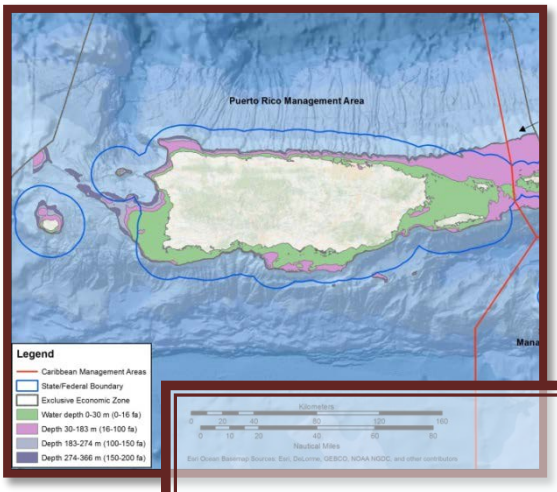


# Comprehensive Fishery Management Plan for the Puerto Rico Exclusive Economic Zone

## Including Draft Environmental Assessment

**Caribbean Fishery Management Council 165th Meeting**
**Briefing Book Version (Draft) - April 2019**

# Comprehensive Fishery Management Plan for the Puerto Rico Exclusive Economic Zone

**Proposed Action**: Establish a new Comprehensive Fishery Management Plan (FMP) for the Puerto Rico Exclusive Economic Zone (Puerto Rico FMP) prepared by the Caribbean Fishery Management Council and repeal the existing species-based FMPs. The action would also modify the composition of the stocks to be managed under the Puerto Rico FMP, organize those stocks for effective management, modify, and/or establish management reference points for managed stocks, establish accountability measures, identify essential fish habitat for stocks new to management, and establish framework measures.

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# Abbreviations and Acronyms

| | |
|---|---|
| ABC | acceptable biological catch |
| ABC CR | acceptable biological catch control rule |
| ACL | annual catch limit |
| ACT | annual catch target |
| AM | accountability measure |
| AP | advisory panel |
| APA | Administrative Procedure Act |
| CCR | commercial catch reporting forms |
| CEA | cumulative effects analysis |
| CEQ | Council on Environmental Quality |
| CFMC | (Council); Caribbean Fishery Management Council |
| CFR | Code of Federal Regulations |
| CV | coefficient of variation |
| CZMA | Coastal Zone Management Act |
| DAP | District Advisory Panel |
| DEIS | draft environmental impact statement |
| DNER | Department of Natural and Environmental Resources of Puerto Rico |
| DPNR | Department of Planning and Natural Resources of the U.S. Virgin Islands |
| EA | environmental assessment |
| EEZ | exclusive economic zone |
| EFH | essential fish habitat |
| EIS | environmental impact statement |
| EPA | Environmental Protection Agency |
| ESA | Endangered Species Act |
| FAO | Food and Agriculture Organization (United Nations) |
| FEIS | final environmental impact statement |
| FMC | fishery management council |
| FMP | fishery management plan |
| $F_{MSY}$ | fishing mortality rate yielding MSY |
| FMU | fishery management unit |
| FONSI | finding of no significant impact |
| HAPC | habitat area of particular concern |
| HMS | highly migratory species |
| ITCZ | inter-tropical convergence zone |
| MFMT | maximum fishing mortality threshold |
| MMPA | Marine Mammal Protection Act |
| MPA | marine protected area |
| MRIP | Marine Recreational Information Program |

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|---|---|
| MSA | (Magnuson- Stevens Act); Magnuson-Stevens Fishery Conservation and Management Act |
| MSST | minimum stock size threshold |
| MSY | maximum sustainable yield |
| NEPA | National Environmental Policy Act |
| NMFS | National Marine Fisheries Service |
| NOAA | National Oceanic and Atmospheric Administration |
| NOI | notice of intent |
| NS | national standard |
| OFL | overfishing limit |
| OMB | Office of Management and Budget |
| ORCS | only reliable catch stocks |
| OY | optimum yield |
| PDF | probability density function |
| PSA | productivity-susceptibility analysis |
| RFA | Regulatory Flexibility Act |
| RIR | Regulatory Impact Review |
| SD | standard deviation |
| SEAMAP | Southeast Area Monitoring and Assessment Program |
| SEDAR | Southeast data assessment review (stock assessment) |
| SEFSC | Southeast Fisheries Science Center |
| SERO | Southeast Regional Office |
| SFA | Sustainable Fisheries Act |
| SSC | Scientific and Statistical Committee |
| SYL | sustainable yield level |
| USVI | United States Virgin Islands |

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# Chapter 1. Introduction

## 1.1 What Action is Being Proposed?

The Caribbean Fishery Management Council (Council) is considering shifting from a species[1]-based management approach to an approach that instead manages at the level of each island (*i.e.*, island-based management), applicable to the three U.S. Caribbean exclusive economic zone (EEZ) management areas: (1) Puerto Rico; (2) St. Thomas/St. John, U.S. Virgin Islands (USVI); and (3) St. Croix, USVI). Historically, the Council has managed federal fisheries in the U.S. Caribbean EEZ under four species-based fishery management plans (FMPs): the FMP for the Reef Fish of Puerto Rico and the USVI (Reef Fish FMP), the FMP for the Spiny Lobster of Puerto Rico and the USVI (Spiny Lobster FMP), the FMP for the Queen Conch Resources of Puerto Rico and the USVI (Queen Conch FMP), and the FMP for the Corals and Reef Associated Plants and Invertebrates of Puerto Rico and the USVI (Coral FMP). Through the actions proposed in this integrated FMP/draft environmental assessment (EA), the Council is proposing to repeal the four existing Caribbean-wide species-based FMPs and manage fishery resources in the U.S. Caribbean under three new island-based FMPs: Comprehensive FMP for the Puerto Rico EEZ (Puerto Rico FMP), Comprehensive FMP for the St. Thomas/St. John EEZ (St. Thomas/St. John FMP), and Comprehensive FMP for the St. Croix EEZ (St. Croix FMP).

Implementing island-based FMPs for Puerto Rico would allow the Council to manage Puerto Rico EEZ fisheries based on the stocks[2] targeted in federal waters surrounding Puerto Rico while accounting for differences between fishing sectors (commercial and recreational) that operate in those waters, the available markets for the products harvested from U.S. EEZ waters off Puerto Rico (hereafter referred to as the Puerto Rico EEZ), the economies of fishermen and the fishing communities they represent, and the social and cultural attributes unique to the island of Puerto Rico. To complete the transition from species-based FMPs to island-based FMPs the Council is considering seven actions to establish and revise the Puerto Rico FMP. These actions provide an opportunity for the Council to update management regulations that are outdated or do not reflect the current state of issues in the Puerto Rico EEZ.

- Action 1 reorganizes existing management measures such that they apply by island, rather than by species;

[1] Species: Group of animals or plants having common characteristics, able to breed together to produce fertile (capable of reproducing) offspring, and maintaining their "separateness" from other groups.

[2] Stock: A part of a fish population usually with a particular migration pattern, specifi c spawning grounds, and subject to a distinct fi shery. A fish stock may be treated as a total or a spawning stock. Total stock refers to both juveniles and adults, either in numbers or by weight, while spawning stock refers to the numbers or weight of individuals that are old enough to reproduce.

- Action 2 revises the list of species (*i.e.*, stocks) included for management, focusing on those applicable to the Puerto Rico EEZ;
- Action 3 establishes how the stocks are grouped into stock complexes based on current information including fishing practices, and identifies indicator stocks for those complexes where appropriate;
- Action 4 establishes maximum sustainable yield (MSY) or an MSY proxy, status determination criteria (SDC), and management reference points for the stocks, stock complexes, or indicator stocks included for management;
- Action 5 establishes accountability measures (AM) to be implemented when landings exceed the annual catch limits (ACL);
- Action 6 identifies and describes essential fish habitat (EFH) for species included in the FMP that have not been previously managed by the Council; and
- Action 7 establishes framework procedures that would allow the Council to adjust reference points and management measures more quickly.

Under the species-based FMPs, the Council manages the fisheries across the entire U.S. Caribbean. However, with the exception of tilefish and aquarium trade species (discussed in Chapter 2), the Council already applies certain required management measures separately within the three island management areas (*i.e.*, Puerto Rico, St. Thomas/St. John, and St. Croix. Through actions taken in the 2010 Caribbean ACL Amendment (CFMC 2011a) and the 2011 Caribbean ACL Amendment (CFMC 2011b), the Council established boundaries (Figure 1.5.1) to define EEZ subdivisions for each island management area and established separate, island-specific acceptable biological catch (ABC), ACL, and AM values within each of those three EEZ subdivisions. Thus, some management measures already apply at specific island or island complex levels. However, other components of management, including a proxy for MSY and an overfishing limit (OFL), were maintained at a U.S. Caribbean region-wide level. This Puerto Rico FMP, including the integrated draft EA, would fully transition to island-based management for the Puerto Rico EEZ. As a result, MSY (or a proxy, depending on data availability), SDC, management reference points, and all other management regulations would be set for and applied to the Puerto Rico EEZ.

The proposed actions in this integrated FMP/EA are fully discussed in Chapter 2.

## 1.2 Why is the Action Being Proposed?

The fisheries and related coastal and marine environments of Puerto Rico are highly valued and remain an important part of the history, culture, and tradition of the island. Fishery resources contribute to the economy, livelihood, food, and recreational enjoyment of the citizens of Puerto Rico. These resources and the habitats upon which they depend are subject to the adverse effects

of anthropogenic impacts and environmental degradation. Both federal and state governments work to conserve and manage the fisheries of Puerto Rico, and both entities recognize the role fishermen and others play in conserving, managing, and sustaining the island's fisheries. Previous FMPs managed U.S. Caribbean fisheries by species, with no regard for differences among islands.

The fishermen, fishing community representatives, and the local governments of Puerto Rico and the USVI have frequently requested the Council consider differences among the islands or island groups when addressing fisheries management in the U.S. Caribbean to recognize the unique attributes of the fishery resources and the communities dependent on those resources on each U.S. Caribbean island. The Council responded to these requests by initiating an assessment of shifting from a species-based management approach to an island-based approach (NMFS 2014). The details of that assessment and process are described in Appendix A. By implementing island-based FMPs, the Council along with the National Marine Fisheries Service (NMFS) concluded they would be better able to account for differences among the U.S. Caribbean islands with respect to environment, culture, markets, gear, seafood preferences, and the ecological impacts that result from these differences.

Tailoring management measures to specific islands could potentially make fisheries management more effective by ensuring to the greatest possible degree that optimum yield is achieved while minimizing adverse direct or indirect effects to the environment, as discussed in the EA initiating this action (NMFS 2014; Appendix A). If approved, the Puerto Rico FMP, in conjunction with the St. Croix and St. Thomas/St. John FMPs, would respond to the Council's decision in their 2014 EA to move forward with island-based management by replacing the existing species-based FMPs with island-based plans.

## 1.3. Who is Proposing the Action

The Council proposes the action considered to establish a new Puerto Rico FMP and repeal the existing species-based FMPs, modify the composition of the stocks to be managed under the Puerto Rico FMP, organize those stocks for effective management, modify and/or establish management reference points for managed stocks, establish AMs, identify EFH for stocks new to management, and establish framework measures. The Council develops the FMP and submits it to NMFS, who implements the actions in the FMP on behalf of the Secretary of Commerce.

The National Environmental Policy Act (NEPA) requires federal agencies to conduct an environmental review when proposing major federal actions. Appendix A describes the process that the Council and NMFS used leading up to the preparation of this integrated MP/EA, which evaluates potential alternative approaches for implementing island-based fishery management in the Puerto Rico EEZ. The new Puerto Rico FMP would then apply the Council's preferred

solution, applying the best available scientific information regarding the management of fisheries in Puerto Rico EEZ waters, within the context of federal fisheries management in the U.S. Caribbean. Alternatives considered in the EA include a "no action" alternative, which essentially maintains provisions established in the species-based FMPs, as well as a range of viable alternative approaches for revising the management of U.S. Caribbean fisheries in the Puerto Rico EEZ management area. The outcomes of the Council preferred alternatives and those management measures migrated from the Council previous FMPs are listed in Chapter 5: Conservation and Management Measures – Action Plan.

The Council and NMFS will consider public comments received on the Puerto Rico FMP and associated EA before voting to approve the Puerto Rico FMP. If the Council approves the FMP, it will submit it to NMFS for Secretarial review, approval, and implementation.

NMFS will announce all public comment periods on the Puerto Rico FMP and its proposed implementing regulations in the *Federal Register*. NMFS will consider all public comments received during the Secretarial review period, whether they are on the Puerto Rico FMP or the proposed regulations, prior to final agency action.

