for both trade and food security for local Caribbean coastal communities and in the tourism sector, the species is traded fresh and frozen, whole and filleted. The Department of Natural Resources (Puerto Rico) monitoring of landings estimated that 193.2 tonnes of groupers were landed and valued in US$ 138,000 (representing the 80% of the landings) in 1972. By 1988, the production of Nassau grouper was estimated in 0.9 tonnes valued at US$ 2,071 (US$ 1.16/kg) (Matos and Sadovy 1990). Just before the species moratorium in 2002, the landings of Nassau grouper reached 8.5 tonnes that were valued at $US 18,708 (US$ 1.75/kg) (Matos-Caraballo 2006) and reduced to 0.1 tonnes valued in US 260$ ($US 2.27/kg) (Matos-Caraballo 2012). Currently the product is traded locally. In most Caribbean islands, Mutton snapper, as several other high-value species, are typically sold directly to hotels, restaurants, and fish markets for local consumption, particularly when captured by commercial fishers (Sadovy et al. 2018).

12.2. **Pressures**

Pressures are factors (natural and/or anthropogenic) that result in unsustainable fishing of the shellfish and finfish resources reviewed or induce negative changes in its health or its populations. The open-access nature of some of the fisheries targeting shellfish and finfish resources in the region can exacerbate its unsustainable exploitation. Among the key pressures that may affect these resources are:

Illegal, unreported and unregulated fishing: Traditionally, three fleets have been active the southern GOM; the Mexican industrial (about 515 vessels) and artisanal vessels (about 1,850 vessels) and a small fishery specific Cuban industrial fleet. However, the last one seems to be no longer active (Scott 2014). The artisanal fishery represents about 55% of the total catch (Diario Oficial de la Federacion (DOF) 2014) and they are known to catch immature Red grouper (40% below MLS, most are immature) (Coronado and Salas 2011), a serious concern for management efforts.

Illegal fishing is detected in Natural Park Arrecife Alacranes as well as in National Park Arrecifes de Cozumel. Control measures are considered insufficient and inefficient and also in Reserve of Biosphere Arrecifes de Sian Ka'an. Goals and actions for fisheries comprised in the management plan of National Park Arrecifes de Cozumel have not yet been accomplished (SAGARPA 2012). Illegal fishing has also been detected in National Parks of the Aves and Los Roques Archipelagos off the Venezuelan central coast for snappers and grouper. Illegal fishing by long range small scale foreign vessels targeting snappers has also been detected in Surinamese waters.

Destructive/ghost fishing: Most lost fishing gear is made of non-biodegradable plastics that may sink to the sea floor or drift around in currents. It may remain unnoticed until it shows up on coral reefs, beaches and in other coastal habitats. Stony corals have fragile skeletons and soft tissues that can easily become damaged when they get in contact with lost fishing gear. In the Caribbean, loss of gillnets may be an issue in areas near coral reefs where juveniles of snapper and groupers will likely be entangled and die (Mathew and Glazer 2010).

Habitat degradation: Coral reef fishes (Groupers and Snappers) production and survival are highly dependent on the quality of its preferred marine habitats, particularly shallow-water nursery habitats and coral reefs (for groupers). Coastal development and pollution, particularly from land-based sources and activities, have degraded mangroves, seagrass beds and coral reefs in the region. Snappers and groupers, as common inhabitants of coral reefs, are unlikely to be able to compensate for the loss of quality coral reef habitat. Between 1970 and 2011 an overall 59% decline in coral cover was directly observed in the Caribbean, which was caused by anthropogenic stressors, *Diadema antillarum* decline, and coral disease (Jackson et al. 2014b).

Predation: The extent of mortality caused by predation on juvenile species coral reef species is largely unknown. There are studies of juveniles of the species reviewed here that are part of the diet of adult fish species. However, in the case of Nassau Grouper, juveniles have been identified as a prey item of the invasive Lionfish (*Pterois volitans*), with only juveniles being consumed (Morris and Akins 2009); in addition Lionfish may also compete with Nassau Grouper for reef shelter (Raymond et al. 2015). This issue on predation of invasive species on local species and competing has not been fully studied in the region and needs further research.

Climate change: Several climate change stressors have been identified and its implications for marine resources and fisheries of the WECAFC area (WECAFC 2019c), which include increasing sea surface temperature (SST), ocean acidification (OA), sea level rise (SLR) and increased frequency of extreme weather events (e.g. storms, hurricanes, precipitation anomalies). However, once currents and winds move it close to shore, the algae start to break-down, sink, and decay, creating an environment poor in oxygen (van Tussenbroek et al. 2017). Also, it has been noted that some *Sargasso* blooms in the region are dominated by a rare *Sargassum* form (*Sargssum natans VIII*) that has a lower value as a nursery and foraging habitat for macrofauna including fishes (Schell et al. 2015). There is no clear understanding how the recurring GASB affects fish populations in the region, clearly future research is critically needed. A shallowing of the oxygen minimum layer (representing a hypoxic habitat boundary for high oxygen demand species) has already been observed in the tropical Atlantic, In coral reef associated species, reduced population sizes and productivity are expected across this multi-species group under near-future climate change, with significant impacts on production of small scale fisheries across the region, particularly in the Small Island Developing States (SIDS) of the Caribbean Large Marine Ecosystem where hard-bottom fisheries that target reef associated species exclusively operate (WECAFC 2019c).

Spawning reef fishes, like snappers and grouper, can be susceptible to warming ocean waters (Asch and Erisman 2018). Using the Nassau grouper, the thermal niche and ecological niche breadth of both non-spawning and spawning adults was estimated. The thermal niche of spawners was narrower, indicating that the spawning life stage may be an obstacle constraining adaptation options to warming ocean temperatures. The study concluded that Nassau grouper conservation should include consideration of these and other aspects of changing phenology, as climate effects may amplify population declines and reduce or otherwise alter the impacts of conservation measures (Sadovy et al. 2018). Furthermore, many species that Mutton snapper and Nassau grouper feed upon or feed upon them, will be exposed to a variety of factors related to climate change over coming decades. Climate change can also affect pre-spawning migrations in multiple manners. There are also a number of potential effects of climate change on the larval products of spawning aggregations which are beginning to be examined in a variety of coastal marine taxa (Pankhurst and Munday 2011, Asch 2015). Climate change effects may exacerbate population declines in highly fished populations and constrain management efforts in multiplicative manners (SFSC, 2017). Modelling suggests that fisheries production in tropical reef systems in particular, are particularly susceptible to declines under different climate change scenarios but that good management can help to reduce impacts (Cheung et al., 2010, 2018).

Disease: In some species like *L. synagris* and *L. griseus* were estimated to have had a high risk of oil encounters from the BP Horizon Oil Spill based on spawning season and cross-shelf larval distribution for each species (Fodrie and Heck 2011).

Fisheries Impact: Bycatch constitutes an important issue in all fisheries. Bycatch can negatively affect species all fish species, sea turtles, protected fish, marine mammals, and sea birds by harming animals, contributing to population declines, and impeding population recovery. Other impacts of fisheries may include removal of preferred prey and sometimes habitat damage. Bycatch is also an issue in bottom trawl fisheries that may have contributed to population declines in the stocks of several snapper species in the GOM shrimp fisheries. However, concern over bycatch of reef fish has been raised, habitat degradation) and socioeconomic issues (food security impacts with coastal communities) (Gillett, 2011).

12.3. Impact of hard-bottom fisheries on marine habitats and biodiversity

An ecosystem approach to fisheries requires that the fishery's impact on other components of the ecosystem is considered in decision-making. Hard-bottom (coral reef) fisheries, as reviewed here, have the potential to affect habitats and biodiversity through various means, like:

Hard-bottom (Coral reefs) fisheries. Fishing gear in the form lost and abandoned gear inflict an important damage in this particular marine habitat, as well as fishing operations, such as boat anchors, oil spills, and bottom-trawling. Intensive artisanal fishing in coral reefs has affected negatively commercially important species by an order of magnitude in some areas (Hawkins and Roberts 2004).

Further specific investigations are needed to assess the impact of these fisheries on marine habitats and biodiversity.

13.Responses

Responses include measures and actions taken by stakeholders to ensure that shellfish and finfish fisheries are sustainable. They also include the institutional, policy and legal frameworks and processes that are relevant to shellfish and finfish fisheries management.

Responses are divided into 'governance' and 'management' (including stress-reduction measures). Governance covers architecture/arrangements and processes.

13.1. Governance architecture

Existence of arrangements that address the governance of shellfish and finfish fisheries at the regional/ sub regional level: Noting that the fishery resources considered in this section report, namely, indicator finfish species from coral reef fisheries. 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 CFMC/ WECAFC/OSPESCA/CRFM Working Group on Spawning Aggregations. Additionally, the development of the Caribbean Management Plan for Spawning Aggregation that was originally introduced in 2012, it has not been approved.

Level of application of fishery policy by the fisheries mechanisms: Unlike other policy arrangements in the region, for species other than large pelagic migratory fish species that are under a binding mandate, the rest of the resources reviewed are dependent on specific National Management and Conservation measures.

In the case of shellfish and finfish fisheries (with exception of highly migratory pelagic species) not having complete set of policies at a specific regional or sub-regional level (CERMES 2018), the stages of application of policy cycles to which attention should be paid, which include management advise, management review, management data and information, policy decision-making, management decision-making, and management implementation. The implications for the different fisheries reviewed that have transboundary and shared stocks is that at ideally the policy cycle stages be sanctioned and implemented by the three Regional Fishery Advisory Bodies in the region (WECAFC, CRFM, OSPESCA), in view of the inexistence of a RFMO for the transboundary and shared stocks that are not under the ICCAT mandate.

13.2. Governance processes

A range of initiatives undertaken in the WECAFC area to improve management of the shellfish and finfish fisheries include:

Sub regional processes:

WECAFC also has promoted the development of a Regional Fish Spawning Aggregation Draft Fishery Management Plan in the region with several provisions that has yet to be adopted (WECAFC 2019e).

In a review conducted to provide an inventory of legal, administrative and management frameworks in place for managing marine capture fisheries in the Western Central Atlantic Fishery Commission (WECAFC) area, several governance and management issues were identified, like the existence of inadequate legislation, ad hoc management processes and plans, uncoordinated monitoring and enforcement, non-management-driven scientific information, insufficient stakeholder identification and participation, among other issues (Singh-Renton and McIvor 2015).

13.3. Stress-reduction measures

Several stress-reduction measures have been adopted by the countries that exploit hard-bottom and coral reef associated finfish resources in the WECAFC area. These measures aim to control fishing pressure on the stocks so that the stocks can be restored to sustainable levels.

Minimum size limits and closed season: In the case of indicator finfish species *(e.g*. snappers and groupers) from coral reef fisheries, in Mutton snapper (*L. analis*), there are minimum size limitation, area closures, gear limitations, in U.S. waters and Puerto Rico and U.S. Virgin Islands, Cuba, and Belize (Lindeman et al. 2016b). For the Nassau grouper (*E. striatus*) stress-reduction measures vary widely by country, and include a total ban on take, fishing restrictions and area/temporal protection for spawning aggregations; recently the Nassau grouper was added to Annex III of the Specially Protected Areas and Wildlife (SPAW) protocol, which is a legally binding regional environmental treaty for the Wider Caribbean region (Sadovy et al. 2018). In the United States, for the Gag grouper (*M. microlepis*), the size limit was established at 61.0 cm TL and 45.7 cm TL for Mutton snapper plus a bag limit of up to 5 Mutton snappers (https://www.federalregister.gov/documents/2018/06/22/2018-13401/fisheries-of-the-caribbean-gulf-of-mexico-and-south-atlantic-reef-fish-fishery-of-the-gulf-of-mexico).