With the exception of management revisions proposed in Actions 2-7 discussed in this document, shifting from species-based FMPs to island-based FMPs (proposed in Action 1) would simply reorganize the existing management measures in the four separate FMP. The reorganization is largely an administrative exercise.

## 1.4 Statement of Purpose and Need

The Puerto Rico FMP is one of three island-based FMPs being developed by the Council to update management of federal fishery resources in the U.S. Caribbean. The Puerto Rico FMP would incorporate and replace those components of the Caribbean-wide Reef Fish, Spiny Lobster, Queen Conch, and Corals FMPs that pertain to the EEZ surrounding the island of Puerto Rico (Figure 1.5.1).

The purpose of developing the Puerto Rico FMP/EA is to ensure the continued health of fishery resources occurring in the EEZ surrounding Puerto Rico within the context of the unique biological, ecological, economic, and cultural characteristics of those resources and the communities' dependent upon them by managing on an island basis. The Puerto Rico FMP is intended to ensure productive and sustainable fisheries for the long-term livelihood, enjoyment, economy, and environment of Puerto Rico and the U.S.; conserve and manage the fisheries of Puerto Rico within an integrative island-based approach; and, enhance stewardship among fishermen, residents, and others who value the fishery resources and the marine and coastal environments of Puerto Rico and the U.S.

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Shifting management from a species-based approach to an island-based approach was deemed necessary based on written and verbal comments received from constituents at scoping hearings held throughout Puerto Rico on various dates, and on written comments submitted in response to notices published in the *Federal Register*, as described in Appendix A. That input suggested that, while not all presently existing fishery management regulations applicable to Puerto Rico EEZ waters are in need of revision, some revisions are needed as the Council and NMFS move from a species-based to an island-based approach to managing resources. In particular, it was recognized that the present management plans target many species that occur infrequently, if at all, in federal waters surrounding the island, such that federal management actions have no impact because federal fishery management authority does not extend to state jurisdictional waters. In contrast, some of the species that are the most economically and ecologically important inhabitants of federal waters are not included in those management plans.

A key goal of this management shift is to better focus federal fishery management efforts on species actually occurring in the federal management domain. Thus, the second action considered in this FMP/EA is to develop and apply a rigorous process for identifying those stocks in need of conservation and management in federal waters surrounding Puerto Rico. A logical next step in that process is to determine if and how a revised list of managed stocks should be grouped into management complexes, if at all. Regardless of whether managed stocks are grouped into complexes, management reference points and status determination criteria need to be defined for any species newly added to management, either individually, as a group within a complex, or as an indicator stock for a complex. Moreover, if an effort-intensive reference point development exercise is to be undertaken, the Council must determine if it would be appropriate to include all stocks to be managed (rather than only those new to management) as a means to ensure all federally managed stocks in the Puerto Rico EEZ have the most up-to-date reference points and status determination criteria within the constraints of available data. The next action in this regime shift would allow for existing management controls (*i.e.*, AMs), which prevent ACLs from being exceeded or to constrain future catch if they are, to be updated and for complimentary management controls to be added for stocks new to management. Next, a requirement of the Magnuson-Stevens Act is to identify EFH for all newly managed stocks. Stocks that previously have been managed under the Council's four FMPs that would be retained in the new Puerto Rico FMP already have EFH described and identified; therefore, EFH needs to be identified and described only for those species new to management in the Puerto Rico FMP. Alternative approaches to identifying EFH are therefore a necessary inclusion. Lastly, in order for the Council to more expeditiously adjust reference points and management measures in response to changing fishery conditions, alternative options for framework measures potentially allow for more efficient responses to changing environmental or biological conditions.

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## 1.5 Project Location

Fisheries governed by the Puerto Rico FMP are located primarily in the U.S. EEZ surrounding Puerto Rico *(i.e.*, the Puerto Rico EEZ), defined as the federal waters ranging from 9 to 200 nautical miles (nm) (17 – 370 kilometers [km]) from the nearest coastline point of the Commonwealth of Puerto Rico (Fig. 1.5.1). Fishery resources within 9 nm (17 km) of the Puerto Rico coast are managed by the Commonwealth of Puerto Rico.

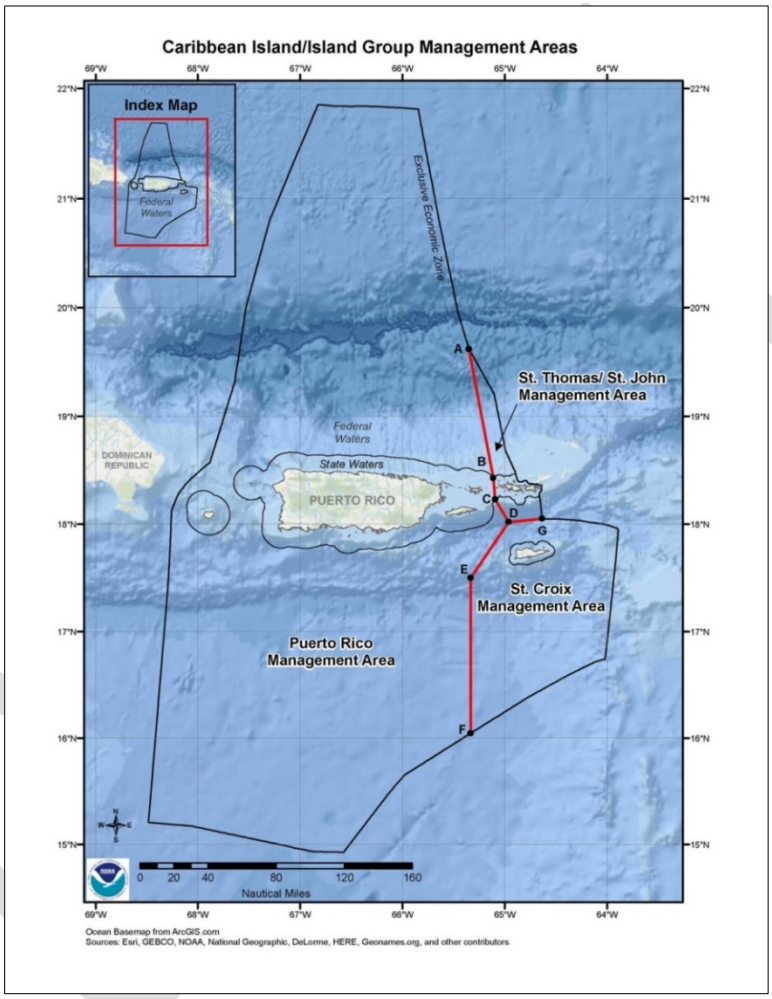


**Figure 1.5.1.** Jurisdictional boundaries of the Caribbean Fishery Management Council. Latitude and longitude coordinates for the boundary connecting points A-G are listed in Appendix E of the Code of Federal Regulations, part 622 (Fisheries of the Caribbean, Gulf of Mexico, and South Atlantic).

## 1.6 Regional Fisheries Management

In the U.S. Caribbean region, there are multiple levels of authority in the geo-political arena, making fisheries management in the region quite complex (Schärer-Umpierre et al. 2014). The U.S. federal government has jurisdiction within the Puerto Rico EEZ (i.e., those waters from 9 - 200 nm (14.5 - 322 km) from the coast), as well as indirect participation elsewhere in agreements with the local Puerto Rican government (Schärer-Umpierre et al. 2014). The Council, NMFS, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Department of Commerce are responsible for developing and implementing management measures for U.S. Caribbean federal fisheries. Other federal entities, such as the U.S. Department of Interior through the U.S. Fish and Wildlife Service (e.g., National Wildlife Refuges), possess other management responsibilities either solely or in cooperation with local entities. The U.S. Department of Defense, through the Air Force, Army, Navy, and Marine Corps, controls access and use of various marine waters throughout the U.S. Caribbean region. The U.S. Coast Guard, Sector San Juan, oversees all the vessels and facilities that operate in the region's 21 deep draft ports, including two of the busiest cruise ship ports in the world, and protect the marine environment in the over 450 miles of coastline encompassing the many islands of Puerto Rico and the USVI that are home to numerous endangered species[3]. NOAA Line Offices, such as the Coral Reef Conservation Program, support effective management and sound science to preserve, sustain, and restore valuable coral reef ecosystems for future generations.

The Commonwealth of Puerto Rico governs those waters from the shore out to 9 nm and manages marine resources within that jurisdiction (*See Section 1.6.2 below for Territorial Fisheries Management*). At present, Puerto Rico manages fisheries resources cooperatively with the Council, although not all regulations are consistent across the state-federal boundary. To conserve and sustain Puerto Rico's fisheries and fishing communities, the federal and commonwealth governments have worked in consultation with fishermen and other constituents to develop strategies, rules, and laws to conserve and manage these valuable resources. A primary goal of these actions has been to ensure productive, healthy, and sustainable ecosystems and fishery resources for the use and enjoyment of Puerto Rico's fishermen, fishing communities, residents, and visitors.

Regulations that implement the management measures contained within the FMPs are enforced through actions of NOAA's Office of Law Enforcement, the U.S. Coast Guard, and various Puerto Rico authorities. To better coordinate enforcement activities, federal, commonwealth, and territorial enforcement agencies have developed cooperative agreements to enforce the Magnuson-Stevens Act. However, enforcement in the Caribbean region is severely underfunded. Because personnel and equipment are limited, compliance with federal regulations depends largely on voluntary compliance (Heinz Center 2000).

[3] Source: http://www.atlanticarea.uscg.mil/Our-Organization/District-7/Units/Sector-San-Juan-PR/

### 1.6.1 Federal Fisheries Management

Federal fishery management is conducted under the authority of the Magnuson-Stevens Act (16 U.S.C. 1801 et seq.), originally enacted in 1976 as the Fishery Conservation and Management Act. The Magnuson-Stevens Act claims sovereign rights and exclusive fishery management authority over most fishery resources within the U.S. EEZ, an area extending from the seaward boundary of each coastal state to 200 nm from shore, as well as authority over U.S. anadromous species and continental shelf resources that occur beyond the U.S. Caribbean EEZ.

Responsibility for federal fishery management decision-making is divided between the U.S. Secretary of Commerce (Secretary) and eight regional Fishery Management Councils (FMC) that represent the expertise and interests of constituent states/territories. Regional councils are responsible for preparing, monitoring, and revising management plans for fisheries needing management[4] within their jurisdiction. The Secretary is responsible for promulgating regulations to implement proposed plans and amendments after ensuring that management measures are consistent with the Magnuson-Stevens Act, and with other applicable laws summarized in Appendix B. In most cases, the Secretary has delegated this authority to NMFS.

Each FMC is responsible for the EEZ adjacent to its constituent states. The FMCs develop FMPs and management measures for the fisheries within their EEZ. Afterwards, and if approved by the Secretary of Commerce, NMFS implements these plans and measures[5].

**Caribbean Fishery Management Council**

In order to conserve, maintain, and sustain the fisheries and related environment and habitats in the U.S. Caribbean, the goal of the Council is to develop and establish effective conservation and management measures that maintain a healthy fishery that meets the needs of fishermen and the general public. These conservation and management measures are based on (1) determining the status of the fisheries stocks and overall biological productivity and capacity to maintain vital fishery resources for the near- and long-term, (2) considering the economic, social and cultural aspects of the fisheries, and (3) determining effective fishing practices, rules, and regulations to ensure sustainable harvest of fishery resources within the context of optimum yield (OY-*see box below*). For more information about the Council, please visit http://www.caribbeanfmc.com/.

The Council is responsible for the conservation and management of fishery stocks within federal waters surrounding Puerto Rico and the USVI, representing the majority of U.S. Caribbean federal fishery resources (highly migratory species are managed directly by NMFS). The Council consists of seven voting members:

- Four public voting members appointed by the Secretary of Commerce.

[4] §600.340 National Standard 7 – Costs and Benefits (2) Criteria.
[5] Source: http://www.nmfs.noaa.gov/sfa/reg_svcs/councils.htm

- The principal officials with marine fishery management responsibility and expertise for the Commonwealth of Puerto Rico and the Territory of the USVI, who are designated as such by the Governors of the territories.
- The Regional Administrator of NMFS for the Southeast Region.

Public interests are also involved in the fishery management process through participation on advisory panels and through Council meetings that, with few exceptions for discussing matters bearing on a national security classification, or matters pertaining to national security, personnel, litigation in which the Council is interested, or other internal administrative matters, are open to the public. In addition, the regulatory process to consider matters approved by the Council is conducted in accordance with the Administrative Procedures Act, in the form of "notice and comment" rulemaking, which provides extensive opportunity for public scrutiny and comment, and requires consideration of and response to those comments.