Marine protected areas (MPAs): MPAs are an important tool in coral reef fisheries for stock replenishment and fishing-related livelihoods. Globally, MPAs have been shown to increase fish size, population density, biomass, and species richness. These increases are also seen outside the MPA boundaries through the spillover effect. A study on the Management Capacity Assessment of Selected Coral Reef Marine Protected Areas in the Caribbean presented its findings from 27 MPA sites in 10 countries and territories in the Caribbean (Gombos et al. 2011). It was provided with a survey tool for self –assessments. Efforts such as this will likely serve as to enhance stress-reduction measures in indicator finfish species from coral reef. Current perceived capacity of sites is lowest in relation to alternative livelihoods, socioeconomic monitoring, and fisheries management. Priority MPA management capacity needs as identified by managers were: 1) enforcement (10 sites) 2) financing (9 sites) 3) management planning, bio-physical monitoring, socio-economic monitoring (7 sites), and 4) MPA effectiveness evaluation, and outreach and education (6 sites). Preferred approaches to capacity building at a regional scale are: 1) technical support, 2) training, 3) more staff, 4) learning exchanges, and 5) higher education course. Individual site results provide more detailed information under the "rationale" narrative sections and can inform users of more specific details of the local situation and capacity strengths, and challenges.

13.4. Recommendations for action

Hard-bottom (Coral reefs) fisheries:

1. Support the implementation of the Regional Fish Spawning Aggregation Fishery Management Plan.
2. Support implementation of the regional closed season for Nassau grouper (*Epinephelus striatus*).
3. The Identification and documentation of all known and exploited spawning aggregation sites and determination of spawning seasons for Mutton snapper and Nassau grouper.
4. Establish a synchronized and strategic regional closed season for protecting spawning aggregations.
5. The Collection of socio-economic data in relation commercial, recreational and subsistence fisheries, ecotourism, local and international trade, and considering food security.
6. Produce / reproduce online and printed educational materials on fishing guidelines, regulations, catch landings, Fish Spawning Aggregation protection, and consider other communication options.

8. References

Abascal, F. J., Mejuto, J., Quintans, M. & Ramos-Cartelle, A. 2010. Horizontal and vertical movements of swordfish in the Southeast Pacific. ICES J. Mar. Sci., 67: 466–474.

Able, K., Cass−Calay, S. & Wilberg, M. 2017. 2017 Atlantic Croaker Stock Assessment Peer Review. Atlantic States Marine Fisheries Commission. 10 pp.

Aguilera Socorro, O., Fredou, F.L., Haimovici, M., Vieira, J.P. & Villwock de Miranda, L. 2015. Micropogonias furnieri (errata version published in 2017). The IUCN Red List of Threatened Species 2015: e.T195076A115338833.

Allen, G.R. 1985. Snappers of the world. An annotated and illustrated catalogue of lutjanid species known to date. FAO Fisheries Synopsis, No.125, Vol.6.

Anderson, J.D. & Torres, A. D. 2016. Genetic Variability and Population Structure of Gulf Menhaden Compared with Yellowfin Menhaden. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science, 8(8): 425-435.

Anderson, W., Claro, R., Cowan, J., Lindeman, K., Padovani-Ferreira, B. & Rocha, L.A. 2015. *Lutjanus campechanus* (errata version published in 2017). The IUCN Red List of Threatened Species 2015: e.T194365A115334224.

Andrade, H., & Santos, J.A. 2004. Seasonal trends in the recruitment of skipjack tuna (*Katsuwonus pelamis*) to the fishing ground in the southwest Atlantic. Fish. Res. 66:185-194.

Arizmendi-Rodríguez, D., Abitia-Cárdenas, L.A., Galván-Magaña, F. & Trejo-Escamilla, I. 2006. Food habits of sailfish *Istiophorus platypterus* off Mazatlán, Sinaloa, Mexico. Bul. Mar. Sci., 79(3):777-791

Arocha, F. 2007. Swordfish reproduction in the Atlantic Ocean: An overview. Gulf Caribb. Res., 19: 21–36.

Arocha, F., & Marcano, L.A. 2005. Population structure of swordfish, *Xiphias gladius*, in Venezuela and adjacent waters. Proceed. 47th Gulf and Carib. Fish. Inst., 650-664.

Arocha, F., & Mendoza, J. 2015. Country review: Venezuela. pp 275-293. In: Review of current fisheries management performance and conservation measures in the WECAFC area. FAO Fisheries and Aquaculture Technical Paper No. 587, Bridgetown, Barbados, FAO.

Arocha, F., & Prince, E.D.1999. Tag and release of juvenile swordfish off Venezuelan industrial longline vessels. ICCAT, Col. Vol. Sci. Pap., 49: 423 - 427.

Arocha, F., Lee, D.W., Marcano, L.A., Marcano, J.S. 2001. Update information on the spawning of yellowfin tuna, *Thunnus albacares*, in the western Central Atlantic. ICCAT Collect. Vol. Sci. Pap, 52(1): 167-176.

Arocha, F., Lee, D.W., Marcano, L.A. & Marcano, J.S. 2000. Preliminary studies on the spawning of yellowfin tuna, *Thunnus albacares*, in the western Central Atlantic. ICCAT Collect. Vol. Sci. Pap, 51(2): 538-551.

Arocha, F., Marcano, L.A., & Silva, J. 2012. Sex ratio at size of blue marlin (*Makaira nigricans*) from the Venezuelan fishery off the Caribbean Sea and adjacent waters. ICCAT Col. Vol. Sci. Pap., 68: 1387-1396.

Arocha, F., Marcano, L., Larez, A., Altuve, D. & Alio, J. 1999. The fishery, demographic size structure and oocyte development of dolphinfish, *Coryphaena hippurus*, in Venezuela and adjacent waters. Scientia Marina: 63 (3-4):401-409.

Arocha F., Narváez, M., Laurent, C., Silva, J. & Marcano, L.A. 2016. Spatial and temporal distribution patterns of sailfish (*Istiophorus albicans*) in the Caribbean Sea and adjacent waters of the western Central Atlantic, from observer data of the Venezuelan fisheries. ICCAT, Col. Vol.Sci.Pap. 72: 2102-2116.

Asch, R.G., 2015. Climate change and decadal shifts in the phenology of larval fishes in the California Current ecosystem. Proceedings of the National Academy of Sciences, 112(30), pp E4065-E4074.

Asch, R.G. & Erisman, B. 2018. Spawning aggregations act as a bottleneck influencing climate change impacts on a critically endangered reef fish. Diversity and Distributions, 24: 1712-1728.

Baisre, J.A. 2018. An overview of Cuban commercial marine fisheries: the last 80 years. Bull. Mar. Sci. 94.

Ball, A.O. & Chapman, R.W. 2003. Population genetic analysis of white shrimp, *Litopenaeus setiferus*, using microsatellite genetic markers. Mol. Ecol. 12(9):2319–2330.

Batista, V., & Fabré, N.N. 2001. Temporal and spatial patterns on serra, *Scomberomorus brasiliensis* (Teleostei, Scombridae), catches from the fisheries on the Maranhão coast, Brazil. Braz. J. Biol., 61(4):541-546.

Bealey, R., Pérez Moreno, M., & Van Anrooy, R. 2019. The Caribbean Billfish Management and Conservation Plan. FAO Fisheries and Aquaculture Technical Paper. No. 643. Rome, FAO. 106 pp.

Biedenweg, K., Stiles, K., & Wellman, K. 2016. A holistic framework for identifying human wellbeing indicators for marine policy. Mar. Policy, 64: 31-37.

Brenner, J. & McNulty, V. 2018. Gulf of Mexico Tuna Migrations. The Nature Conservancy, Arlington, 24pp.

Brule, T., Bertoncini, A.A., Ferreira, B., Aguilar-Perera, A. & Sosa-Cordero, E. 2018. *Epinephelus morio*. The IUCN Red List of Threatened Species 2018: e.T44681A46914636.

Burke, L. & Maidens, J. 2004. Reefs at risk in the Caribbean. World Resources Institute, Washington, DC. 80 pp.

Carpenter, K.E., Claro, R., Cowan, J., Espinosa-Perez, H., Sedberry, G. & Zapp-Sluis, M. 2015. *Epinephelus morio* (Red Grouper). The IUCN Red List of Threatened Species 2015: e.T44681A70324362.

Carta Nacional Pesquera. 2017. Diario Oficial de la Federación. DOF: 11/06/2018. Mexico. 69 pp.

Carta Nacional Pesquera. 2012. Diario Oficial de la Federación. Segunda sección. DOF: 24/06/2012. Mexico. 21-128 pp.

Carson, E., W., Saillant, E., Renshaw, M.A., Cummings, N.J., & Gold, J.R. 2011. Population structure, long-term connectivity, and effective size of mutton snapper (*Lutjanus analis*) in the Caribbean Sea and Florida Keys. Fish. Bull. 109(4): 416-428

Casazza T.L., & Ross, S.W. 2008. Fishes associated with pelagic Sargassum and open water lacking *Sargassum* in the Gulf Stream off North Carolina. Fish. Bull. 106:348–363.

Castillo-Rivera, M. & Kobelkowsky, A. 2000. Distribution and Segregation of Two Sympatric *Brevoortia* Species (Teleostei: Clupeidae). Estuarine, Coastal and Shelf Science 50: 593-398.

Cayré, P. & Farrugio, H. 1986. Biologie de la reproduction du listao (*Katsuwonus pelamis*) de l'océan Atlantique. In: Symons, P.E.K., Miyake, P.M., Sakagawa, G.T. (eds.), Proc. ICCAT conference on the international skipjack year program, Madrid, pp. 252–272.

CERMES. 2018. Application of the Governance Effectiveness Assessment Framework (GEAF) to the CLME+ EcoLangosta Lobster Pilot. Draft Report. Centre for Resource Management and Environmental Studies (CERMES) University of the West Indies, Cave Hill Campus.

Coleman, F.C. & Koenig, C.C. 2010. The effects of fishing, climate change, and other anthropogenic disturbances on red grouper and other reef fishes in the Gulf of Mexico. Integrative and Comparative Biology 50: 201-212.

Collette, B.B., & Nauen, C.E. 1983. FAO Species Catalogue. Vol. 2. Scombrids of the world. An annotated and illustrated catalogue of tunas, mackerels, bonitos and related species known to date. FAO Fish. Synop., 125(2):137 p.

Coronado, E., & Salas, S. 2011. Características de Operación de Tres Flotas que Inciden sobre el Mero Rojo y Especies Asociadas en Yucatán, México: Potenciales Efectos de Externalidades. Proceedings of the 64th Gulf and Caribbean Fisheries Institute. Puerto Morelos, Mexico.