Council Committees and Panels

*Scientific and Statistical Committee (SSC)*

Each FMC establishes, maintains, and appoints members of an SSC to assist it in the development, collection, and evaluation of statistical, biological, economic, social, and other scientific information relevant to the Council's development of or amendment to any FMP. The SSC provides expert scientific and technical advice to the Council on the development of fishery management policy, on the preparation of FMPs, and on the effectiveness of such plans once in operation. The SSC also provides ongoing scientific advice for fishery management decisions. The SSC aids the Council in identifying scientific resources available for the development of plans, in establishing the objectives of plans, in establishing criteria for judging plan effectiveness and in the review of plans. Scientific and Statistical Committee members also play a key role in developing stock assessments for Council-managed resources through participation in SEDAR, the Southeast Data Assessment, and Review program (SAFMC[6]). The SSC is composed of economists, biologists, sociologists, and natural resource experts who are knowledgeable about the technical aspects of fisheries in the U.S. Caribbean.

*Advisory Panels (AP)*

Fishery management councils are authorized to establish APs as necessary or appropriate to assist in carrying out its functions in accordance with the Magnuson-Stevens Act. Advisory Panels obtain and transmit to the Council advice and information from the people most affected by and knowledgeable of fishery management actions and needs. The APs aid the Council in establishing the goals and objectives of plans and the criteria for judging plan effectiveness, while also providing a communication link with those who operate under the management regime. The size of each AP is discretionary within the resources available to each FMC, but

[6] https://safmc.net/scientific-and-statistical-committee/

each panel must be of sufficient size and number to permit a balanced representation of interests. The Council's Puerto Rico District Advisory Panel (PR DAP) is composed of fifteen members either actually engaged in the harvest, processing, or consumption of fishery resources, or are knowledgeable of the conservation and management of fishery resources and the ecosystem upon which they depend.

**Management of Highly Migratory Species (HMS)**

The Fishery Conservation Amendments of 1990 (P.L. 101-627) conferred management authority for Atlantic HMS, including some tunas, oceanic sharks, marlins, sailfishes, and swordfish, to the Secretary of Commerce (Secretary). At that time, the Secretary delegated authority to manage these species in the Atlantic Ocean, including the Gulf of Mexico and the U.S. Caribbean Sea, to NMFS. NMFS is responsible for preparing, monitoring, and revising management plans for HMS needing management, while the Secretary is responsible for promulgating regulations to implement proposed plans and amendments after ensuring that management measures are consistent with the Magnuson-Stevens Act, and with other applicable laws as summarized in Appendix B of this document. In 2013, Amendment 4 to the Consolidated Atlantic HMS FMP: Caribbean Fishery Management Measures re-evaluated the management measures for commercial and recreational HMS fisheries operating in the U.S. Caribbean. This action had the purpose of improving permitting of and data collection from vessels operating in the U.S. Caribbean to better manage the traditional small-scale commercial HMS fishing fleet in the U.S. Caribbean region, enhance fishing opportunities, improve profits for the fleet, and provide improved capability to monitor and sustainably manage those fisheries (NMFS 2012). For additional information regarding the HMS management process and authority in the Atlantic, including the Caribbean, please see (http://www.nmfs.noaa.gov/sfa/hms/documents/fmp/index.html).

### 1.6.2 Territorial Fisheries Management

The *Estado Libre Asociado de Puerto Rico* (i.e., Commonwealth of Puerto Rico) is an unincorporated territory of the United States. Puerto Rico has jurisdiction over fisheries in waters extending up to 9 nm from shore. Those fisheries are managed by Puerto Rico's Department of Natural and Environmental Resources (DNER) per Puerto Rico Law 278 of November 29, 1998 as amended, known as Puerto Rico's Fisheries Law, which establishes public policy regarding fisheries (CFMC 2017). Section 19 of Article VI of the Constitution of the Commonwealth of Puerto Rico provides the foundation for the fishery rules and regulations. The first fishery law was enacted in Puerto Rico in 1936. An amendment to the Puerto Rico Fisheries Law implemented in 2004, also known as Puerto Rico Fishing Regulations 6902 (DNER 2004), included regulations for the management of marine managed areas (MMA)[7] for

[7] Defined in Scharer et al 2014 as "Those areas of marine waters designated by legal mechanisms (local or federal) including submerged marine areas within the boundaries of the designation."

fisheries purposes and imposed regulations for the protection of several species such as the Nassau grouper and the red hind. A later amendment to those regulations, Puerto Rico Regulations 7949 from 2010, is the current regulatory mechanism for management of fishery resources in Puerto Rico territorial waters as well as for those resources and areas with shared jurisdiction with the U.S. government through the Council (DNER 2010). Article 5 of Law Number 115 of September 6, 1997, known as Puerto Rico Law for the Promotion and Development of Recreational and Sport Fishing; Law Number 46 of June 18, 1965, known as Piranhas, Prohibition and Penalties; and Article 5 of Law Number 23 of June 20, 1972 as amended, known as the Department of Natural and Environmental Resources Organic Law, Law number 170 of August 12, 1988, as amended and known as the Law of Uniform Administrative Procedures, Law number 9 of June 18, 1970, as amended, are other legal authorities for the Puerto Rico Fisheries Law as amended (DNER 2004).

In Puerto Rico territorial waters, several MMAs were designated as part of the 1978 Coastal Zone Management Program (Schärer et al. 2014).

Puerto Rico's DNER has a designated seat on the Council to facilitate state participation in federal fishery management decision-making. As mentioned above, the Puerto Rico government has the authority to manage its respective state fisheries. Puerto Rico exercises legislative and regulatory authority over its natural resources through discrete administrative units. Although each agency is the primary administrative body with respect to the states' natural resources, Puerto Rico cooperates with numerous state and federal regulatory agencies when managing marine resources. In addition, it promotes the development of compatible regulations between state and federal waters. Puerto Rico has adopted compatible regulations for several management issues, but some fishery regulations remain inconsistent. For example, Puerto Rico prohibits the taking of corals from state waters, which is consistent with federal regulations. However, while the harvest of queen conch is prohibited year-round in the EEZ, it is allowed in Commonwealth waters from November 1st to July 31st, each year. Other incompatible regulations are for example, the Bajo de Sico and Tourmaline seasonal closures. The closures apply to the federal portion of those areas but not in state waters. The lack of compatible regulations complicates enforcement, confuses the public with regard to applicable regulations, and may hinder both the State's and the Council's ability to achieve management objectives in some instances. The Council is working with fishery managers to increase compatibility of fisheries regulations between federal and Commonwealth waters.

Another aspect where federal and Commonwealth jurisdiction share responsibilities has to do with federal consistency provisions of the Coastal Zone Management Act (CZMA), which requires NMFS to seek consistency to the maximum extent practicable with enforceable policies

of the approved coastal management program of Puerto Rico. Federal consistency[8] provides states with an important tool to manage coastal uses and resources and to facilitate cooperation and coordination with Federal agencies. Under the CZMA, Federal agency activities that have coastal effects are evaluated to ensure they are consistent to the maximum extent practicable with federally approved enforceable policies of a state's coastal management plan. In addition, the statute requires non-federal applicants for federal authorizations and funding to be consistent with enforceable policies of state coastal management plan.

It is important to note that the Puerto Rico's State Department cannot enter into fishing agreements with other countries, such as fishing in other countries waters or to allow them to fish in the Puerto Rico EEZ, given that these waters are under U.S. jurisdiction. In this manner, the Puerto Rico Commonwealth is bound by the rules and conditions enforced by NMFS (Valdés-Pizzini and Schärer 2011).

The Puerto Rico DNER requires a commercial fishing license in Commonwealth waters. As an obligation of the harvest permit, commercial fishermen are required to submit monthly catch reports to the DNER. Although Puerto Rico fishing regulations state that a license for all recreational fishermen 13 years and older (excluding fishermen on charter or head boats) is required, this requirement is not currently enforced (CFMC 2017). Additional information about licenses and permits to fish in Puerto Rico territorial waters can be found in Sections 3.2.6 (Commercial Sector) and 3.3.7 (Recreational Sector) of this document.

Additional information regarding fishery management in Puerto Rico Commonwealth waters can be found in Section 2.1 of the 2005 Caribbean Sustainable Fisheries Act (SFA) Amendment (CFMC 2005), and in the 2010 Caribbean ACL Amendment (CFMC 2011a). Additional information about commercial and recreational fisheries in Puerto Rico can be found in Chapter 3 of this document.

### 1.6.3 International Fisheries Management Pertaining to the U.S. Caribbean

#### 1.6.3.1 U.S. Authority in International Waters

In certain cases, U.S. authority for fishery management extends beyond the boundaries of the U.S. EEZ. Federal regulations (50 CFR 600.310(k)) address international overfishing in the following manner. If the Secretary determines that a fishery is overfished or approaching a condition of being overfished due to excessive international fishing pressure, and for which there are no management measures (or no effective measures) to end overfishing under an

[8] Federal consistency is the CZMA provision that federal actions that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone (also referred to as coastal uses or resources, or coastal effects) should be consistent with the enforceable policies of a coastal state's federally approved coastal management plan (DOC 2009)

international agreement to which the United States is a party, then the Secretary and/or the appropriate Council shall take certain actions as provided under Magnuson-Stevens Act section 304(i). The Secretary, in cooperation with the Secretary of State, must immediately take appropriate action at the international level to end the overfishing. In addition, within one year after the determination, the Secretary and/or appropriate Council shall effect several actions, as follows. First, develop recommendations for domestic regulations to address the relative impact of U.S. fishing vessels on the stock. Council recommendations should be submitted to the Secretary. Second, develop and submit recommendations to the Secretary of State, and to the Congress, for international actions that will end overfishing in the fishery and rebuild the affected stocks, taking into account the relative impact of vessels of other nations and vessels of the United States on the relevant stock. Councils should, in consultation with the Secretary, develop recommendations that take into consideration relevant provisions of the Magnuson-Stevens Act and NS1 guidelines, including section 304(e) of the Magnuson Stevens Act and paragraph (j)(3)(iii) of this section (600.310), and other applicable laws. In assessing the relative impact of U.S. fishing vessels and vessels of other nations, as set forth above, the Secretary or appropriate Council may consider factors that include, but are not limited to domestic and international management measures already in place, management history of a given nation, estimates of a nation's landings or catch (including bycatch) in a given fishery, and estimates of a nation's mortality contributions in a given fishery. Information used to determine the relative impact must be based upon the best available scientific information.

#### 1.6.3.2 International Authorities

The "Wider Caribbean" region, referred to as the Western Central Atlantic (Fishery Statistical Area 31) by the United Nations Food and Agriculture Organization (FAO), includes the northeast coast of South America, the Caribbean Sea, the Gulf of Mexico, and the southeastern Atlantic coast of North America. The region is geopolitically complex with the highest density of separate states per unit area in the world. The Caribbean Community[9] (CARICOM) countries are distributed throughout the region, and their EEZs form a mosaic, which includes most of the marine space in the region. The USVI is not included as a CARICOM entity.

The Western Central Atlantic Fishery Commission (WECAFC) is a regional fishery body (a group of states or organizations that are parties to an international fishery arrangement). The general objective of WECAFC is to "promote the effective conservation, management, and development of the living marine resources of the area of competence of the Commission, in

[9] The Caribbean Community (CARICOM) is an organization of 15 Caribbean nations and dependencies. CARICOM's main purposes are to promote economic integration and cooperation among its members, to ensure that the benefits of integration are equitably shared, and to coordinate foreign policy. Its major activities involve coordinating economic policies and development planning; devising and instituting special projects for the less-developed countries within its jurisdiction; operating as a regional single market for many of its members (Caricom Single Market); and handling regional trade disputes.

accordance with the FAO Code of Conduct for Responsible Fisheries, and address common problems of fisheries management and development faced by members of the Commission". Membership is open to coastal States whose territories are situated wholly or partly within the area of the Commission or States whose vessels engage in fishing in the area of competence of the Commission that notify in writing to the Director-General of the organization of their desire to be considered as members of the Commission. The United States is a member country.

Activities of the WECAFC are arranged under the following four components:

- Promote the application of the FAO Code of Conduct on Responsible Fisheries and its related instruments;
- Support the development and management of responsible small-scale, artisanal and subsistence fisheries and aquaculture;
- Coordinate and cooperate with other relevant international organizations on matters of common interest;
- Manage the work programme and carry-out a strategic reorientation of the functions and mandate of the Commission.