Clardy, T.R., Patterson, W.F., DVries, D.A. & Palmer, C. 2008. Spatial and temporal variability in the relative contribution of king mackerel (*Scomberomorus cavalla*) stocks to winter mixed fisheries off South Florida. Fish. Bull., 106:152-160.

Claydon, J. 2004. Spawning aggregations of coral reef fishes: Characteristics, hypotheses, threats and Management. Oceanography and Marine Biology: An Annual Review, 42: 265–302.

CLME. 2013. Case Study on Shrimp and Groundfish - Report. No. 9 -, Rome, FAO. 99 p.

Cornic, M. & Rooker, J. 2018. Influence of oceanographic conditions on the distribution and abundance of blackfin tuna (*Thunnus atlanticus*) larvae in the Gulf of Mexico. Fish. Res. 201:1-10.

Cramer, J. 1996. Recent trends in the catch of undersized swordfish by the U.S. pelagic longline fishery. Mar. Fish. Rev., 58: 24–32.

CRFM. 2015. Draft Sub-Regional Management Plan for FAD Fisheries in the Eastern Caribbean Stakeholder Working Document). CRFM Technical & Advisory Document 2015/ 05. 94p.

CRFM. 2014. Sub-Regional Fisheries Management Plan for Flyingfish in the Eastern Caribbean. CRFM. Special Publication No. 2. 42 p.

CRFM. 2013a. Draft Sub-Regional Management Plan for Blackfin Tuna Fisheries in the Eastern Caribbean (Stakeholder Working Document). CRFM Technical & Advisory Document 2013/17. 35p.

CRFM. 2013b. Report of the CRFM independent performance review. CRFM Management Report. Belize. 79 pp.

CRFM. 2011. CRFM Fishery Report – 2011. Fishery Management Advisory Summaries. Report of Seventh Annual Scientific Meeting – Kingstown, St. Vincent and the Grenadines, 16 – 24 June 2011, Volume 2. 85 p.

CRFM. 2010. Report of Sixth Annual Scientific Meeting – Kingstown, St. Vincent and the Grenadines, 07 - 16 June 2010 – Fishery Management Advisory Summaries. CRFM Fishery Report - 2010. Volume 2. 41p.

CRFM, 2007. Report of the Third Annual Scientific Meeting - St. Vincent and the Grenadines, 17-26 July 2007. CRFM Fishery Report – 2007, Volume 1. 183 pp.

CRFM. 2006. Report of Second Annual Scientific Meeting – Port of Spain, Trinidad and Tobago, 13-22 March 2006. CRFM Fishery Report - 2006, Volume 1. 188 p.

Chao, L. & Espinosa-Perez, H. 2015. *Micropogonias undulatus*. The IUCN Red List of Threatened Species2015: e.T193268A49228279.

Chapman, R.W., Sedberry, G.R., Koenig, C.C. & Eleby, B.M. 1999. Stock Identification of Gag, *Mycteroperca microlepis*, along the Southeast Coast of the United States. Marine Biotechnology 1, 137-146.

Cheung, W.W.L., Jones, M.C., Reygondeau, G. & Frölicher, T.L. 2018. Opportunities for climate−risk reduction through effective fisheries management. Global Change Biology, 24: 5149–5163. https://doi.org/10.1111/gcb.14390

Cheung, W.W., Lam, V.W., Sarmiento, J.L., Kearney, K., Watson, R., Zeller, D. & Pauly, D. 2010. Large−scale redistribution of maximum fisheries catch potential in the global ocean under climate change. Global Change Biology, 16: 24-35. doi:10.1111/j.1365-2486.2009.01995.x

de León, A.F., Polanco Vásquez, F., Avalos Castillo, C., & Rivas, C. 2016. Determinación de la época de reproducción del camarón *Farfantepenaeus notialis* (Pérez Farfante, 1967) y *Litopenaeus schmitti* (Burkenroad, 1936) en el Atlántico de Guatemala. Instituto de Investigaciones Hidrobiológicas, Centro de estudios del Mar y Acuicultura. Universidad de San Carlos de Guatemala. 32 pp.

Derrell, C., Ferreira, L., Medley, P., & Soekradj, R. (2009). Report of the Shrimp and Groundfish Resource Working Group (SGWG). CRFM 2009. In CRFM Fishery Report – 2009. Volume 1. Report of Fifth Annual Scientific Meeting – Kingstown, St. Vincent and the Grenadines, 09-18 June 2009. 167p.

De Sylva, D. & Breder, P.R.. 1997. Reproduction, gonad histology, and spawning cycles of north Atlantic billfishes (Istiophoridae). Bull. Mar. Sci., 60(3): 668-697.

Diario Oficial de la Federacion (DOF). 2014. Acuerdo por el cual se da a conocer el Plan de Manejo Pesquero de Mero (*Epinephelus morio*) y especies asociadas en la Península de Yucatán. 76 pp. SAGARPA, Mexico. http://extwprlegs1.fao.org/docs/pdf/mex140179.pdf

Duarte-Neto, P.J., Lessa, R., Stosic, B. & Morize, E. 2008. The use of sagittal otoliths in discriminating stocks of common dolphinfish (*Coryphaena hippurus*) off northeastern Brazil using multishape descriptors. ICES J. Mar. Sci. 65:1144-1152.

Ehrhardt, N., Brown, J.E, & Pohlot, B.G. 2017. Desk Review of FADs fisheries development in the WECAFC region and the impact on stock assessments. WECAFC/SAG/VIII/2017/5. 38 pp.

Fanning, L.P, & Oxenford, H.A. 2011. Ecosystem issues pertaining to the flyingfish (*Hirundichthys affinis*) fisheries of the eastern Caribbean. Pp. 227-240, in: Fanning, L., R. Mahon and P. McConney (eds.). Towards marine ecosystem-based management in the Wider Caribbean, Amsterdam University Press, Netherlands.

FAO. 2018a. Guyana. Country Profile Fact Sheets. In: FAO Fisheries and Aquaculture Department [online]. Rome. Updated 27/06/2019. [Cited 5 October 2019]. http://www.fao.org/fishery/

FAO. 2018b. Trinidad and Tobago. Country Profile Fact Sheets. In: FAO Fisheries and Aquaculture Department [online]. Rome. Updated 01/05/2018. [Cited 9 October 2019]. http://www.fao.org/fishery/

FAO. 2017. Background documents for the Workshop on investing in ecosystem-based shrimp and groundfish fisheries management of the Guianas – Brazil shelf, Barbados, 7–8 September 2015. FAO Fisheries and Aquaculture Circular No. 1120. 88 pp.

Farrell, E.R., Boustany, A.M., Halpin, P.N., & Hammond, D.L. 2014. Dolphinfish (*Coryphaena hippurus*) distribution in relation to biophysical ocean conditions in the northwest Atlantic. Fish. Res. 151:177– 190.

Fonteneau, A. 2015. On the movement patterns and stock structure of skipjack (*Katsuwonus pelamis*) in the Atlantic: how many skipjack stocks in the Atlantic Ocean? ICCAT Collect. Vol. Sci. Pap, 71:205-220.

Frédou, F., Frédou, T., Ménard, F., Beare, D., Abid, N. & Kell, L. 2017. Preliminary ecological risk assessment of small tunas of the Atlantic Ocean. Collect. Vol. Sci. Pap. ICCAT, 73(8): 2663-2678.

Fredou, F.L. & Villwock de Miranda, L. 2015a. *Cynoscion virescens*. The IUCN Red List of Threatened Species 2015: e.T47147660A49238270.

Fredou, F.L. & Villwock de Miranda, L. 2015b. *Cynoscion jamaicensis*. The IUCN Red List of Threatened Species 2015: e.T47147457A49237421.

Fredou, F.L., Haimovici, M., Santos, S. & Villwock de Miranda, L. 2015. *Macrodon ancylodon*. The IUCN Red List of Threatened Species 2015: e.T195074A49238121.

Fréon, P., & Mendoza, J. 2003. The sardine (*Sardinella aurita*), its environment and exploitation in eastern Venezuela. IRD Editions, Paris. 549 p.

Fréon, P., El Khattabi, M., Mendoza, J. & Guzmán, R. 1997. Unexpected reproductive strategy of *Sardinella aurita* off the coast of Venezuela. Mar. Biol., 128:363-372.

Gaceta Oficial de la República Bolivariana de Venezuela. 2017. Resolución que regula el aprovechamiento, comercialización, procesamiento y almacenamiento del recurso hidrobiológico sardina (*Sardinella aurita*) en la República Bolivariana de Venezuela. No. 41.295:439.049-439.053.

Gaceta Oficial de la República Bolivariana de Venezuela. 2003. Providencia administrativa para regular la pesca y comercialización de las especies de la Familia Istiophoridae y Xiphiidae. No. 37.787:330.436-330.437.

Gaertner, D. & Gaertner-Medina, M. 1999. An overview of the tuna fishery in the southern Caribbean sea. Proceedings of the International Workshop on fishing for Tunas associated with floating objects (Compiled by M. D. Scott, W. H. Bayliff, C. E. Lennert-Cody and K. M. Schaefer). IATTC, Special report, 11: 66-86.

García de los Salmones, R., Infante, O. & Alio, J.J. 1989. Reproducción y alimentación del pez vela, de la aguja blanca y de la aguja azul en la región central de Venezuela. ICCAT Collect. Vol. Sci. Pap., 30:436-439.

Garstin, A. & Oxenford, R. 2018. Reducing elasmobranch bycatch in the Atlantic seabob (*Xiphopenaeus kroyeri*) trawl fishery of Guyana. Gulf Caribb. Res., 29(1):10-21.

Gassman, J.P., López, A., Achury, A., Barrios, J., Cárdenas, J.J., Díaz, A., Hernández, H., González, L. & Mendoza, J. 2012. Seguimiento de la pesca de la sardina (*Sardinella aurita*) como recurso de interés estratégico: cuantificación de la biomasa mediante prospección acústica (Proyecto INPA 045). In: III Congreso Venezolano de Diversidad Biológica, Libro de resúmenes, p. 148. May 22, 2012, San Carlos, Venezuela.

Gentner, B., & Obregon, P. 2018. Economic Impact Analysis of Commercial and Recreational Billfish Fisheries in the Western Central Atlantic: Grenada and the Dominican Republic. Gentner Consulting Group. 62pp.

Gentner, B., Arocha, F., Anderson, C., Flett, K., Obregon, P. & van Anrooy, R. 2018. Fishery performance indicator studies for the commercial and recreational pelagic fleets of the Dominican Republic and Grenada. FAO Fisheries and Aquaculture Circular No. 1162. Rome, Italy. 68pp.

Gillett, R. 2011. Bycatch in small-scale tuna fisheries: a global study. FAO Fisheries and Aquaculture Technical Paper. No. 560. Rome, FAO. 116 p.

Gilman, E. & Lundin, C. 2010. Minimizing Bycatch of Sensitive Species Groups in Marine Capture Fisheries: Lessons from Commercial Tuna Fisheries. pp. 150-164.

Gledhill, C.T. & Lyczkowski-Shultz, J. 2000. Indices of larval king mackerel (*Scomberomorus cavalla*) abundance in the Gulf of Mexico for use in population assessments. Fish. Bull., 98(4): 684-691.

Gold, J.R. & Richardson. L.R. 1998. Mitochondrial DNA Diversification and Population Structure in Fishes from the Gulf of Mexico and Western Atlantic. The Journal of Heredity 89 (5): 404-414.

Gold, J.R., Jobity, A.M.C., Saillant, E. & Renshaw, M.A. 2010. Population structure of carite (*Scomberomorus brasiliensis*) in waters of Trinidad and northern Venezuela. Fish. Res. 103:30-39.

Gold, J.R., Pak, E. & DeVries, D.A. 2002. Population structure of king mackerel (*Scomberomorus cavalla*) around peninsular Florida, as revealed by microsatellite DNA. Fish. Bull. 100: 492-509.

Gold, J.R., Saillant, E., Cummings, N.J. & Renshaw, M.A. 2011. Genetic divergence and effective size among lane snapper in U.S. waters of the western Atlantic Ocean. N. A. J. Fish. Manag. 31(2): 209-223.

Gombos, M., Arrivillaga, A., Wusinich-Mendez, D., Glazer, B., Frew, S., Bustamante, G., Doyle, E., Vanzella-Khouri, A., Acosta, A. & Causey, B. 2011. A Management Capacity Assessment of Selected Coral Reef Marine Protected Areas in the Caribbean. Commissioned by the National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (CRCP), the Gulf and Caribbean Fisheries Institute (GCFI) and by the UNEP-CEP Caribbean Marine Protected Area Management Network and Forum (CaMPAM). 252 pp.

Gomes, C., Oxenford, H.A. & Dales, R.B.G. 1999. Mitochondrial DNA D-Loop Variation and Implications for Stock Structure of the Four-Wing Flyingfish, *Hirundichthys affinis*, in the Central Western Atlantic. Bull. Mar. Sci., 64(3): 485-500.

Gomes, G., Sampaio, I. & Schneider, H. 2012. Population Structure of *Lutjanus purpureus* (Lutjanidae – Perciformes) on the Brazilian coast: further existence evidence of a single species of red snapper in the western Atlantic. An. Acad. Bras. Ciênc. 84(4): 979-999.

Goodyear, C.P., Luo, J.G., Prince, E.D., Hoolihan, J.P., Snodgrass. D., Orbesen. E.S. & Serafy, J.E. 2008. Vertical habitat use of Atlantic blue marlin, *Makaira nigricans*: interaction with pelagic longline gear. Mar. Ecol. Prog. Ser., 365: 233–245.

Government of Guyana Ministry of Agriculture. 2019. Marine Fisheries Management Plan 2013-2020. Department of Fishery. 76 pp.

Grafton, Q., Hillborn, R., Squires, D., Tait, M. & Williams, M. (eds.). Handbook of Marine Fisheries Conservation and Management. Oxford University Press.

Graves, J.E. & McDowell, J.R. 2003. Population structure of the world's billfishes: a genetic perspective. Mar. and Fresh. Res., 54:287-298.

Gulf of Mexico Fishery Management Council (GMFMC-NOAA). 2017. Shrimp Amendment 17B to the Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters: Yield, Threshold Number of Permits, and Transit Provisions, Including Environmental Assessment, Fishery Impact Statement, Regulatory Impact Review, and Regulatory Flexibility Act Analysis, pp163.

Hall, M., & Roman, M. 2013. Bycatch and non-tuna catch in the tropical tuna purse seine fisheries of the world. FAO Fisheries and Aquaculture Technical Paper. No. 568. Rome, FAO. 249 p.

Hallier, J.P. & Gaertner, D. 2008. Drifting fish aggregation devices could act as an ecological trap for tropical tuna species. Mar. Ecol. Prog. Ser. 353, 255-264.

Hare, J., Alexander, M., Fogartry, M., Williams, E. & Scott, J. 2010. Forecasting the dynamics of a coastal fishery species using a coupled climate–population model. Ecological Applications 20(2): 452-464.

Hare, J.A., Hoss, D.E., Powell, A.B., Konieczna, M., Peters, D.S., Cummings, S.R. & Robbins, R.E. 2001. Larval distribution and abundance of the family Scombridae and Scombrolabracidae in the vicinity of Puerto Rico and the Virgin Islands. Bulletin of the Sea Fisheries Institute 153(2):13-30.

Hart, R. 2017. Stock Assessment Update for Pink Shrimp (*Farfantepenaeus duorarum*) in the U.S. Gulf of Mexico for the 2016 Fishing Year. NOAA Fisheries Southeast Fisheries Science Center. 17 pp.

Hart, R. 2016a. Stock Assessment Update for Brown Shrimp (*Farfantepenaeus aztecus*) in the U.S. Gulf of Mexico for 2015. NOAA Fisheries Southeast Fisheries Science Center. 18 pp.

Hart, R. 2016b. Stock Assessment Update for White Shrimp (*Litopenaeus setiferus*) in the U.S. Gulf of Mexico for 2015. NOAA Fisheries Southeast Fisheries Science Center. 19 pp.

Hawkins, J., & Roberts, C.M. 2004. Effects of artisanal fishing on Caribbean coral reefs. Conservation Biology, 18 (1):215-226.

Headly, M., Oxenford, H.A., Peterson, M.S. & Fanning, P. 2009. Size related variability in the summer diet of the blackfin tuna (*Thunnus atlanticus* Lesson, 1831) from Tobago, the Lesser Antilles. J.Appl.Ichthyo. l.25,669–675.

Henry, C. & Martin, L. 1992. Preliminary stock assessment for the carite fishery of Trinidad. Technical Report of the Project for the Establishment of Data Collection Systems and Assessment of the Fisheries Resources. FAO/ UNDP: TRI/91/001. P.O.S. Trinidad & Tobago: 32 p.

Hogarth, D.D., & Martin, L. 2006. Stock Assessment and Management Advice for the King Mackerel (*Scomberomorus cavalla*) Fishery of Trinidad and Tobago. Proc. Gulf. Caribb. Fish. Inst. 59, 602 pp.

Holthuis, L.B. 1980. FAO Species Catalogue. Vol. 1. Shrimps and prawns of the world. An annotated catalogue of species of interest to fisheries. FAO Fish. Synop. 125(1):271 p. Rome: FAO.

Hornby, C., Harper, S., MacDonald, J. & Zeller, D. 2015. Reconstruction of Suriname's marine fisheries catches from 1950-2010. Working Paper Series #2015-49. Fisheries Centre, University of British Columbia, pp. 14.

ICCAT. 2019a. Basic texts. 7th Revision. International Commission for the Conservation of Atlantic Tunas. Madrid. 120 pp.

ICCAT . 2019b. Report of the Standing Committee on Research and Statistics, 2018. ICCAT, Madrid.

ICCAT. 2018-2019. Report of the 2018 ICCAT blue marlin stock assessment session (Miami, USA 18-22 June, 2018). ICCAT Collect. Vol. Sci. Pap., 75(5):813-888.

ICCAT. 2017a. Report of the 2016 yellowfin stock assessment session (San Sebastian, Spain, 27 June to 1 July 2016). ICCAT Collect. Vol. Sci. Pap., 73(1):76-227.

ICCAT. 2017b. Report of the 2016 sailfish stock assessment (Miami, USA – 30 May to 3 June 2016). ICCAT Collect. Vol. Sci. Pap., 73(5):1579-1684.

ICCAT. 2017c. Report of the 2016 small tunas species group intersessional meeting. (Madrid, Spain, 4-8 April 2016). Collect. Vol. Sci. Pap. ICCAT, 73(8): 2591-2662.

ICCAT. 2017d. Report of the 2017 small tunas species group intersessional meeting (Miami, United States, 24-28 April 2017). Collect. Vol. Sci. Pap. ICCAT, 74(1): 1-75.

ICCAT. 2016a. Report of the 2015 Blue Shark Stock Assessment (Oceanário de Lisboa, Lisbon, Portugal – 27-31 July 2015). ICCAT Collect. Vol. Sci. Pap., 72(4):866-1019.

ICCAT. 2016b. Report of the 2015 small tunas species group intersessional meeting. (Madrid, Spain – June 10-13, 2015). Collect. Vol. Sci. Pap. ICCAT, 72(8): 2120-2185.

ICCAT. 2015. Report of the 2014 ICCAT East and West Atlantic Skipjack Stock Assessment Meeting (Dakar, Senegal -23 June - 1 July 2014). ICCAT Collect. Vol. Sci. Pap., 71(1):1-172.

ICCAT. 2014. Report of the 2013 Atlantic Swordfish Stock Assessment Session (Olhão, Portugal, September 2-10, 2013). ICCAT Collect. Vol. Sci. Pap., 70(4):1484-1678.

ICCAT. 2011. Report for the Biennial Period, 2010-2011, Part I (2010), Vol. 2. ICCAT, Madrid, Spain. 260 pp.

ICCAT. 2012. Report for the Biennial Period, 2010-2011, Part II (2011), Vol. 2. ICCAT, Madrid, Spain. 268 pp.

ICCAT. 2006-2016. ICCAT Manual. International Commission for the Conservation of Atlantic Tuna. In: ICCAT Publications [on-line]. Updated 2016.

ICCAT. 1986. International Skipjack Year Program. Madrid. 384 pp.

Jackson, A.M., Semmens, B.X., De Mitcheson, Y.S., Nemeth, R.S., Heppell, S.A., Bush, P.G., Aguilar-Perera, A., Claydon, J.A.B., Calosso, M.C., Sealy, K.S., Schärer, M.T. & Bernardi, G. 2014a. Population structure and phylogeography in Nassau grouper (*Epinephelus striatus*), a mass-aggregating marine fish. PLoS One 9(5): e97508.

Jackson, J.B.C, Donovan, M.K., Cramer, K.L. & Lam, W. (eds). 2014b. Status and Trends for Caribbean Coral Reefs: 1970-2012. Global Coral Reef Monitoring Network, IUCN, Gland, Switzerland.

Johnson, A.G., Fable, Jr. W.A., Grimes, C.B., & Trent, L. 1994. Evidence for distinct stocks of King Mackerel, *Scomberomorus cavalla*, in the Gulf of Mexico. Fish. Bull. 92: 91-101.

Karlsson, S., Saillant, E. & Gold, J.R. 2009. Population structure and genetic variation of the lane snapper (*Lutjanus synagris*) in the northern Gulf of Mexico. Mar. Biol. 156: 1841-1855.

Kerstetter, D., Bayse, S.M., Fenton, J.L. & Graves, J.E.. 2011. Sailfish Habitat Utilization and Vertical Movements in the Southern Gulf of Mexico and Florida Straits. Marine and Coastal Fisheries, 3(1): 353-365.

Khokiattiwong, S., Mahon, R. & Hunte, W. 2000. Seasonal abundance and reproduction of the fourwing flyingfish, *Hirundichthys affinis*, off Barbados. Environmental Biology of Fishes 59: 43-60.

Kinsey, S.T., Orsoy, T., Bert, T.M. & Mahmoudi, B. 1994. Population structure of the Spanish sardine *Sardinella aurita*: natural morphological variation in a genetically homogeneous population. Mar. Biol., 118(2): 309-317.

Koenig, C., Bertoncini, A.A. & Ferreira, B. 2018. *Mycteroperca microlepis*. The IUCN Red List of Threatened Species 2018: e.T14050A46910927.