These activities are conducted in addition to the advisory services (policy advice, provision of information, management advice, legal, etc.) that the Commission usually provides.

### 1.6.4 Ecosystem-based Fisheries Management

On May 23, 2016, NOAA's National Marine Fisheries Service (NMFS) rolled out their ecosystem-based fisheries management policy. The purpose of that policy is to define ecosystem-based fisheries management (EBFM), describe the benefits of EBFM, relate EBFM to management of living marine resources, establish the principles guiding the EBFM approach (Figure 1.6.1), and build on past progress with respect to management within an ecosystem context. The EBFM approach is being implemented nationwide by NMFS, with the intent of informing better decisions regarding trade-offs among and between fisheries, aquaculture, protected species, biodiversity, and habitats. Ultimately, an EBFM approach will help to build and maintain resilient and productive ecosystems within the context of the human community dependent upon ecosystem services, while ensuring timely and effective response to a constantly changing environment.

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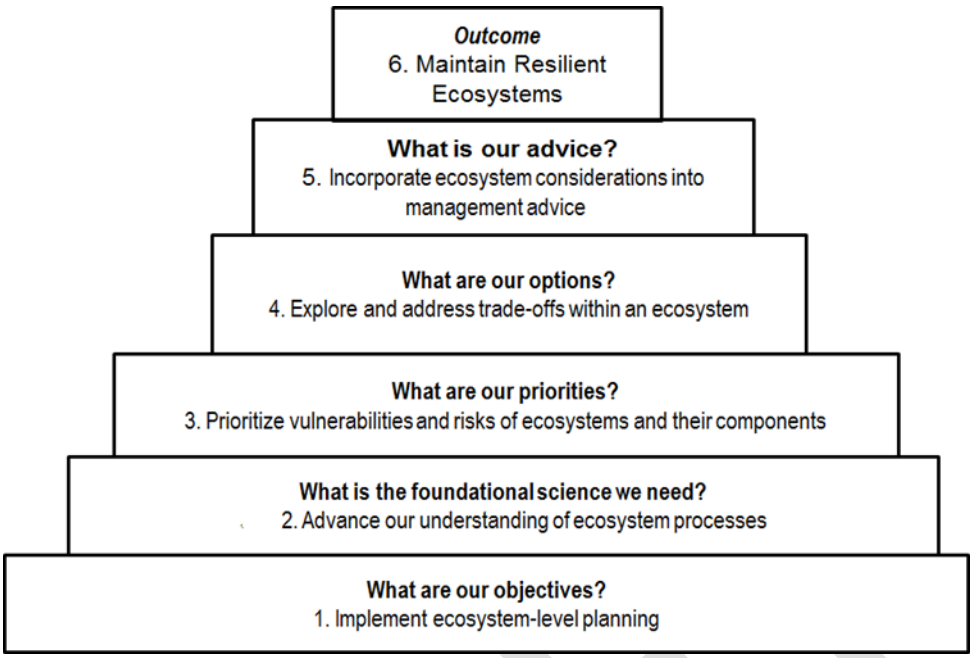


**Figure 1.6.1.** Hierarchical arrangement of NMFS' six guiding principles for implementation of ecosystem-based fisheries management.
(Source: http://www.nmfs.noaa.gov/op/pds/index.html)

Ecosystem-based fisheries management is defined by NMFS as "a systematic approach to fisheries management in a geographically specified area that contributes to the resilience[10] and sustainability of the ecosystem[11]; recognizes the physical, biological, economic, and social interactions among the affected fishery-related components of the ecosystem, including humans; and seeks to optimize benefits among a diverse set of societal goals." A central tenet of this definition, and of the NMFS approach to management within an ecosystem context, is recognition of the human community as a component of the ecosystem, thereby ensuring a full and equal treatment of economic needs and cultural values. Particularly in the U.S. Caribbean, a region characterized by cultural diversity and subtle economic interrelationships, consideration of the human community is essential.

[10]Resilience is defined as the capacity of an ecosystem to persist or maintain function in the face of exogenous disturbances. That is, the capacity of an ecosystem to tolerate disturbance without collapsing into a different state that is controlled by a different set of processes. This is primarily encapsulated by two elements, resistance to and recovery from pressure.
[11]In the NMFS context, the term "ecosystem" means a geographically specified system of fishery resources, the persons that participate in that system, the environment, and the environmental processes that control that ecosystem's dynamics (c.f. Murawski and Matlock, 2006, NMFS-F/SPO-74). To be clear, fishers and fishing communities are understood to be included in the definition.

In 2016, the Council initiated their process of evaluating the EBFM approach and implementing it in the region. Their approach to EBFM is hierarchical, considering the ecosystem at the local (e.g., among coasts within an island), island, U.S. Caribbean region, Caribbean basin, and global scales. This hierarchical approach allows a more intensive focus on fine-scale management needs while still allowing consideration of the larger-scale effects of management decisions. The Council intends the process to be open and inclusive. To that end, the Council will conduct frequent public meetings, provide educational opportunities via brochures and web-based information, directly involved the District Advisory Panels (DAP) representing each of the three island management areas (Puerto Rico, St. Thomas/St. John, St. Croix), and present progress reports to the public at every Council meeting. The first step in moving from the historic species-based management approach to an EBFM approach is the shift from species-based FMPs to island-based FMPs as described and proposed in this document and the companion documents regarding the St. Thomas/St. John and St. Croix FMPs.

## 1.7 History of Federal Fisheries Management

Prior to development of the Puerto Rico FMP described herein, stocks and stock complexes in the Puerto Rico EEZ (and throughout the U.S. Caribbean) were managed within the Reef Fish FMP (CFMC 1985), the Spiny Lobster FMP (CFMC 1981), the Queen Conch FMP (CFMC 1996), and the Coral FMP (CMFC 1994), as respectively amended.

The following amendments and documents, pertaining to the four previously operational species-based FMPs, are of particular relevance to the development of the Puerto Rico FMP: The 2005 Caribbean SFA Amendment (CFMC 2005), where the Council took several actions to address required provisions of the Magnuson-Stevens Act, as amended by the Sustainable Fisheries Act of 1996, many of which set the basis for the current management regime in the U.S. Caribbean; (2) the 2010 Caribbean ACL Amendment (CFMC 2011a) and the 2011 Caribbean ACL Amendment (CFMC 2011b), both implemented in 2012, where the Council took several actions to comply with the 2007 revisions to the Magnuson-Stevens Act[12], specifically the implementation of ACLs and AMs; and (3) the EA for the Development of Island-Based FMPs in the U.S. Caribbean - Transition from Species-Based FMPs to Island-Based FMPs (NMFS 2014) and Finding of No Significant Impact (FONSI), which evaluated the effects of transitioning management of federal fisheries in the U.S. Caribbean from a species-based approach to an island-based approach and set the basis for the reorganization of management

[12] Magnuson-Stevens Fishery Conservation and Management Act – 2007 Reauthorization – In 2006, Congress passed a significant amendment, the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, which was signed into law in January 2007. This law was groundbreaking in several respects as it featured a number of new requirements to: prevent overfishing by establishing ACLs and accountability measures; promote market-based management strategies, including limited access privilege programs, such as catch shares; strengthen the role of science through peer review, the Councils' Scientific and Statistical Committees, and the Marine Recreational Information Program; enhance international fisheries sustainability by addressing illegal, unregulated, and unreported fishing and bycatch (http://www.nmfs.noaa.gov/sfa/laws_policies/msa/msa_2007.html).

measures under the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs into FMPs for each of the Puerto Rico, St. Thomas/St. John, and St. Croix management areas.

The amendments and documents mentioned above, as well as the history of management actions taken to date under all four of the historic species-based FMPs are summarized in Appendix C of this document.

## 1.8 Goals and Objectives of the Puerto Rico FMP

The overarching *goal* of the Puerto Rico FMP is to ensure the continued health of fishery resources occurring in the EEZ surrounding Puerto Rico, within the context of the unique biological, ecological, economic, and cultural characteristics of those resources and the communities dependent upon them.

Specific fishery management goals for the EEZ off Puerto Rico are:

**Goal 1:** Prevent overfishing while achieving, on a continuing basis, the OY from each fishery in the U.S. Caribbean taking into account and allowing for variations among, and contingencies in, fisheries, fishery resources, and catches.

**Goal 2:** Maintain long-term sustainable use of coral reef fishery resources while preventing adverse impacts to stocks, habitats of the fisheries resources, protected species, or the reef ecosystem as a whole.

**Goal 3:** Ensure the continued health of fishery resources occurring in Puerto Rico EEZ waters to provide for the sustained participation of Puerto Rico fishing communities and, to the extent practicable, minimize adverse economic impacts on such communities.

**Goal 4**: Manage the fisheries within the limits of local ecosystem production so as to not jeopardize a wide range of goods and services provided by a healthy ecosystem, including food, revenue, and recreation for humans.

**Goal 5:** Account for biological, social, cultural, and economic differences among the communities and fisheries of Puerto Rico.

**Goal 6:** Foster collaboration among territorial and federal authorities to achieve compatible management of fisheries throughout the waters surrounding Puerto Rico**.**

**Goal 7:** Ensure effective outreach and enforcement efforts.

To achieve the goals described above, the following *objectives* are defined:

**Objective 1:** Provide for long-term sustainable use of fisheries resources within the limits of local ecosystem production using a precautionary, ecosystem-based approach to management that accounts for uncertainty and relevant biological, ecological, economic, and social factors in the fishery, including the benefits of food production, recreational opportunities, and protection of marine ecosystems. Prevent overfishing, rebuild overfished stocks, and achieve OY on a continuing basis.

**Objective 2:** Reduce bycatch and waste in the fishery.

**Objective 3:** Ensure the metrics upon which OY is based are derived from the best available scientific information and are updated continuously every five years to respond to changing ecological, biological, economic, and social conditions.

**Objective 3:** Establish and maintain data collection and reporting programs necessary to support the conservation and management objectives of the Plan, including the biological, ecological, economic, and social data needed to assess the impacts of management measures. Adapt to technological and technical advances in methods of data collection, reporting, and analysis.

**Objective 4:** Promote international and domestic cooperation in the management of pan-Caribbean stocks.

**Objective 5:** Minimize conflicts between stakeholders by promoting effective marine spatial planning.

**Objective 6:** Promote fair and equitable use of fishery resources, recognizing the importance of those resources to fishing communities within the context of differences in local environment, culture, markets, user groups, gears, and seafood preferences.

**Objective 7:** Establish resource access permits as necessary and appropriate to facilitate data collection, sustainability, and long-term yield.

**Objective 8:** Provide flexibility in the management process which minimizes regulatory delay and allows for rapid adaptation to changing resource abundance, availability, health, or preference, using the best available scientific and socioeconomic information.

**Objective 9:** Devise a regulatory framework that maximizes the efficiency and efficacy of enforcement efforts within and across jurisdictional boundaries while promoting the safe conduct of fishing operations.

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**Objective 10:** Promote awareness of laws and regulations governing marine resource management and the science and social obligations that support that management, and to ensure informed public input into the management process.

**Objective 11:** Ensure the socioeconomic health of the fishing communities dependent on federal fishery resources.

**Objective 12:** Protect spawning aggregations and, when needed, the habitats supporting those aggregations to ensure the future health of the resource.

**Objective 13:** Describe and identify EFH, adverse impacts on EFH, and other actions to conserve and enhance EFH. Adopt management measures that minimize adverse impacts from fishing on EFH and promote habitat conservation, including designation of specific habitat areas of particular concern within EFH for more focused management action.

**Objective 14:** Map, define, and manage habitat upon which the resource depends, with particular emphasis on coral reef resources throughout the region.

**Objective 15:** Ensure continued provision of ecosystems services derived from living marine resources, including adequate abundance of forage resources to ensure a healthy and diverse trophic web.

**Objective 16:** Account for ecological relationships and functional roles of species in the fishery that contribute to a healthy ecosystem, such as grazers, forage fish, habitat-builders, and top predators.

**Objective 17:** Require essential scientific data is gathered and analyzed in advance to guide the development of new fisheries to ensure they are sustainable from the start.

**Objective 18:** Promote measures to develop and sustainably manage underutilized marine fishery resources.

While most of these goals and objectives are being addressed throughout this plan, some will be addressed through future amendments to the Puerto Rico FMP, as requested by the Council to NMFS.