Kohler, N., & Turner, P. 2008. Stock structure of the blue shark (*Prionace glauca*) in the North Atlantic Ocean based on tagging data. In: Camhi, M., Pikitch, E., Babcock, E. (eds.), Sharks of the Open Ocean: Biology, Fisheries and Conservation. Blackwell Publishing, Oxford, UK, pp. 339–348.

Kraus R.T. & Rooker, J.R. 2007. Patterns of vertical habitat use by Atlantic blue marlin (*Makaira nigricans*) in the Gulf of Mexico. Gulf Caribb Res 19:89–97.

Kraus, R.T., Wells, D. & Rooker, J. 2011. Horizontal movements of Atlantic Blue Marlin (*Makaira nigricans*) in the Gulf of Mexico. Mar. Biol., 153 (3):699-713.

Kurvers, R.H., Krause, S., Viblanc, P.E., Herbert-Read, J.E., Zaslansky, P., Domenici, P., Marras, S., Steffensen, J.F., Svendsen, M., Wilson, A., Couillaud, P., Boswell, K. & Krause, J. 2017. The Evolution of lateralization in group hunting sailfish. Current Biology, 27: 521–526

Lam, C. H., Galuardi, B., Mendillo, A., Chandler, E. & Lutcavage, M. E. 2016. Sailfish migrations connect productive coastal areas in the west Atlantic Ocean. Sci. Rep. 6, 38163.

Lappo, A., Bjørndal, T., Fernández-Polanco, J. & Lem, A. 2015. Consumers' concerns and external drivers in food markets. FAO Fisheries and Aquaculture Circular No. 1102. Rome, Italy.

Lewis, J.B., Brundritt, J.K. & Fish, A.G. 1962. The Biology of the flyingfish *Hirundichthys affinis* (Gunther). Bull. Mar. Sci., 12(1): 73-94.

Lindeman, K., Anderson, W., Carpenter, K.E., Claro, R., Cowan, J., Padovani-Ferreira, B., Rocha, L.A., Sedberry, G. & Zapp-Sluis, M. 2016a. *Lutjanus analis*. The IUCN Red List of Threatened Species 2016: e.T12416A506350.

Lindeman, K., Anderson, W., Carpenter, K.E., Claro, R., Cowan, J., Padovani-Ferreira, B., Rocha, L.A., Sedberry, G. & Zapp-Sluis, M. 2016b. *Lutjanus synagris*. The IUCN Red List of Threatened Species 2016: e.T194344A2317059.

Marcano, J., Lárez, A. & Carrión, A. 1998. Pesquería de carite rey, *Scomberomorus cavalla*, por la flota artesanal cordelera del estado Nueva Esparta en el oriente de Venezuela y áreas adyacentes. Mem. Fundacion La Salle, 149:89-104.

Marguiles, D., Suter, J.M., Hunt, S.L., Olson, R.J., Scholey, V.P., Wexler, J.B. & Nakazawa, A. 2005. Spawning and early development of captive yellowfin tuna (*Thunnus albacares*). Fish. Bull., 105: 249-265.

Martin, L., & Nowlis, J. 2004. Report of the first annual Caribbean Regional Fisheries Mechanism (CRFM) Scientific Meeting. Surplus production model of Serra Spanish mackerel (*Scomberomorus brasiliensis*), St. Vincent and the Grenadines. In: Fisheries Division (ed.). Ministry of Agriculture, Land and Marine Resources, Trinidad & Tobago.

Matthews, T. R., & Glazer, R. A. 2010. Assessing opinions on abandoned, lost, or discarded fishing gear in the Caribbean, In: Proceedings of the Gulf and Caribbean Fisheries Institute pp 12–22, Gulf and Caribbean Fisheries Institute.

Maunder, M. 2001. Growth of skipjack tuna (*Katsuwonus pelamis*) in the eastern Pacific Ocean, as estimated from tagging data. Bull. IATTC 22, 2: 95-131.

McDowell, J.R. & Graves, J.E. 2002. A genetic perspective on Atlantic sailfish stock structure. ICCAT Collect. Vol. Sci. Pap., 54 (3):805-810.

McDowell, J.R., Carlson, J.E. & Graves, J.E. 2007. Genetic Analysis of Blue Marlin (*Makaira nigricans*) Stock Structure in the Atlantic Ocean. Gulf Carib. Res., 19(2):75-82.

McEachran, J. D., Finucane, J. H. & Hall, L.S. 1980. Distribution, seasonality, and abundance of king and Spanish mackerel larvae in the northwestern Gulf of Mexico (Pisces: Scombridae). Northeast Gulf Sci. 4:1–16.

McManus, E. 2018. MSC certification of Guyana´s industrial seabob fishery. Center for Environment, Fisheries and Aquaculture Science (CEFAS). Lowestoft, Suffolk, UK. 35 pp.

McMillen-Jackson, A. L. & Bert, T.M. 2003. Disparate patterns of population genetic structure and population history in two sympatric penaeid shrimp species (*Farfantepenaeus aztecus* and *Litopenaeus setiferus*) in the eastern United States. Molecular Ecology 12 (11): 2895–2905.

Medley, P., Caesar, K., Hubert-Medar, P., Isaacs, K., Leslie, J., Mohammed, E., Oxenford, H.A., Parker, C., Phillip, P., Potts, A.C., Ryan, R. & Walters, R. 2010. Part II: Management summary and stock assessment report for flyingfish. Meeting of the WECAFC Ad Hoc Flyingfish Working Group of the Eastern Caribbean. Mount Irvine, Tobago, 21–25 July 2008. FAO Fisheries and Aquaculture Report. No. 929. Rome, FAO. 88p.

Meeremans, P., Babb-Echteld, T. & Willems, T. 2017. Bycatch and discards in Suriname trawl fisheries (2012 – 2017): a baseline study. Sustainable Management of Bycatch in Latin America and Caribbean Trawl Fisheries, REBYC-II LAC – SURINAME. 64 pp.

Mejuto, J. 2007. Aspectos biológicos y pesqueros del pez espada (*Xiphias gladius* Linnaeus, 1758) del Océano Atlántico, con especial referencia a las áreas de actividad de la flota española. Doctoral Thesis. University of Santiago de Compostela, Santiago de Compostela, Spain. 224 p.

Mendoza, J. 2015. Rise and fall of Venezuelan industrial and artisanal marine fisheries: 1950-2010. Working Paper Series #2015-27. Fisheries Centre, University of British Columbia, pp. 15.

Merten, W., Appeldoorn. R. & Hammond., D. 2016. Movement dynamics of dolphinfish (*Coryphaena hippurus*) in the northeastern Caribbean Sea: Evidence of seasonal re-entry into domestic and international fisheries throughout the western central Atlantic. Fish. Res., 175:24-34.

Merten, W., Appeldoorn, R., Rivera, R. & Hammond, D. 2014. Diel vertical movements of adult male dolphinfish (*Coryphaena hippurus*) in the western central Atlantic as determined by use of pop-up satellite archival transmitters. Mar. Biol., 161(8): 1823-1834.

Merten, W.B., Schizas, N.V., Craig, M.T., Appeldoorn, R.S., & Hammond, D.L. 2015. Genetic structure and dispersal capabilities of dolphinfish (*Coryphaena hippurus*) in the western central Atlantic. Fish. Bull. 113: 419–429.

Ministry of Agriculture, Animal Husbandry and Fisheries. 2013. Fisheries management plan for Suriname 2014 – 2018. Department of Fisheries. Paramaribo, Suriname. 57 pp.

Mohammed, E. 2017. Current initiatives for fisheries management in Trinidad and Tobago. Enhancing Ocean Governance in the Caribbean Region Symposium. UTT-Maritime Studies Unit, Chaguaramas, Trinidad. June 29-30, 2017.

Morris, J.A. & Akins, J.L. 2009. Feeding ecology of invasive lionfish (*Pterois volitans*) in the Bahamian archipelago. Environmental Biology of Fishes 86(3): 389-398.

Mourato, B., Narváez, M., Amorim, A., Hazin, H., Carvalho, F., Hazin, F. & Arocha, F. 2018. Reproductive biology and space-time modelling of spawning for sailfish *Istiophorus platypterus* in the western Atlantic Ocean. Mar. Biol. Res., 14:269-286.

Munroe, T., Brown, J., Aiken, K.A. & Grijalba Bendeck, L. 2015. *Sardinella aurita* (errata version published in 2017). The IUCN Red List of Threatened Species 2015: e.T198581A115340607.

Nakamura, I. 1985. FAO species catalogue. Vol. 5. Billfish of the World. FAO Fisheries Synopsis, 125(5):1–65.

Nakano, H. & Stevens, J. 2008. The biology and ecology of the blue shark *Prionace glauca*. In: Camhi, M., Pikitch, E., Babcock, E. (eds.), Sharks of the Open Ocean: Biology, Fisheries and Conservation. Blackwell Publishing, Oxford, UK, pp. 140–148.

Narváez M., Ariza, L., Evaristo, E., Bermudez, R., Marcano, J.H., Gutierrez, X. & Arocha, F. 2017. Blackfin tuna (*Thunnus atlanticus*) updates on catch, effort and size distribution from Venezuelan fisheries. ICCAT Collect. Vol. Sci. Pap., 74(1): 82-94.

National Oceanic and Atmospheric Administration (NOAA). 2013. Status of U.S. Fisheries, Second Quarter, FSSI and non FSSI Stocks. http://www.nmfs.noaa.gov/sfa/fisheries_eco/status_of_fisheries/status_updates.html

National Oceanic and Atmospheric Administration (NOAA). 2011. HMS Commercial Compliance Guide. 55 pp.

National Research Council. 2002. Committee on Ecosystem Effects of Fishing: Phase 1 Effects of trawling and dredging on seafloor habitat. National Academy Press, Washington, D.C.

Neilson, J., Arocha, F., Calay, S., Mejuto, J., Ortiz, M., Scott, G., Smith, C., Travassos, P., Tserpes, G. & Andrushchenko, I. 2013. The Recovery of Atlantic Swordfish: The Comparative Roles of the Regional Fisheries Management Organization and Species Biology. Rev. Fish. Sci., 21(2): 59-97.

Neilson, J.D., Smith, S., Roter, F., Paul, S.D., Porter, J.M. & Lutcavage, M. 2009. Investigations of horizontal movements of Atlantic swordfish using pop-up satellite archival tags. In: Tagging and Tracking of Marine Animals with Electronic Devices (Nielsen, J. L., H. Arrizabalaga, N. Fragoso, A. Hobday, M. Lutcavage, and J. Sibert, eds). pp. 145–159. London: Springer.

Nóbrega, M.F. & Lessa, R.P. 2009a. Age and growth of the king mackerel (*Scomberomorus cavalla*) off the northeastern coast of Brazil. Braz. j. oceanogr., 57(4):273-285.

Nóbrega, M.F. & Lessa, R.P. 2009b. Espécies Pelágicas, *Scomberomorus brasiliensis*. In: Lessa, R. P., M. F. Nobrega, J. L. Bezerra Jr., F. M. Santana, P. Duarte Neto, F. H. V. Hazin, B. P. Ferreira, F. L. Frédou, M. Diedhou and A. Monteiro (eds), Dinâmica de Populações e Avaliação dos Estoques dos Recursos Pesqueiros da Região Nordeste, pp. 304. Martins & Cordeiro Ltda, Fortaleza.