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# Chapter 2. Creating a Puerto Rico Fishery Management Plan (FMP) – Proposed Actions and Alternatives

This chapter discusses each proposed management action and the respective alternatives that were considered by the Caribbean Fishery Management Council (Council) in creating a St. Puerto Rico FMP. The presentation and evaluation of management actions included in this chapter are not mutually exclusive, in that some of the proposed management actions are directly related to the previous action(s) and thus "tier" from one another. As a first step, through Action 1 the Council would decide to either continue managing fisheries at the U.S. Caribbean level under the four species-based FMPs (by selecting the no action alternative), or switch to an island-based approach through the establishment of a Puerto Rico FMP (by selecting the action alternative). As noted elsewhere, to transition to island-based management, the action alternative must be selected in each of the three island-based FMPs under development. Action 1 thus describes no action at the highest level, which means not taking action to establish the Puerto Rico FMP.

Because the Council decided to establish the new Puerto Rico FMP by selecting the action alternative in Action 1, it developed and evaluated Actions 2-7, which provide the opportunity to modify that newly created FMP to revise the regulations for managing fisheries in the Puerto Rico exclusive economic zone (EEZ). The order in which the actions are presented in this chapter reflects the tiered structure the Council used when developing the Puerto Rico FMP (Figure 2.1): Action 2 tiers directly from Action 1, Action 3 tiers directly from Action 2, and Action 4 tiers directly from Action 3. Action 5 follows Action 4, but tiers to both Action 3 and Action 4. Action 6 tiers from Action 2 and Action 7 tiers from Action 1. As a result, the no action alternative in each of Actions 2-7 tiers from the Council's preferred alternative in one or more prior actions, and reflects not taking further action to adjust the management plan.

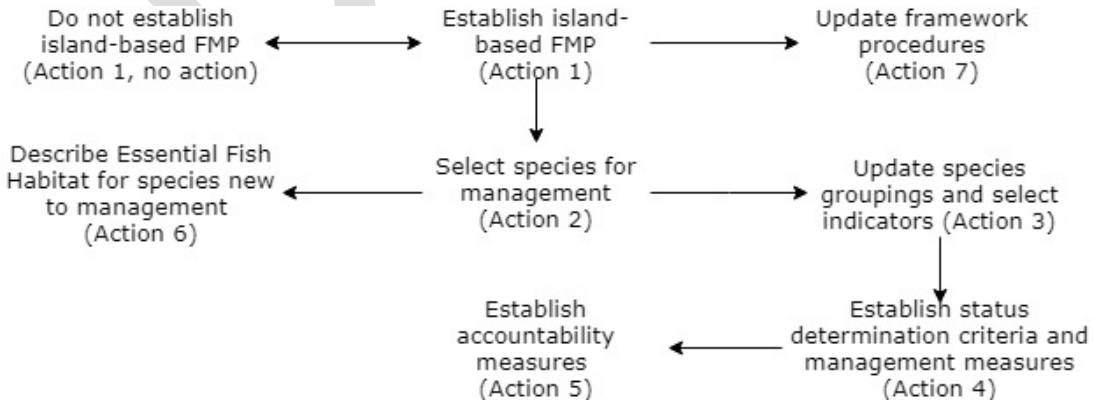


**Figure 2.1.** Structure of the management actions considered in Chapter 2.

## 2.1 Action 1: Transition Fisheries Management in the Puerto Rico Exclusive Economic Zone from a Species-based Approach to an Island-based Approach

Action 1 provides the actual mechanism for transitioning from species-based to island-based management in Puerto Rico EEZ waters. This action has two alternatives. **Alternative 1** is the no action alternative and would provide the choice to not transition from species-based to island-based management in Puerto Rico EEZ waters. **Alternative 2** would establish a new island-based FMP for Puerto Rico EEZ waters and would repeal the existing species-based FMPs and replace them with the island-based FMP for Puerto Rico EEZ waters.

### 2.1.1 Proposed Alternatives for Action 1

**Alternative 1.** No action. The transition from a species-based to a fully island-based approach to management would not be implemented. Instead, the four presently existing U.S. Caribbean-region FMPs (FMP for the Reef Fish of Puerto Rico and the U.S. Virgin Islands (USVI) (Reef Fish FMP); FMP for the Spiny Lobster Fishery of Puerto Rico and the USVI (Spiny Lobster FMP); FMP for the Queen Conch Resources of Puerto Rico and the USVI (Queen Conch FMP); and, FMP for Corals and Reef Associated Plants and Invertebrates of Puerto Rico and the USVI (Coral FMP)) would continue to guide federal fishery management in the Puerto Rico EEZ.

**Alternative 2 (Preferred).** Establish a new Puerto Rico FMP to manage fishery resources in the Puerto Rico EEZ and repeal the Caribbean Fishery Management Council's (Council) Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs and replace them with the new Puerto Rico FMP. The new Puerto Rico FMP would include all fishery management measures presently included in the Spiny Lobster, Reef Fish, Queen Conch, and Coral FMPs that are applicable to the Puerto Rico EEZ (Chapter 10).

### 2.1.2 Discussion of Action 1 Alternatives

**Alternative 1** (no action) would maintain the existing species-based fisheries management approach. The Council would continue to manage federal fisheries in the U.S. Caribbean EEZ via amendments to each of the Spiny Lobster FMP, Reef Fish FMP, Queen Conch FMP, and Coral FMPs, as appropriate. To initially evaluate the environmental effects of shifting from species-based to island-based management in the U.S. Caribbean, and to identify the most appropriate aggregation of islands for island-based management, the Council, in partnership with NMFS, prepared an environmental assessment (EA) that concluded with a Finding of No Significant Impact (FONSI) regarding the management transition (NMFS 2014).

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Additionally, if the current management regime is continued, as noted in the 2014 EA, under **Alternative 1**, the Council would have to develop a new Aquarium Trade Species FMP as recommended by the Council in the 2011 Caribbean Annual Catch Limit (ACL) Amendment (CMFC 2011b).

**Preferred Alternative 2** would complete the transition from species-based to island-based fishery management in the Puerto Rico EEZ as initiated and evaluated in the 2014 EA. The EA evaluated the impact of incorporating the most current regulations under the four species-based FMPs into the Puerto Rico, St. Thomas/St. John, and St. Croix FMPs. With the exception of the management revisions proposed in the subsequent six actions discussed in this EA, shifting from species-based FMPs to island-based FMPs would only restructure or reorganize the existing management measures and thus would be considered largely an administrative exercise. Moreover, tailoring management measures to specific islands, in this case Puerto Rico, could potentially make fisheries management more effective by ensuring to the greatest possible degree that optimum yield (OY) is achieved while minimizing adverse direct or indirect effects to the environment (NMFS 2014).

The Puerto Rico management area in the Puerto Rico FMP encompasses the boundaries defining EEZ subdivisions established for each island or island group in the 2010 and 2011 Caribbean ACL Amendments (CFMC 2011a, b). This island-based allocation provided the initial foundation for partitioning the current species-specific FMPs into three island-based FMPs. **Preferred Alternative 2** would establish the same management regime chosen by the Council in the 2014 EA and is consistent with the Council's expressed intention in the 2014 EA.

The creation of the new island-based Puerto Rico FMP in **Preferred Alternative 2**, would bring to this new plan all provisions pertinent to the Puerto Rico management area from the Council's presently operating species-based plans.

An implicit requirement of **Preferred Alternative 2** is that it be implemented for all three proposed island-based management areas: Puerto Rico, St. Thomas/St. John, and St. Croix. It would not be possible to partially transition from species-based management to island-based management, as the species-based FMPs are based on certain measures that were established across the entire U.S. Caribbean region. For example, in the 2010 and 2011 Caribbean ACL Amendments, the maximum sustainable yield (MSY) and overfishing limit (OFL) were set on a Caribbean-wide basis for managed stocks and stock complexes, and two stock complexes (tilefish, aquarium trade) are presently managed Caribbean-wide. Removing some, but not all, of those management measures from the species-based plans would undermine the rationale behind the species-based FMPs. In addition, even if it was possible to partially transition to island-based management, specifically if island-based management was implemented for the Puerto Rico EEZ but the Caribbean-wide species-based regulations were maintained for either or

both of the USVI island groups, the outcome would be two sets of management measures applicable to the Puerto Rico EEZ. In at least some cases, those management measures would overlap and likely would be contradictory. The effects of such contradictory management would be generally negative, in many cases unenforceable, and would violate the mandates of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act).

As is noted above, the Caribbean-wide management measures established in the species-specific FMPs are not amenable to being transferred to the island-based FMPs. Thus, after choosing to transition to island-based management, the Caribbean-wide status determination criteria (SDC), such as MSY and OFL, must be updated. A complete transition to island-based management (for all three island management areas) would be needed, otherwise the Council would need to reevaluate their approach to this proposed management transition.

**Comparison of Action 1 Alternatives and Summary of Effects**

As described in the 2014 EA, continuing the status quo in **Alternative 1** is an administrative action that would not result in changes to the management of federal fisheries in the U.S. Caribbean EEZ; therefore, would not have any direct effects on the physical environment or the biological/ecological environments. When compared to **Preferred Alternative 2** (establishing a new Puerto Rico FMP), taking no action in **Alternative 1** would benefit the administrative environment in the short-term because it would not require administrative adjustments. However, long-term effects would be negative as prior federal management addressed stocks over which the Council now has little or no influence. Indirect effects to the biological/ecological and socio-economic environments largely would be negative for those same reasons. Expending resources to manage stocks over which there is little federal control, for example, by expending resources to monitor ACLs and implement AMs, could prove costly in terms of the actual expense of implementing measures that will be difficult to enforce. In addition, this process could take away resources from developing and implementing management measures for stocks over which the Council has more influence. Taking away resources from developing and improving fisheries management could lead to short-term and long-term negative effects to the resources upon which fishermen and the communities supporting those fishermen depend, resulting in negative socio-economic consequences.

**Preferred Alternative 2** would have short-term effects to the human environment (physical, biological/ecological, and socio-economic) mostly similar to those described for **Alternative 1** because, based solely on the outcome from Action 1, the applied regulatory environment would not change. An island-based approach proposed by **Preferred Alternative 2**, could in the long term, potentially minimize impacts to the physical, biological, economic, and social environments from fishing activities by enhancing fisheries management. However, some of the expected benefits are unknown at this time because some future impacts to the human

environment depend on the nature of the specific future management actions implemented under the new Puerto Rico FMP as proposed in Actions 2-7. However, the ultimate outcome from implementing **Preferred Alternative 2**, coupled with implementation of any combination of proposed management actions (except the no action alternatives) presented and discussed in Actions 2-7, likely would be positive.

With the exception of Actions 2-7, all present management measures applicable to the Puerto Rico EEZ would be included (migrated to) in the new plan, and their effect on the human environment would not be expected to be different than status quo. The effects of those regulations have been analyzed and disclosed in previous Council National Environmental Policy Act (NEPA) documents (see Appendix C for the History of Management).

## 2.2 Action 2: Identify Stocks in Need of Federal Conservation and Management

Through Action 2, the Council would determine the species that would be included for management under the new Puerto Rico FMP. This action follows from selecting Alternative 2 in Action 1 and proceeding with establishing a Puerto Rico FMP comprised of measures pertinent to Puerto Rico.

The Magnuson-Stevens Act guidelines for developing and reviewing FMPs state that "stocks that are predominantly caught in Federal waters and are overfished or subject to overfishing, or likely to become overfished or subject to overfishing" require conservation and management (50 CFR 600.305(c)(1)). These stocks must be included in an FMP. In addition, the regulations provide the following non-exhaustive factors that may be considered when deciding whether additional stocks require conservation and management and should be included in the FMP (50 CFR 600.305(c)(1)(i)-(x)):

(i) The stock is an important component of the marine environment.

(ii) The stock is caught by the fishery.

(iii) Whether an FMP can improve or maintain the condition of the stock.

(iv) The stock is a target of a fishery.

(v) The stock is important to commercial, recreational, or subsistence users.

(vi) The fishery is important to the Nation or to the regional economy.

(vii) The need to resolve competing interests and conflicts among user groups and whether an FMP can further that resolution.

(viii) The economic condition of a fishery and whether an FMP can produce more efficient utilization.

(ix) The needs of a developing fishery, and whether an FMP can foster orderly growth.

(x) The extent to which the fishery is already adequately managed by states, by state/Federal programs, or by Federal regulations pursuant to other FMPs or international commissions, or by industry self-regulation, consistent with the requirements of the Magnuson-Stevens Act and other applicable law.

In evaluating these factors, the Council considered the specific circumstances of the Puerto Rico fishery, based on the best scientific information available, to determine which species should be selected for federal management in the Puerto Rico FMP.

### 2.2.1 Proposed Alternatives for Action 2

**Alternative 1.** No action. The Puerto Rico FMP, created in Action 1, is composed of all species within the fishery management units presently managed under the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs and occurring within Puerto Rico EEZ waters.

**Alternative 2 (Preferred)**. For those species for which landings data are available (Appendix D), the Council would follow a stepwise application of a set of criteria to determine if a species should be included for management in the Puerto Rico FMP. The criteria under consideration include, in order:

***Criterion A.*** Include for management those species that are presently classified as overfished in U.S. Caribbean federal waters based on National Marine Fisheries Service (NMFS) determination, or for which historically identified harvest is now prohibited due to their ecological importance as habitat (corals presently included in the Coral FMP) or habitat engineers (midnight, blue, rainbow parrotfish), or those species for which seasonal closures or size limits apply (Table 2.2.1).

***Criterion B***. From the remaining species, i.e., those not included via Criterion A, <u>exclude</u> from federal management those species that have been determined to infrequently occur in federal waters based on expert analysis guided by available data (Table 2.2.2).

***Criterion C***. From the remaining species, i.e., those not included via Criterion A or excluded via Criterion B, <u>include</u> for management those species that are biologically vulnerable, constrained to a specific habitat that renders them particularly vulnerable, or have an essential ecological value, as determined by expert analysis (Table 2.2.3).

***Criterion D***. From the remaining species, i.e., those not included via Criteria A and C or excluded via Criterion B, include those species possessing economic importance to the national or regional economy based on a threshold of landings or value separately determined for each of the recreational, commercial, and aquarium trade sectors as appropriate (e.g., top 90%) and those representing an important component of bycatch, as established by expert analysis (Table 2.2.4).

***Criterion E***. From the remaining list of species, include any other species that the Council determines are in need of conservation and management.

**Alternative 3**. Identify species to be managed by the Council in waters of the EEZ off Puerto Rico using, in any order, some or all of the criteria presented in **Preferred Alternative 2**. For those species for which landings data are available, the Council would choose a subset (possibly including all) of the **Preferred Alternative 2** criteria and apply those criteria in a pre-defined order to determine if a species should be managed under the Puerto Rico FMP. The criteria under consideration are the same those listed in **Preferred Alternative 2**. Briefly, the criteria include (A) the status of the stock and/or if it currently has a harvest prohibition, size limit, or seasonal closure in federal waters, (B) the degree to which the species occurs in state rather than in federal waters and can therefore be affected by federal management, (C) the ecological importance of a species within the coral reef ecosystem, (D) the extent of harvest relative to a pre-established threshold, and (E) other species that the Council determines are in need of conservation and management. Although the order of criteria application would be pre-defined, it would not necessarily match the order used in **Preferred Alternative 2**. **Alternative 3** presents 325 alternative criteria combinations, from which the Council could choose any approach ranging from a single combination of criteria and order to be applied to all stocks to a different combination of criteria and order to be applied to each stock.

**Table 2.2.1.** Species proposed to be included in the Puerto Rico Fishery Management Plan based on Preferred Alternative 2, Criterion A.

| Family | Scientific Name | Common Name |
|---|---|---|
| **Lutjanidae -- Snappers** | *Apsilus dentatus* | Black snapper |
| | *Lutjanus buccanella* | Blackfin snapper |
| | *Lutjanus vivanus* | Silk snapper |
| | *Rhomboplites aurorubens* | Vermilion snapper |
| | *Lutjanus synagris* | Lane snapper |
| | *Lutjanus analis* | Mutton snapper |
| | *Ocyurus chrysurus* | Yellowtail snapper |
| **Serranidae -- Groupers** | *Epinephelus striatus* | Nassau Grouper |
| | *Epinephelus itajara* | Goliath grouper |
| | *Epinephelus guttatus* | Red hind |
| | *Mycteroperca bonaci* | Black grouper |

| Family | Scientific Name | Common Name |
|---|---|---|
| | *Epinephelus morio* | Red grouper |
| | *Mycteroperca tigris* | Tiger grouper |
| | *Mycteroperca venenosa* | Yellowfin grouper |
| | *Epinephelus flavolimbatus* | Yellowedge grouper |
| **Scaridae -- Parrotfishes** | *Scarus coeruleus* | Blue parrotfish |
| | *Scarus coelestinus* | Midnight parrotfish |
| | *Scarus guacamaia* | Rainbow parrotfish |
| **Strombidae -- True conchs** | *Lobatus gigas* | Queen conch |
| **Palinuridae -- Spiny lobsters** | *Panulirus argus* | Caribbean spiny lobster |
| **Corals** | All Corals | All Corals |

**Table 2.2.2.** Stocks previously managed under the Reef Fish and Coral FMPs that are proposed to be excluded from the Puerto Rico FMP based on Preferred Alternative 2, *Criterion B.*

| Family | Scientific Name | Common Name |
|---|---|---|
| **Lutjanidae -- Snappers** | *Lutjanus griseus* | Gray snapper |
| | *Lutjanus mahogoni* | Mahogany snapper |
| **Haemulidae -- Grunts** | *Haemulon album* | Margate |
| | *Haemulon aurolineatum* | Tomtate |
| | *Haemulon sciurus* | Bluestriped grunt |
| | *Haemulon flavolineatum* | French grunt |
| | *Anisotremus virginicus* | Porkfish |
| **Mullidae -- Goatfishes** | *Pseudupeneus maculatus* | Spotted goatfish |
| | *Mulloidichthys martinicus* | Yellow goatfish |
| **Sparidae -- Porgies** | *Calamus bajonado* | Jolthead porgy |
| | *Archosargus rhomboidalis* | Sea bream |
| | *Calamus penna* | Sheepshead porgy |
| | *Calamus pennatula* | Pluma |
| **Holocentridae -- Squirrelfishes** | *Myripristis jacobus* | Blackbar soldierfish |
| | *Priacanthus arenatus* | Bigeye |
| | *Holocentrus rufus* | Longspine squirrelfish |
| | *Holocentrus adscensionis* | Squirrelfish |
| **Malacanthidae -- Tilefishes** | *Caulolatilus cyanops* | Blackline tilefish |
| | *Malacanthus plumierii* | Sand tilefish |
| **Carangidae -- Jacks** | *Caranx crysos* | Blue runner |
| | *Caranx latus* | Horse-eye jack |
| | *Caranx lugubris* | Black jack |
| | *Seriola rivoliana* | Almaco jack |
| | *Caranx ruber* | Bar jack |
| | *Seriola dumerili* | Greater amberjack |
| | *Caranx bartholomaei* | Yellow jack |
| **Scaridae -- Parrotfish** | *Sparisoma rubripinne* | Redfin parrotfish |
| **Balistidae -- Triggerfishes** | *Xanthichthys rigens* | Sargassum triggerfish |
| **Monocanthidae -- Filefishes** | *Aluterus scriptus* | Scrawled filefish |
| | *Cantherhines macrocerus* | Whitespotted filefish |
| | *Melichthys niger* | Black durgon |
| **Ostraciidae -- Boxfishes** | *Lactophrys polygonia* | Honeycomb cowfish |
| | *Lactophrys quadricornis* | Scrawled cowfish |
| | *Lactophrys trigonus* | Trunkfish |
| | *Lactophrys bicaudalis* | Spotted trunkfish |

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| Family | Scientific Name | Common Name |
|---|---|---|
| | *Lactophrys triqueter* | Smooth trunkfish |
| **Aquarium Trade Fish Species -- Reef Fish FMP** | | |
| | *Antennarius* spp. | Frogfish |
| | *Apogon maculatus* | Flamefish |
| | *Astrapogen stellatus* | Conchfish |
| | *Ophioblennius atlanticus* | Redlip blenny |
| | *Bothus lunatus* | Peacock flounder |
| | *Chaetodon aculeatus* | Longsnout butterflyfish |
| | *Chaetodon capistratus* | Foureye butterflyfish |
| | *Chaetodon ocellatus* | Spotfin butterflyfish |
| | *Chaetodon striatus* | Banded butterflyfish |
| | *Amblycirrhitus pinos* | Redspotted hawkfish |
| | *Dactylopterus volitans* | Flying gurnard |
| | *Chaetodipterus faber* | Atlantic spadefish |
| | *Gobiosoma oceanops* | Neon goby |
| | *Priolepis hipoliti* | Rusty goby |
| | *Gramma loreto* | Royal gramma |
| | *Clepticus parrae* | Creole wrasse |
| | *Halichoeres cyanocephalus* | Yellowcheek wrasse |
| | *Halichoeres garnoti* | Yellowhead wrasse |
| | *Halichoeres maculipinna* | Clown wrasse |
| | *Hemipteronotus novacula* | Pearly razorfish |
| | *Hemipteronotus splendens* | Green razorfish |
| | *Thalassoma bifasciatum* | Bluehead wrasse |
| | *Echidna catenata* | Chain moray |
| | *Gymnothorax funebris* | Green moray |
| | *Gymnothorax miliaris* | Goldentail moray |
| | *Ogcocepahalus spp.* | Batfish |
| | *Myrichthys ocellatus* | Goldspotted eel |
| | *Opistognathus aurifrons* | Yellowhead jawfish |
| | *Opistognathus whitehursti* | Dusky jawfish |
| | *Centropyge argi* | Cherubfish |
| | *Holacanthus tricolor* | Rock beauty |
| | *Abudefduf saxatilis* | Sergeant major |
| | *Chromis cyanea* | Blue chromis |
| | *Chromis insolata* | Sunshinefish |
| | *Microspathodon chrysurus* | Yellowtail damselfish |
| | *Pomacentrus fuscus* | Dusky damselfish |
| | *Pomacentrus leucostictus* | Beaugregory |
| | *Pomacentrus partitus* | Bicolor damselfish |
| | *Pomacentrus planifrons* | Threespot damselfish |
| | *Priacanthus cruentatus* | Glasseye snapper |
| | *Equetus acuminatus* | High-hat |
| | *Equetus lanceolatus* | Jackknife-fish |
| | *Equetus punctatus* | Spotted drum |
| | *Scorpaenidae* | Scorpionfishes |
| | *Hypoplectrus unicolor* | Butter hamlet |
| | *Liopropoma rubre* | Swissguard basslet |
| | *Rypticus saponaceus* | Greater soapfish |
| | *Serranus annularis* | Orangeback bass |
| | *Serranus baldwini* | Lantern bass |

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| Family | Scientific Name | Common Name |
|---|---|---|
| | *Serranus tabacarius* | Tobaccofish |
| | *Serranus tigrinus* | Harlequin bass |
| | *Serranus tortugarum* | Chalk bass |
| | *Symphurus arawak* | Caribbean tonguefish |
| | *Hippocampus* spp. | Seahorses |
| | *Syngnathus* spp. | Pipefishes |
| | *Synodus intermedius* | Sand diver |
| | *Canthigaster rostrata* | Sharpnose puffer |
| | *Diodon hystrix* | Porcupinefish |
| **Aquarium Trade Invertebrate Species -- Coral FMP** | | |
| | *Aphimedon compressa* | Erect rope sponge |
| | *Chondrilla nucula* | Chicken liver sponge |
| | *Cynachirella alloclada* | |
| | *Geodia neptuni* | Potato sponge |
| | *Haliclona* spp. | Finger sponge |
| | *Myriastra* spp. | |
| | *Niphates digitalis* | Pink vase sponge |
| | *N. erecta* | Lavender rope sponge |
| | *Spinosella policifera* | |
| | *S. vaginalis* | |
| | *Tethya crypta* | |
| | *Aiptasia tagetes* | Pale anemone |
| | *Bartholomea annulata* | Corkscrew anemone |
| | *Condylactis gigantea* | Giant pink-tipped anemone |
| | *Hereractis lucida* | Knobby anemone |
| | *Lebrunia* spp. | Staghorn anemone |
| | *Stichodactyla helianthus* | Sun anemone |
| | *Zoanthus* spp. | Sea mat |
| | *Discosoma* spp. (formerly *Rhodactis*) | False coral |
| | *Ricordia florida* | Florida false coral |
| | *Sabellastarte* spp. | Tube worms |
| | *S. magnifica* | Magnificent duster |
| | *Spirobranchus giganteus* | Christmas tree worm |
| | *Tridachia crispata* | Lettuce sea slug |
| | *Oliva reticularis* | Netted olive |
| | *Cyphoma gibbosum* | Flamingo tongue |
| | *Lima* spp. | Fileclams |
| | *L. scabra* | Rough fileclam |
| | *Spondylus americanus* | Atlantic thorny oyster |
| | *Octopus* spp. (except the Common octopus, *O.vulgaris*) | |
| | *Alpheaus armatus* | Snapping shrimp |
| | *Paguristes* spp. | Hermit crabs |
| | *P. cadenati* | Red reef hermit |
| | *Percnon gibbesi* | Nimble spray crab |
| | *Lysmata* spp. | Peppermint shrimp |
| | *Thor amboinensis* | Anemone shrimp |
| | *Mithrax* spp. | Clinging crabs |
| | *M. cinctimanus* | Banded clinging |
| | *M. sculptus* | Green clinging |
| | *Stenorhynchus seticornis* | Yellowline arrow |