Nyman, E. 2012. Culture, economics and maritime Disagreements: Barbados and the Flying Fish. Social and Economic Studies, 61(4): 145-169.

O'Hop, J., Muller, R. & Addis, D. 2015. Stock Assessment of Mutton Snapper (*Lutjanus analis*) of the U.S. South Atlantic and Gulf of Mexico through 2013. SEDAR Update Assessment. 142 pp.

Oxenford, H. A. 1999. Biology of the dolphinfish (*Coryphaena hippurus*) in the western central Atlantic: A review. Sci. Mar., 63(3-4): 277-301.

Oxenford, H.A. 1994. Movements of Flyingfish (*Hirundichthys affinis*) in the eastern Caribbean. Bull. Mar. Sci. 54: 49-62.

Oxenford, H.A. & Hunt, W. 1986. A preliminary investigation of the stock structure of the dolphin, *Coryphaena hippurus*, in the Western central Atlantic. Fish. Bull. 81:906-909.

Oxenford, H.A., Mahon, R. & Hunte, W. (eds). 2007. Biology and management of eastern Caribbean flyingfish. Centre for Resource Management and Environmental Studies, UWI, Barbados. 268pp.

Pagavino, M. 1997. Indice gonadal y crecimiento del atún listado (*Katsuwonus pelamis*) del Mar Caribe. ICCAT Collect. Vol. Sci. Pap, 46(4):268-276.

Palko, B.J., Beardsley, G.L. & Richards, W.J. 1982. Synopsis of the biological data on dolphin-fishes, *Coryphaena hippurus* Linnaeus and *Coryphaena equiselis* Linnaeus. NOAA Tech. Rep. NMFS Circ., 443.

Palko, B.J., Beardsley, G. & Richards, W.J. 1981. Synopsis of the biology of the swordfish, *Xiphias gladius* Linnaeus. NOAA Tech. Rep., NMFS Circ., 441.

Pankhurst, N.W. & Munday, P.L. 2011. Effects of climate change on fish reproduction and early life history stages. Marine and Freshwater Research, 62(9): 1015-1026.

Páramo, J., Pérez, D. & Wolff, M. 2014. Reproducción del camarón rosado *Farfantepenaeus notialis* (Decapoda: Penaeidae) en el Caribe colombiano. Rev. Biol. Trop., 62 (2): 513-521.

Parsons, G. & Foster, D. 2015. Reducing bycatch in the United States Gulf of Mexico shrimp trawl fishery with an emphasis on red snapper bycatch reduction. Fish. Res., 167:210-215.

Pauly, D. & Zeller, D. (eds). 2015. Sea Around Us Concepts, Design and Data (seaaroundus.org).

Pecoraro, C., Babbucci, M., Franch, R., Rico, C., Papetti, C., Chassot, E., Bodin, N., Cariani, A., Bargelloni, L., Tinti, F. 2018. The population genomics of yellowfin tuna (*Thunnus albacares*) at global geographic scale challenges current stock delineation. Scientific Reports, 8:13890.

Pecoraro, C., Babbucci, M., Villamor, A., Franch, R., Papetti, C., Leroy, B., Ortega-Garcia, S., Muir, J., Rooker, J., Arocha, F., Murua, H., Zudaire, I., Chassot, E., Bodin, N., Tinti, F., Bargelloni, L. & Cariani, A. 2016. Methodological assessment of 2b-RAD genotyping technique for population structure inferences in yellowfin tuna (*Thunnus albacares*). Mar. Genomics, 25:43–48.

Prager, M. 2000. Exploratory assessment of dolphinfish, *Coriphaena hippurus*, based on U.S. landings from the Atlantic and Gulf of Mexico. In: Fishery Management Plan for the dolphinfish and wahoo fishery of the Atlantic, Caribbean, and Gulf of Mexico. South Atlantic Fishery Management Council. (2001) NOAA, U.S. Appendix B.

Prince, E.D., Cowen, R.K., Orbesen, E.S., Luthy, S.A., Llipoz, J.K., Richardson, D.E. & Serafy, J.E. 2005. Movements and spawning of white marlin (*Tetrapturus albidus*) and blue marlin (Makaira nigricans) off Punta Cana, Dominican Republic. Fish. Bull. 103:659-669.

Prince, E., Luo, J., Goodyear, C.P., Hoolihan, J.P., Snodgrass, D., Orbesen, E., Serafy, J., Ortiz, M. & Schirripa, M.J. 2010. Ocean scale hypoxia-based habitat compression of Atlantic istiophorid billfishes. Fish. Oceanogr. 19:448-462.

Queiroz, N., Humphries, N.E., Noble, L.R., Santos, A.M. & Sims, D. 2012. Spatial dynamics and expanded vertical niche of blue sharks in the oceanographic fronts reveal habitat targets for conservation. PLoS ONE 7, e32374, http://dx.doi.org/10.1371/journal.pone.0032374.

Raymond, W.W., Albins, M.A. & Pusack, T.J. 2015. Competitive interactions for shelter between invasive Pacific red lionfish and native Nassau grouper. Environmental Biology of Fishes 98: 57-65.

Richardson, D.E., Cowen, R.K., Prince, E.D. & Sponaugle, S. 2009a. Importance of the Straits of Florida spawning ground to Atlantic sailfish (*Istiophorus platypterus*) and blue marlin (*Makaira nigricans*). Fish. Oceanogr. 18:402–418.

Richardson, D.E., Llopiz, J.K., Learman, K.D., Vertes, P.S., Muller-Karger, F.E. & Cowen, R.K. 2009b. Sailfish (*Istiophorus platypterus*) spawning and larval environment in a Florida Current frontal eddy. Prog. Oceanogr. 82, 252–264.

Rinaldo, R., Evans, R. & Vergne, P. 1981. Preliminary results of a 1980 skipjacktuna tagging cruise in the western Atlantic and Caribbean Sea. ICCAT Collect. Vol. Sci. Pap, 15(1):150-164.

Rooker, J.R., Kitchens, L.L., Dance, M.A., Wells, R.J.D., Falterman, B. & Cornic, M. 2013. Spatial, Temporal, and Habitat-Related Variation in Abundance of Pelagic Fishes in the Gulf of Mexico: Potential Implications of the Deepwater Horizon Oil Spill. PLoS ONE 8(10): e76080.

Rooker, J., Simms, J.R., Wells, R.J., Holt, S.A., Holt, G.J., Graves, J., Furey, N. 2012. Distribution and habitat associations of billfish and swordfish larvae across mesoscale features in the Gulf of Mexico. PLoS ONE 7(4):e34180.

Rueda-Roa, D., J. Mendoza, F. Muller-Karger, J.J. Cardenas, A. Achury, Y. Astor. 2017. Spatial variability of Spanish sardine (*Sardinella aurita*) abundance as related to the upwelling cycle off the southeastern Caribbean Sea. PLOS ONE. https://doi.org/10.1371/journal.pone.0179984.

Sadovy, Y., Aguilar-Perera, A. & Sosa-Cordero, E. 2018. *Epinephelus striatus*. The IUCN Red List of Threatened Species 2018: e.T7862A46909843.

Sadusky, H., Chaibongsai, P., Die, D., Agar, J. & Shivlani, M. 2018. Management of moored fish aggregation devices (FADs) in the Caribbean. ICCAT Collect. Vol. Sci. Pap. 74(5): 2230-2242.

SAGARPA. 2012. Carta Nacional Pesquera, Diario Oficial, Jueves 24 de agosto de 2012 (segunda sección). Secretaria de Agricultura, Ganaderia, Desarrollo Rural, Pesca y Alimentación. http://www.gob.mx/cms/uploads/attachment/file/117714/Carta-Nacional-Pesquera-2012.pdf

Saillant, E., Antoni, L., Short, E., Luque, P., Franks, J., Reynal, L., Pau, C., Arocha, F., Roque, P., Hazin, F., Falterman, B., Hanke, M., Ngom Sow, F. & Bannerman, P. 2016. Assessment of the Genetic Structure of Yellowfin and Blackfin Tuna in the Atlantic Ocean. Proc. 69th Gulf and Caribb. Fish. Inst., 341-342.

Santos, S., Hrbek, T., Farias, I.P., Schneider, H. & Sampaio, I. 2006. Population genetic structuring of the king weakfish, *Macrodon ancylodon* (Sciaenidae), in Atlantic coastal waters of South America: deep genetic divergence without morphological change. Molecular Ecology 15:4361–4373.

Santos S., Schneider, H. & Sampaio, I. 2003. Genetic differentiation of *Macrodon ancylodon* (Sciaenidae, Perciformes) populations in Atlantic coastal waters of South America as revealed by mtDNA analysis. Genetics and Molecular Biology 26 (2): 151-161.

Saxton, B.L. 2009. Historical demography and genetic population structure of the blackfin tuna (*Thunnus atlanticus*) from the Northwest Atlantic Ocean and the Gulf of Mexico. Master of Science Thesis.Texas A&M University. 91 p.

Schell, J.M., Goodwin, D.S. & Siuda, A.N.S. 2015. Recent Sargassum inundation events in the Caribbean: Shipboard observations reveal dominance of a previously rare form. Oceanography 28(3): 8–10.

SEDAR. 2018a. SEDAR 63 - Gulf of Mexico menhaden Stock Assessment Report. SEDAR, North Charleston SC. 422 pp.

SEDAR. 2018b. SEDAR 52. Stock Assessment Report, Gulf of Mexico Red Snapper. 434 pp.

SEDAR. 2017a. SEDAR 41. Stock Assessment of Red Snapper off the Southeastern United States, SEDAR Benchmark Assessment. 143 pp.

SEDAR. 2017b. SEDAR 53 – South Atlantic Red Grouper Assessment Report. North Charleston SC.

SEDAR. 2016. SEDAR 33 Update Report: Gulf of Mexico Gag Grouper. North Charleston SC.

SEDAR. 2015. SEDAR 42 Stock Assessment Report for Gulf of Mexico Red Grouper.

SEDAR. 2014a. SEDAR 38 – Stock Assessment Report. South Atlantic King Mackerel. SEDAR, North Charleston SC. 502 pp.

SEDAR. 2014b. SEDAR 38 – Stock Assessment Report. Gulf of Mexico King Mackerel. SEDAR, North Charleston SC. 465 pp.

SEDAR. 2014c. SEDAR 10. Stock Assessment of Gag off the Southeastern United States. SEDAR Update Assessment. 112 pp.

SEDAR. 2013. SEDAR 32A - Gulf of Mexico menhaden stock assessment report. SEDAR. North Charleston, SC. 442 p.

SEDAR 2007. SEDAR 14. Stock Assessment Report, Caribbean Mutton Snapper.

Serafy, J.E., Cowen, R.K., Paris, C.B., Capo, T.R. & Luthy, S.A. 2003. Evidence of blue marlin, *Makaira nigricans*, spawning in the vicinity of Exuma Sound, Bahamas. Marine and Freshwater Research 54: 299-306.

Sharp, G. 2001. Tuna oceanography - An applied science. In: Tuna: Physiology, ecology, and evolution (B.A. Block and E.D. Stevens, eds.), pp. 345-389. Academic Press, San Diego-USA.