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| Family | Scientific Name | Common Name |
|---|---|---|
| | *Periclimenes* spp. | Cleaner shrimp |
| | *Gonodactylus* spp. | |
| | *Lysiosquilla* spp. | |
| | *Stenopus hispidus* | Banded shrimp |
| | *S. scutellatus* | Golden shrimp |
| | *Analcidometra armata* | Swimming crinoid |
| | *Davidaster* spp. | Crinoids |
| | *Nemaster* spp. | Crinoids |
| | *Astropecten* spp. | Sand stars |
| | *Linckia guildingii* | Common comet star |
| | *Ophidiaster guildingii* | Comet star |
| | *Oreaster reticulatus* | Cushion sea star |
| | *Astrophyton muricatum* | Giant basket star |
| | *Ophiocoma* spp. | Brittlestars |
| | *Ophioderma* spp. | Brittlestars |
| | *O. rubicundum* | Ruby brittlestar |

**Table 2.2.3.** Species proposed to be included in the Puerto Rico FMP based on Preferred Alternative 2, *Criterion C*. Species marked with an asterisk would be new to federal management.

| Family | Scientific Name | Common Name |
|---|---|---|
| **Lutjanidae -- Snappers** | *Lutjanus jocu* | Dog snapper |
| | *Lutjanus apodus* | Schoolmaster |
| | *Lutjanus cyanopterus* | Cubera snapper* |
| **Serranidae -- Groupers** | *Epinephelus fulvus* | Coney |
| | *Epinephelus cruentatus* | Graysby |
| | *Epinephelus adscensionis* | Rock hind |
| | *Epinephelus mystacinus* | Misty grouper |
| | *Mycteroperca interstitialis* | Yellowmouth grouper* |
| **Scaridae -- Parrotfishes[1]** | *Scarus vetula* | Queen parrotfish |
| | *Scarus taeniopterus* | Princess parrotfish |
| | *Sparisoma chrysopterum* | Redtail parrotfish |
| | *Sparisoma viride* | Stoplight parrotfish |
| | *Sparisoma aurofrenatum* | Redband parrotfish |
| | *Scarus croicensis* | Striped parrotfish |
| **Acanthuridae -- Surgeonfishes** | *Acanthurus coeruleus* | Blue tang |
| | *Acanthurus bahianus* | Ocean surgeonfish |
| | *Acanthurus chirurgus* | Doctorfish |
| **Balistidae -- Triggerfishes** | *Canthidermis sufflamen* | Ocean triggerfish |
| | *Balistes vetula* | Queen triggerfish (Old Wife) |
| | *Balistes capriscus* | Gray triggerfish* |
| **Labridae -- Wrasses** | *Lachnolaimus maximus* | Hogfish |
| | *Halichoeres radiatus* | Puddingwife |
| | *Bodianus rufus* | Spanish hogfish |
| **Pomacanthidae -- Angelfishes** | *Holacanthus ciliaris* | Queen angelfish |
| | *Pomacanthus arcuatus* | Gray angelfish |
| | *Pomacanthus paru* | French angelfish |

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| Family | Scientific Name | Common Name |
|---|---|---|
| **Sphyraenidae -- Barracudas** | *Sphyraena guachancho* | Guaguanche* |
| | *Sphyraena barracuda* | Great barracuda* |
| **Lobotidae -- Tripletail** | *Lobotes surinamensis* | Tripletail* |
| **Myliobatidae – Eagle and Manta rays** | *Manta birostris* | Manta* |
| | *Aetobatus narinari* | Spotted eagle ray (chucho)* |
| **Dasyatidae - Stingrays** | *Dasyatis americana* | Southern sting ray* |

[1] The Council added the parrotfish species, except for the redfin parrotfish, for management in the Puerto Rico FMP at the 153rd Council Meeting, which correspond to this Criterion.

**Table 2.2.4.** Species proposed to be included in the Puerto Rico FMP based on Preferred Alternative 2, *Criterion D*. Species marked with an asterisk would be new to federal management.

| Family | Scientific Name | Common Name |
|---|---|---|
| **Lutjanidae - Snappers** | *Pristipomoides aquilonaris* | Wenchman |
| | *Pristipomoides macrophthalmus* | Cardinal |
| | *Etelis oculatus* | Queen snapper |
| **Haemulidae--Grunts** | *Haemulon plumierii* | White grunt |
| **Carangidae--Jacks** | *Caranx hippos* | Crevalle Jack* |
| | *Alectis ciliaris* | African pompano* |
| | *Elagatis bipinnulata* | Rainbow runner* |
| **Coryphaenidae - Dolphin fish** | *Coryphaena hippurus* | Dolphin* |
| | *Coryphaena equiselis* | Pompano dolphin* |
| **Scombridae -- Mackerels and tunas** | *Euthynnus alletteratus* | Little tunny* |
| | *Thunnus atlanticus* | Blackfin tuna* |
| | *Scomberomorus cavalla* | King mackerel* |
| | *Scomberomorus regalis* | Cero* |
| | *Acanthocybium solandri* | Wahoo* |

The Puerto Rico FMP draft list of species would include queen conch (1 species), spiny lobster (1 species), all sea cucumbers, all sea urchins, all species of coral, and 63 species of finfish (Table 2.2.5).

**Table 2.2.5.** Species included in the Puerto Rico FMP based on Criteria A-E of Preferred Alternative 2. The Council proposed these species for management at their 153rd Regular Meeting (August 2015).

| Family or Class | # | Species Name | Common Name | Criterion |
|---|---|---|---|---|
| **Strombidae -- True conchs** | 1 | *Lobatus (Strombus) gigas* | Queen conch | A |
| **Palinuridae -- Spiny lobster** | 2 | *Panulirus argus* | Caribbean spiny lobster | A |
| **Lutjanidae -- Snappers** | 3 | *Apsilus dentatus* | Black snapper | A |
| | 4 | *Lutjanus buccanella* | Blackfin snapper | A |
| | 5 | *Lutjanus vivanus* | Silk snapper | A |
| | 6 | *Rhomboplites aurorubens* | Vermilion snapper | A |

| Family or Class | # | Species Name | Common Name | Criterion |
|---|---|---|---|---|
| | 7 | *Lutjanus synagris* | Lane snapper | A |
| | 8 | *Lutjanus analis* | Mutton snapper | A |
| | 9 | *Ocyurus chrysurus* | Yellowtail snapper | A |
| | 10 | *Pristipomoides aquilonaris* | Wenchman | D |
| | 11 | *Pristipomoides macrophthalmus* | Cardinal snapper | D |
| | 12 | *Etelis oculatus* | Queen snapper | D |
| | 13 | *Lutjanus jocu* | Dog snapper | C |
| | 14 | *Lutjanus apodus* | Schoolmaster | C |
| | 15 | *Lutjanus cyanopterus* | Cubera snapper | C |
| **Serranidae -- Groupers** | 16 | *Epinephelus striatus* | Nassau Grouper | A |
| | 17 | *Epinephelus itajara* | Goliath grouper | A |
| | 18 | *Epinephelus guttatus* | Red hind | A |
| | 19 | *Mycteroperca bonaci* | Black grouper | A |
| | 20 | *Epinephelus morio* | Red grouper | A |
| | 21 | *Mycteroperca tigris* | Tiger grouper | A |
| | 22 | *Mycteroperca venenosa* | Yellowfin grouper | A |
| | 23 | *Hyporthodus flavolimbatus* | Yellowedge grouper | A |
| | 24 | *Cephalopholis fulva* | Coney | C |
| | 25 | *Cephalopholis cruentatus* | Graysby | C |
| | 26 | *Epinephelus adscensionis* | Rock hind | C |
| | 27 | *Hyporthodus mystacinus* | Misty grouper | C |
| | 28 | *Mycteroperca interstitialis* | Yellowmouth grouper | C |
| **Scaridae -- Parrotfishes** | 29 | *Scarus coeruleus* | Blue parrotfish | A |
| | 30 | *Scarus coelestinus* | Midnight parrotfish | A |
| | 31 | *Scarus guacamaia* | Rainbow parrotfish | A |
| | 32 | *Scarus vetula* | Queen parrotfish | C |
| | 33 | *Scarus taeniopterus* | Princess parrotfish | C |
| | 34 | *Sparisoma chrysopterum* | Redtail parrotfish | C |
| | 35 | *Sparisoma viride* | Stoplight parrotfish | C |
| | 36 | *Sparisoma aurofrenatum* | Redband parrotfish | C |
| | 37 | *Scarus iseri* | Striped parrotfish | C |
| **Acanthuridae -- Surgeonfishes** | 38 | *Acanthurus coeruleus* | Blue tang | C |
| | 39 | *Acanthurus tractus* | Ocean surgeonfish | C |
| | 40 | *Acanthurus chirurgus* | Doctorfish | C |
| **Balistidae -- Triggerfishes** | 41 | *Canthidermis sufflamen* | Ocean triggerfish | C |
| | 42 | *Balistes vetula* | Queen triggerfish | C |
| | 43 | *Balistes capriscus* | Gray triggerfish | C |
| **Labridae -- Wrasses** | 44 | *Lachnolaimus maximus* | Hogfish | C |
| | 45 | *Halichoeres radiatus* | Puddingwife | C |
| | 46 | *Bodianus rufus* | Spanish hogfish | C |
| **Pomacanthidae -- Angelfishes** | 47 | *Holacanthus ciliaris* | Queen angelfish | C |
| | 48 | *Pomacanthus arcuatus* | Gray angelfish | C |
| | 49 | *Pomacanthus paru* | French angelfish | C |
| **Sphyraenidae -- Barracudas**[13] | 50 | *Sphyraena barracuda* | Great barracuda | C |
| **Lobotidae -- Tripletail** | 51 | *Lobotes surinamensis* | Tripletail | C |
| **Myliobatidae -- Eagle and Manta Rays** | 52 | *Manta birostris* | Manta | C |
| | 53 | *Aetobatus narinari* | Spotted eagle ray | C |

[13] The guaguanche barracuda (*Sphyraena guachancho*) was eliminated from the list of species to be considered by Council motion at the 154th Regular Meeting in December 2015. The distribution of this species is more coastal, and it is not expected to be found in Puerto Rico EEZ waters.

| Family or Class | # | Species Name | Common Name | Criterion |
|---|---|---|---|---|
| **Dasyatidae - Stingrays** | 54 | *Dasyatis americana* | Southern sting ray | C |
| **Haemulidae -- Grunts** | 55 | *Haemulon plumierii* | White grunt | D |
| **Carangidae -- Jacks** | 56 | *Caranx hippos* | Crevalle jack | D |
| | 57 | *Alectis ciliaris* | African pompano | D |
| | 58 | *Elagatis bipinnulata* | Rainbow runner | D |
| **Coryphaenidae -- Dolphinfish** | 59 | *Coryphaena hippurus* | Dolphin | D |
| | 60 | *Coryphaena equiselis* | Pompano dolphin | D |
| **Scombridae -- Mackerels and tunas** | 61 | *Euthynnus alletteratus* | Little tunny | D |
| | 62 | *Thunnus atlanticus* | Blackfin tuna | D |
| | 63 | *Scomberomorus cavalla* | King mackerel | D |
| | 64 | *Scomberomorus regalis* | Cero | D |
| | 65 | *Acanthocybium solandri* | Wahoo | D |
| **Class Holothuroidea -- Sea Cucumbers** | 66 | All (several species) | Sea cucumbers | Council Motion |
| **Class Echinoidea -- Sea Urchins** | 67 | All (several species) | Sea urchins | Council Motion |
| **All Corals (soft, hard, mesophotic, deep-water)** | 68 | Several species | Corals | A |

### 2.2.2 Discussion of Action 2 Alternatives

Under **Alternative 1** (no action), the species that were previously managed under the four species-based FMPs would be managed under the new Puerto Rico FMP. Under **Alternative 1**, the Puerto Rico FMP would include 81 species of reef fish, 58 species of aquarium trade fish, spiny lobster, queen conch, 94 species or genera of corals, and 63 species or genera of aquarium trade invertebrates. **Alternative 1** would not allow that list of species to be managed to be tailored to the specific characteristics of the Puerto Rico EEZ, as many species included in the Council's current FMPs are not necessarily present, or are not an economically important component of the fishery, in the Puerto Rico EEZ waters. **Alternative 1** would also not allow for new species to be included in the FMP for management. Several species that would meet the selection criteria are being landed from Puerto Rico EEZ waters but are not currently managed, and it may be appropriate to account for and manage these species via the Puerto Rico FMP.