Sims, J., Holt, S., Holt, G. & Rooker, J. 2009. Age and Growth of Larval Sailfish, *Istiophorus platypterus*, in the Northern Gulf of Mexico. Proc. 61st Gulf and Caribb. Fish. Inst., 17-21.

Simms, J. R., Rooker, J., Holt, S., Holt, J. & Bangma, J. 2010. Distribution, growth, and mortality of sailfish (*Istiophorus platypterus*) larvae in the northern Gulf of Mexico. Fish. Bull. 108(4):478-490.

Singh-Renton, S. & McIvor, I. 2015. Review of current fisheries management performance and conservation measures in the WECAFC area. FAO Fisheries and Aquaculture Technical Paper No. 587, Bridgetown, Barbados, FAO. 293 pp.

Singh-Renton, S. & Renton, J. 2007. CFRAMP's Large Pelagic Fish Tagging Program. Gulf Caribb. Res. 19(2), 99–102.

Smith, G. & Burkhardt, D. 2017. Socio-economic Study of the Fisheries Sector in Suriname. WWF Guianas, 46 pp.

Southall, T., Addison, J. & Keus, B. 2019. Marine Stewardship Council Fisheries Assessment. Guyana Seabob Fishery, Final Report. Report on the 1st full assessment of the fishery. 192 pp.

Southall, T., Blyth-Skyrme, R. & Tremblay, T. 2017. MSC sustainable fisheries certification. Acoura Marine, Public Certification Report, Suriname Atlantic Seabob Shrimp. 176 pp.

Southeast Fisheries Science Center (SFSC). 2017. South Atlantic Regional Action Plan to Implement the NOAA Fisheries Climate Science Strategy: Draft for Public Review. February 2017. 37 pp

SSC. 2013. Standing and Special Reef Fish SSC Meeting Summary. Tampa, Florida, May 29-31, 2013. Available online through the Gulf Council's FTP server (http://www.gulfcouncil.org/about/ftp.php) in Archived Meetings>SSC Meetings>SSC Meeting-2013-05>Meeting Summaries Reef_Fish_SSC_Meeting_Summary_05-2013.pdf.

Stone, H.H. 2000. Update on the Canadian juvenile swordfish cooperative tagging program. ICCAT Collect. Vol. Sci. Pap., 51: 1470–1479.

Strum, M. & Salter, P. 1989. Age, growth, and reproduction of the king mackerel (*Scomberomorus cavalla* Cuvier) in Trinidad waters. Fish. Bull., 88:361-370.

Strum, M.G. 1978 Aspects of the biology of *Scomberomorus maculatus* (Mitchill) in Trinidad. J. Fish. Biol., 13:155-172.

Strum, M.G., Julien, M. & Salter, P. 1984. Exploitation and biology of the mackerel fishery in Trinidad. Proc. Gulf. Caribb. Fish. Inst. 36:142-151.

Tavares, R., Ortiz, M. & Arocha, F. 2012. Population structure, distribution, and relative abundance of the blue shark (*Prionace glauca*) in the Caribbean Sea and adjacent waters of the North Atlantic. Fish. Res., 129-130:137-152.

Taylor, G.T., Muller-Karger, F.E., Thunell, R.C., Scranton, M.I., Astor, Y., Varela, R., Troccoli-Ghinaglia, L., Lorenzoni, L., Fanning, K.A., Hameed, S. & Doherty, O. 2012. Ecosystem responses in the southern Caribbean Sea to global climate change. PNAS 109(47): 19315-19320.

VanderKooy, S. J. & Smith, J. W. 2002. The Menhaden Fishery of the Gulf of Mexico, United States: A Regional Management Plan. Gulf States Marine Fisheries Commission (GSMFC). Number 99, March 2002. 143 pp.

van Tussenbroek, B.I., Arana, H.A.H., Rodríguez-Martínez, R.E., Espinoza-Avalos, J., Canizales-Flores, H.M., González-Godoy, C.E., Barba-Santos, M.G., Vega-Zepeda, A. & Collado-Vides, L. 2017. Severe impacts of brown tides caused by *Sargassum* spp. on near-shore Caribbean seagrass communities. Marine Pollution Bulletin 122(1-2): 272-281.

Veríssimo, A., Sampaio, Í., McDowell, J.R., Alexandrino, P., Mucientes, G., Queiroz, N., Da Silva, C., Jones C.S. & Noble L.R. 2017. World without borders-genetic population structure of a highly migratory marine predator, the blue shark (*Prionace glauca*). Ecology and Evolution 7(13):4768-4781.

Wang, M., Hu, C., Barnes, B., Mitchum, G., Lapointe, B., Montoya, J. 2019. The great Atlantic Sargassum belt. Science, 365 (6448): 83-87.

Ward, P., Porter, J. M. & Elscot, S. 2000. Broadbill swordfish: status of established fisheries and lessons for developing fisheries. Fish & Fish., 1: 317–336.

WECAFC. 2019a. State of Fisheries and Aquaculture in the WECAFC Area. Seventeenth session. Miami, United States of America, 15-18 July 2019. WECAFC/XVII/2019/02.

WECAFC. 2019b. Report of the ninth session of the scientific advisory group. Bridgetown, Barbados, 19-20 November 2018. FAO Fisheries and Aquaculture Report No. 1266. 148 pp.

WECAFC. 2019c. Impacts of Climate Change on Western Central Atlantic marine fisheries. Seventeenth session. Miami, United States of America, 15-18 July 2019. WECAFC/XVII/2019/3.

WECAFC. 2019d. Summary of the reports of the Scientific Advisory Group (SAG) meetings held during the intersessional period- SAG 8 (Mexico 2017), SAG 9 (Barbados 2018), and SAG 10 (virtual meeting 2019). Seventeenth session. Miami, United States of America, 15-18 July 2019. WECAFC/XVII/2019/6.

WECAFC. 2019e. Status and future work on the development of the Caribbean management plan for spawning aggregation. Seventeenth session. Miami, United States of America, 15-18 July 2019. WECAFC/XVII/2019/13.

WECAFC. 2018. Report of the FIRMS-WECAFC regional workshop on recreational fisheries statistics in the Caribbean. Nassau, The Commonwealth of the Bahamas, 20–22 June 2017. FAO Fisheries and Aquaculture Report No. 1194. Rome, Italy. 26 pp.

WECAFC. 2016. Report of the Sixteenth session of the Commission. Guadeloupe, 20–24 June 2016. FAO Fisheries and Aquaculture Report No. 1162. 137 pp.

World Bank. 2019. Gross Domestic Product GDP: national accounts data and OECD National Accounts data files. https://data.worldbank.org/indicator/ny.gdp.mktp.cd Accessed: August 27th, 2019.

Zatcoff, M.S., Ball, A.O. & Sedberry, G.R. 2004. Population genetic analysis of red grouper, *Epinephelus morio* , and scamp, *Mycteroperca phenax* , from the southeastern U.S. Atlantic and Gulf of Mexico. Mar. Biol. 144(4):769-777.

Zeller, D., Graham, R., & Harper, S. 2011. Reconstruction of total marine fisheries catches for Belize, 1950-2008. In: Palomares, M.L.D., Pauly, D. (eds.), Too Precious to Drill: the Marine Biodiversity of Belize, pp. 142-151. Fisheries Centre Research Reports 19(6). Fisheries Centre, University of British Columbia.

Table 1. Groups and species reviewed in the status of fish and shellfish in the WECAFC region.

Main groups	Species
Large pelagics	***Thunnus albacares*** Yellowfin tuna ***Katsuwonus pelamis*** Skipjack tuna ***Xiphias gladius*** Swordfish ***Makaira nigricans*** Blue marlin ***Istiophorus platypterus*** Atlantic sailfish ***Thunnus atlanticus*** Blackfin tuna ***Scomberomorus cavalla*** King mackerel ***Scomberomorus brasiliensis*** Serra-Spanish mackerel ***Coryphaena hippurus*** Common dolphinfish ***Prionace glauca*** Blue shark
Small pelagics	***Brevoortia patronus*** Gulf menhaden ***Sardinella aurita*** Round sardinella **Flyingfishes nei** Four-wing flyingfish

Shrimps and Groundfish	***Farfantepenaeus aztecus*** Northern brown shrimp ***Farfantepenaeus brasiliensis*** Spotted shrimp ***Farfantepenaeus schmitti*** Southern white shrimp ***Litopenaeus setiferus*** Northern white shrimp ***Farfantepenaeus subtilis*** Southern brown shrimp ***Farfantepenaeus duorarum*** Northern pink shrimp ***Farfantepenaeus notialis*** Southern pink shrimp ***Xiphopenaeus kroyeri*** Atlantic seabob ***Penaeus* spp** Penaeus shrimps nei ***Cynoscion jamaicensis*** Jamaica weakfish ***Cynoscion virescens*** Green weakfish ***Macrodon ancylodon*** King weakfish ***Mycrospogonias furnieri*** Whitemouth croaker ***Micropogonias undulatus*** Atlantic croaker ***Cynoscion* spp** Weakfishes nei
Snappers and Groupers	***Epinephelus morio*** Red grouper ***Epinephelus striatus*** Nassau grouper ***Mycteroperca microlepis*** Gag grouper ***Lutjanus analis*** Mutton snapper ****Lutjanus campechanus*** Northern red snapper ****Lutjanus purpureus*** Southern red snapper ****Lutjanus synagris*** Lane snapper

* Described and reviewed in the Shrimp and Groundfish group because these snappers are bycatch of Soft-bottom fisheries operated with bottom trawls.

Table 2. Catch (tonnes) by main groups (excluding mollusks) landed in FAO area 31 during 2017, of selected species for the present report.

	All species in FAO 31		Selected species	
Main groups	**Tonnes**	**%**	**Tonnes**	**%**
Large pelagics	67,123	2.68	41,234	1.65
Small pelagics	595,217	23.77	588,502	23.50
Shrimps	173,179	6.92	170,708	6.82
Groundfishes	30,669	1.22	25,177	1.01
Snappers	18,534	0.74	12,388	0.49
Groupers	18,416	0.74	15,388	0.61

Table 3. Landings, landing revenues and average annual price for U.S. regions of the WECAFC area (U.S. South Atlantic and U.S Gulf of Mexico) during 2016 (National Marine Services, 2018).

	South Atlantic			Gulf of Mexico		
Species group	**Landings (kg)**	**Landing Revenues (thousands of dollars)**	**Average annual price (US$/ kg)**	**Landings (kg)**	**Landing Revenues (thousands of dollars)**	**Average annual price (US$/ kg)**
Tunas	4,687,032	4,322	0.92	773,828	5,790	1.54
Swordfish	2,945,378	4,474	1.52			
King mackerel	5,765,093	6,252	1.08			
Shrimp	52,811,778	56,993	1.08	96,064,889	412,947	0.88
Menhaden				618,713,096	143,339	0.05
Red snapper				2,928,844	26,450	1.86
Snappers	2,072,347	3,285	1.59			
Groupers	1,294,115	2,824	2.18	3,599,706	28,694	1.64

Table 4. Contribution of fisheries and aquaculture in WECAFC area to the GDP.

Country or Overseas Territories*	Share of fish in GDP (in decreasing order)
Belize	3.00
Suriname	2.26
Grenada	1.30

Antigua and Barbuda	1.00
Bahamas	1.00
Turks and Caicos	0.82
Br. Virgin Islands	0.80
Curaçao	0.70
Saint Vincent and the Grenadines	0.61
Guyana	0.60
Panama	0.60
Saint Lucia	0.50
Dominica	0.45
Jamaica	0.45
Dominican Republic	0.30
Trinidad and Tobago	0.30
Venezuela	0.26
Guatemala	0.25
Colombia	0.17
Saint Kitts and Nevis	0.17
Cayman Islands	0.05
Mexico	0.05
Bermuda	0.02

Source: WECAFC 2019a. Author's calculations based on Primary data of SDG 14.7.1 (UNSD) and various FAO fisheries country profiles.
(*) Only those WECAFC countries or OTs, for which figures for fish are available, therefore some countries could not be covered

Table 5. Number of fishers, total population, and percentage of fishers in the WECAFC area for 2017**.

Country/Overseas T.* in alphabetical order	Number of fishers	Population (in MM)	Share of fishers in total population
Antigua & Barbuda (2015)	1877	0.009	2.09%
Bahamas	9300	0.377	2.47%
Barbados (2012)	3000	0.285	1.04%
Belize (2015)	2716	0.332	0.82%
Bermuda	277	0.061	0.45%
Cayman Isl. (2015)	100	0.058	0.17%
Colombia (2014)	40000	13.85	0.29%
Costa Rica	2500	4.872	0.05%
Cuba (2013)	7479	11.266	0.07%
Curaçao	120	0.161	0.07%
Dominica	1383	0.072	1.92%
Dominican Republic (2012)	10900	10.404	0.10%
French Guiana (2013)	2800	0.300	0.93%
Grenada (2014)	3500	0.106	3.50%
Guadeloupe (2013)	2500	0.466	0.54%
Guatemala	1000	0.400	0.25%
Guyana	10000	0.760	1.32%
Haiti (2012)	15000	10.317	0.15%
Honduras	7500	2.420	0.31%
Jamaica	14923	2.784	0.70%
Martinique (2013)	2500	0.404	0.62%
Mexico	100000	18.400	0.54%
Nicaragua	20000	0.700	2.86%
Netherlands	400	0.025	1.60%
Panama	1000	0.557	0.18%
Saint Kitts & Nevis	954	0.054	1.61%
Saint Lucia	3150	0.182	1.14%
St. Vincent & the Grenadines	3000	0.109	2.75%

Suriname	8000	0.570	1.40%
Trinidad & Tobago (2012)	12063	1.341	1.20%
Turks & Caicos	2105	0.033	6.40%
U.S.A.	155000	73.100	0.21%
Venezuela (2016)	95000	32.400	0.29%
Total	**567352**	**186.971**	**0.30%**

Source: WECAFC 2019a. Calculations based on various FAO fisheries country profiles and –Fisheries Economics of the United States, 2016 Fact Sheet.
(*) only for countries where employment statistics in fisheries are available, fish farmers are not included
(**) if not otherwise stated

Table 6. Countries and overseas territories in the WECAFC region with memberships (green) in the main fisheries related international bodies. Other colors indicate the kind of participation of a country in the international body.

Country	WECAFC	ICCAT	CRFM	OSPESCA
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
Cuba	green			
Curaçao		green		
Dominica	green		green	
Dominican Republic	green			green
El Salvador				green
European Union	green	green		

France		St-Pierre et Miquelon		
Grenada				
Guatemala				
Guinea				
Guyana		Cooperating Non-Contracting Party		
Haiti				
Honduras				
Jamaica				
Japan				
Mexico				
Monserrat*				
Netherlands				
Nicaragua				
Panama				
Republic of Korea				
Saint Kitts and Nevis				
Saint Lucia				
Saint Vincent/Grenadines				
Spain				
Suriname		Cooperating Non-Contracting Party		
Trinidad and Tobago				
Turk and Caicos Islands*				
United Kingdom*				
United States of America				
Venezuela				

*The British Government deals with all international relations on behalf of these territories.

List of FIGURES

Figure 1. (**A**)Total landings (nominal weight in tonnes) Yellowfin tuna (*Thunnus albacares*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 83% of the total average landings; (**C**) Countries landing 76% of Yellowfin tuna in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 2. (**A**)Total landings (nominal weight in tonnes) Skipjack tuna (*Katsuwonus pelamis*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 94% of the total average landings; (**C**) Countries landing 86% of Skipjack tuna in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 3. (**A**)Total landings (nominal weight in tonnes) Blue marlin (*Makaira nigricans*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 83% of the total average landings; (**C**) Countries landing 81% of Blue marlin in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 4. (**A**)Total landings (nominal weight in tonnes) Sailfish (*Istiophorus platypterus*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 78% of the total average landings; (**C**) Countries landing 84% of Sailfish in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 5. (**A**)Total landings (nominal weight in tonnes) Swordfish (*Xiphias gladius*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 78% of the total average landings; (**C**) Countries landing 95% of Swordfish in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 6. (**A**)Total landings (nominal weight in tonnes) Blue shark (*Prionace glauca*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 98% of the total average landings; (**C**) Countries landing 89% of Blue shark in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 7. (**A**)Total landings (nominal weight in tonnes) Blackfin tuna (*Thunnus atlanticus*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 89% of the total average landings; (**C**) Countries landing 93% of Blackfin tuna in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 8. (**A**)Total landings (nominal weight in tonnes) King mackerel (*Scomberomorus cavalla*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 99% of the total average landings; (**C**) Countries landing 97% of King mackerel in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 9. (**A**)Total landings (nominal weight in tonnes) Serra-Spanish mackerel (*Scomberomorus brasiliensis*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 100% of the total average landings; (**C**) Countries landing 100% of Serra Spanish mackerel in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 10. (**A**)Total landings (nominal weight in tonnes) Dolphinfish/Dorado (*Coryphaena hippurus*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 84% of the total average landings; (**C**) Countries landing 84% of Dolphinfish/Dorado in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 11. (**A**)Total landings (nominal weight in tonnes) Gulf menhaden (*Brevoortia patronus*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 100% of the total average landings; (**C**) Countries landing 100% of Gulf menhaden in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 12. (**A**)Total landings (nominal weight in tonnes) Round sardinella (*Sardinella aurita*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 100% of the total average landings; (**C**) Countries landing 100% of Round sardine in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 13. (**A**)Total landings (nominal weight in tonnes) Four-wing flyingfish (Flyingfishes neii) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 100% of the total average landings; (**C**) Countries landing 97% of Four-wing flyingfish in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 14. (**A**)Total landings (nominal weight in tonnes) Northern brown shrimp (*Farfantepenaeus aztecus*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 100% of the total average landings; (**C**) Countries landing 100% of Northern brown shrimp in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 15. (**A**)Total landings (nominal weight in tonnes) Northern white shrimp (*Litopenaeus setiferus*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 100% of the total average landings; (**C**) Countries landing 100% of Northern white shrimp in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 16. (**A**)Total landings (nominal weight in tonnes) Northern pink shrimp (*Farfantepenaeus duorarum*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 100% of the total average landings; (**C**) Countries landing 100% of Northern pink shrimp in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 17. (**A**)Total landings (nominal weight in tonnes) Northern red snapper (*Lutjanus campechanus*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 100% of the total average landings; (**C**) Countries landing 100% of Northern red snapper in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 18. (**A**)Total landings (nominal weight in tonnes) Atlantic croaker (*Microspogonias undulatus*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 100% of the total average landings.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 19. (**A**)Total landings (nominal weight in tonnes) Penaeus shrimp nei (*Penaeus* spp) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 100% of the total average landings.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 20. (**A**) Percentage of landings Penaeus shrimp nei (*Penaeus* spp) from the Guianas-Brazil Shelf, by countries from 1950 to 2017, landing 100% of the total average landings; (**B**) Countries landing 100% of Penaeus shrimp nei from the Guianas-Brazil Shelf in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 21. (**A**)Total landings (nominal weight in tonnes) Atlantic seabob (*Xiphopenaeus kroyeri*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 99% of the total average landings; (**C**) Countries landing 100% of Atlantic seabob in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 22. (**A**)Total landings (nominal weight in tonnes) Whitemouth croaker (*Microspogonias furnieri*) and (**B**) Weakfishes (*Cynoscion* spp) from 1950 to 2017; (**C**) Percentage of Whitemouth croaker and (**D**) Weakfishes landings by countries from 1950 to 2017, landing 100% and 99% of the total average landings, respectively.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 23. (**A**)Total landings (nominal weight in tonnes) Southern red snapper (*Lutjanus purpureus*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 99% of the total average landings; (**C**) Countries landing 88% of Southern red snapper in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 24. (**A**)Total landings (nominal weight in tonnes) Lane snapper (*Lutjanus synagris*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 98% of the total average landings; (**C**) Countries landing 92% of Lane snapper in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 25. (**A**)Total landings (nominal weight in tonnes) Red grouper (*Epinephelus morio*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 100% of the total average landings; (**C**) Countries landing 100% of Red grouper in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 26. (**A**)Total landings (nominal weight in tonnes) Nassau grouper (*Epinephelus striatus*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 100% of the total average landings; (**C**) Countries landing 100% of Nassau grouper in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 27. (**A**)Total landings (nominal weight in tonnes) Mutton snapper (*Lutjanus analis*) from 1950 to 2017; (**B**) Percentage of landings by countries from 1950 to 2017, landing 100% of the total average landings; (**C**) Countries landing 100% of Mutton snapper in the last 5 years.
Source: FAO statistics for Area 31, Brazil was not included because Brazil does not discriminate landings between WECAFC region and Area 41.

Figure 28. (**A**)Total landings (excluding mollusks) by main groups of interest in the western central Atlantic, FAO area 31. (**B**) Landings of species of interest by groups in the western central Atlantic, FAO area 31.

Figure 29. Annual value (million US$) for several of the groups of interest in the FAO area 31 for 2014 (Source: Pauly and Zeller, 2015 – Sea Around Us).

Figure 30. (**A**) Percentage of total landed catch of pelagic species during 2017 in FAO area 31. The countries showed represent the 98.34% of total catches. (**B**) Percentage of landed pelagic catch of species of interest during 2017 in FAO area 31; (**C**) Large pelagic species, the countries showed represent 81.42% of total catches; (**D**) Small pelagic species, the countries showed represent 100% of total catches.

Figure 31. (**A**) Percentage of total landed catch of shrimp species during 2017 in FAO area 31; (**B**) Percentage of landed shrimp catch of species of interest during 2017 in FAO area 31; (**C**) Percentage of total landed catch of groundfishes during 2017 in FAO area 31; (**D**) Percentage of landed groundfish catch of species of interest during 2017 in FAO area 31. The countries showed represented 97.75% of total catches in shrimps and groundfish species.

Figure 32. (**A**) Shrimps and groundfish species, the countries showed represent 97.75% of total catches; (**B**) Percentage of total landed catch of snapper and grouper species during 2017 in FAO area 31; (**C**) Percentage of landed snapper and grouper catch of species of interest during 2017 in FAO area 31 (**D**) Snappers and groupers species, the countries showed represent 98.59% of total catches.