**Preferred Alternative 2** uses an integrated attributes analysis the select species for management in the Puerto Rico FMP. The five selection criteria (Criteria A-E [discussed below]) were based on attributes that reflect present management status, biological attributes such as ecological importance or vulnerability, and the importance and value of the fishery to the region.

The Council's Scientific and Statistical Committee (SSC) and the Puerto Rico district advisory panel (DAP) provided input and recommendations on the criteria used to select the species in need of conservation and management. Species considered for management included those within the Puerto Rico FMP (as retained from the four species-based FMPs) as well as non-managed species for which the Southeast Fisheries Science Center (SEFSC) had landings (See

Appendix D). These experts developed the initial list of species to be included in the Puerto Rico FMP by applying selection criteria A-D in a stepwise manner. The final list of proposed species was considered by the Council at their 153rd meeting in August 2015. A fifth criterion, *Criterion E*, was added at the Council's 162nd regular meeting in April 2018, as a means to deal with stocks for which average landings (commercial and recreational combined) during the reference period were so low as to be considered *de minimis*[14]. However, at the 163rd Council meeting in August 2018, the Council decided to reject *Criterion E* (see Appendix E for the rationale) and replace it with a new *Criterion E* that would include species the Council determined were in need of conservation and management, such as sea cucumbers and sea urchins that were not previously managed.

The stepwise approach proposed in **Preferred Alternative 2** begins with application of *Criterion A*, which ensures the inclusion of stocks in the Puerto Rico FMP that currently have specific management measures in place, including those classified as overfished in U.S. Caribbean waters, stocks for which historically identified harvest is now prohibited due to ecological importance as habitat or habitat engineers, and those stocks for which seasonal closures or size limits apply. Inclusion of *Criterion A* is necessary to ensure that management of those identified stocks continues to aid their recovery and/or conservation. Under *Criterion A* of **Preferred Alternative 2**, 18 finfish, queen conch, spiny lobster, and previously managed corals would be included in the Puerto Rico FMP (Table 2.2.1). Following a recommendation from the Puerto Rico DAP, the Council agreed that all corals[15] occurring in Puerto Rico EEZ waters were in need of conservation and management and therefore should be included in the FMP.

Under *Criterion B* of **Preferred Alternative 2** species that occur infrequently in federal waters would not be excluded from the Puerto Rico FMP, unless they were included under Criterion A. For these excluded species, the Council determined that the FMP would not be able to improve or maintain the condition of the stock and so they were not in need of conservation and management. Suitable harvest location data (e.g., catch from federal waters versus territorial waters) were not available from commercial catch reports. However, depth distribution data were available and were used in the expert determination as to whether the species

[14] Definition - too trivial or minor to merit consideration. The *de mininis* landings would not apply to previously identified conservation and management concerns that resulted in the application of specific management regulations (captured in Criterion A). The *de minimis* classification is appropriate when low landings of a stock reflect fishery socioeconomics rather than the biological condition of the stock.

[15] At their 153rd Regular meeting, the Council moved to include all soft, hard, mesophotic, and deep water corals under the new island-based FMPs. This would include all species in Orders Scleractinia (hard corals), Alcyonacea (soft corals), and Antipatharia (black corals).[16] Under the Reef Fish FMP, the Snapper Unit 3 complex consisted of lane snapper, mutton snapper, dog snapper, schoolmaster, gray snapper, and mahogany snapper. These latter two species—gray snapper and mahogany snapper—were not included in the FMP under Action 2, Preferred Alternative 2. This action is limited to grouping species selected for management in Action 2, and **Alternative 1** maintains the complex groupings, as applied to the stocks for which management is continued under the Puerto Rico FMP.

predominantly occurred in Puerto Rico territorial waters (generally ≤ 30 m) and were therefore not appropriate for federal management, or commonly occurred in federal waters (generally > 30 m) and were therefore eligible for further consideration under *Criteria C* and *D*. Under *Criterion B*, 36 individual species of finfish and all finfish included in the Reef Fish FMP aquarium trade category and all invertebrates included in the Coral FMP, and 56 aquarium trade invertebrate species originally included in the Puerto Rico FMP through Action 1, would be excluded from management (Table 2.2.2).

Under *Criterion C* of **Preferred Alternative 2**, for species that were not excluded from federal management based on Criterion B, a species would be included in the Puerto Rico FMP if it was biologically vulnerable, constrained to a specific habitat that renders it particularly vulnerable, or has an essential ecological value. Under *Criterion C* of **Preferred Alternative 2**, 31 species would fall under this criterion, including new species such as barracudas, tripletail, manta ray, spotted eagle ray, and the southern sting ray (Table 2.2.3).

Under *Criterion D* of **Preferred Alternative 2**, for species not already included for federal management based on Criteria A or C, or excluded based on *Criterion B*, a species would be included in the Puerto Rico FMP if the species possesses economic importance to the nation or regional economy based on a threshold of landings or value. That threshold was separately established by the SSC for each of the recreational and commercial sectors as appropriate (e.g., top 90%). Additionally, a species would be included in the Puerto Rico FMP if it represents an important component of bycatch. Fourteen species were selected for inclusion under this criterion, including members of the snapper, grunts, jacks, dolphin, and mackerel and tuna groups (Table 2.2.4). New species added to management under this criterion include the crevalle jack, African pompano, rainbow runner, dolphin, pompano dolphin, little tunny, blackfin tuna, wahoo, cero, and king mackerel.

Each of the species added under *Criterion D* provides substantial value to the Puerto Rico fishery, either directly (harvested for consumption) or indirectly (used as bait). After careful consideration, pelagic species were included for federal management under this criterion. The Council recognized the economic importance of these stocks within the region and decided to include them for management under the Puerto Rico FMP, even though, given their migratory nature, they are exposed to harvest pressure across a wide area of the Atlantic Ocean.

As mentioned above, a new description for *Criterion E* was added to **Preferred Alternative 2** to allow the Council discretion to add those species they considered were in need of conservation or management. All sea cucumbers and sea urchins that were not previously managed under the Coral FMP as aquarium trade species, and thus included in the Puerto Rico FMP under Action 1, but that occur in the Puerto Rico EEZ, would fall under this category. These groups were added to the Puerto Rico FMP by Council motion at their 153rd regular meeting in August 2015,

because as slow-moving benthic invertebrates, they are commercially exploited for consumption through export to Asian markets and are highly vulnerable to overharvest.

During the process of applying the criteria included in **Preferred Alternative 2** to choose species in need of conservation and management, divergent perspectives arose both within the SSC and the Puerto Rico DAP and between these two entities. For example, the Puerto Rico DAP recommended that barracuda not be included for management because they are not commercially targeted due to their ciguatoxicity and are therefore not a key component of the commercial fishery. However, the SSC explained that barracuda occurs in the EEZ (not excluded under *Criterion B*) and opined that though they are not targeted or landed often nor are they biologically vulnerable, they are ecologically important as top-level predators. The Council considered both perspectives and chose to include the barracuda. Redfin parrotfish is another example where the DAP and SSC were not in agreement. The Puerto Rico DAP recommended redfin parrotfish be included for management, but the SSC disagreed, noting that the redfin parrotfish stock rarely occurs in waters subject to federal management (i.e., those waters at least 9 nm from shore, generally equivalent to those waters > 30 m depth). For this reason, the SSC opined that redfin should be excluded from management in the Puerto Rico FMP based on application of *Criterion B*. After considering this information, the Council chose to exclude the redfin parrotfish from the list of species to be included in the Puerto Rico FMP (Table 2.2.5).

In summary, **Preferred Alternative 2** would result in the following list of species to be included in the Puerto Rico FMP: queen conch, spiny lobster, all species of sea cucumbers, sea urchins, and corals occurring in Puerto Rico EEZ waters, and 63 species of finfish (Table 2.2.5).

**Alternative 3** is similar to **Preferred Alternative 2**, with two important exceptions. First, **Alternative 3** does not call for a stepwise application of the criteria. Second, **Alternative 3** does not require that all of the five criteria be used. Instead, **Alternative 3** allows for any subset of the criteria to be applied and in any order. As an example of the potential drawbacks of this *ad hoc* approach, if Criterion C or D were applied before *Criterion B*, then stocks could be included in the FMP for which federal management might not be as effective. Of even greater concern, if one of the Criterion was not applied, then species that may be in need of conservation and management would be overlooked. **Alternative 3** presents 325 alternative criteria combinations, from which the Council could choose a different combination and order for each stock in the fishery. Without guidance from the Council regarding which criteria would be included when applying **Alternative 3**, it is not practically possible to compare all of the alternative outcomes. The Council considered **Alternative 3** and decided not to move forward with the alternative. Therefore, **Alternative 3** was eliminated from further detailed study.

**<u>Comparison of Action 2 Alternatives and Summary of Effects</u>**

**Alternative 1** would continue management of those stocks that are included under the existing FMPs, without alteration. When compared to the no action **Alternative 1**, **Preferred Alternative 2** would identify species in need of conservation and management using an expert-based analysis of available data and information applied within an ordered set of evaluation criteria. The outcome of this ordered selection process would result in a change in the number of stocks subject to federal management in Puerto Rico EEZ waters relative to **Alternative 1**. Although 18 finfish stocks would be newly included in the federal management regime, 36 finfish stocks would be simultaneously removed from management, resulting in an overall decrease in the number and composition of managed reef fish (from 81 to 63). Both alternatives would continue to include spiny lobster and queen conch. In contrast, in **Preferred Alternative 2** all species of sea cucumbers and sea urchins occurring in Puerto Rico EEZ waters would be added to the federal management regime, whereas this would not be the case in **Alternative 1**. Additionally, 94 species or genera of corals, including members of each of the hard, soft, and black coral groups, are presently and specifically included in the Corals FMP that presently governs coral species in Puerto Rico EEZ waters (i.e., **Alternative 1**). **Preferred Alternative 2** would result in an unknown number of additional coral species being included for management as a result of including all hard (Order Scleractinia), soft (Order Hydrocorallina) and black (Order Antipatharia) corals in the FMP rather than limiting inclusion to only those species or genera specifically identified in the management plan for inclusion. **Alternative 3** includes the same selection criteria described for **Preferred Alternative 2**, but does not require that all criteria be used, or that they be applied in a step-wise manner. The list of species selected under **Alternative 3** could be either very inclusive if all species for which landings data are available were included, or minimal if only those species determined to be overfished or undergoing overfishing, or likely to become overfished or subject to overfishing were included.

**Alternative 1** would not have direct physical, biological/ecological, socio-economic, or administrative effects relative to the present situation. **Alternative 1** would be expected to have indirect biological/ecological, socio-economic, and administrative effects because it would not extend management to other species in need of conservation and management based on the criteria established in the guidance on the Magnuson-Stevens Act. The Council would not set management reference points or other conservation measures for those species, or otherwise ensure those species are managed in a manner that prevents overfishing while achieving, on a continuing basis, the optimum yield (OY) from the fishery as required by National Standard (NS) 1 of the Magnuson-Stevens Act. Additionally, not including species that are economically important could have both short- and long-term socioeconomic effects on fishermen pursuing the locally occurring stocks of those species, if unregulated harvest results in depletion of the stock. Conversely, including stocks predominantly harvested from Puerto Rico commonwealth waters in a management plan applicable only to federal waters is administratively ineffective because of the lack of federal authority and resultant enforcement capacity in those local waters, particularly with respect to application of AMs in response to harvest exceeding the allowable catch limit.

When compared to the no action **Alternative 1**, implementing **Preferred Alternative 2** would be expected to have few if any indirect physical and/or biological/ecological effects on the environment, beyond those already experienced under the present management regime. For example, if fishing for a species that would be removed from management under **Preferred Alternative 2** continues as is regardless of federal management, no effects would be expected from its removal from the FMP. Removal of species preliminarily caught in territorial waters or those with low or infrequent catch levels in federal waters would allow management efforts to be concentrated on the more heavily targeted and exploited stocks that are in need of management, thus providing increased benefits to the biological/ecological environment. Contrary to **Alternative 1**, revising federal fishery management in the Puerto Rico EEZ in **Preferred Alternative 2** provides the opportunity to reevaluate managed species in response to changing environmental (e.g., habitat availability or health) or anthropogenic (e.g., fishing practices) factors to maximize biological as well as socioeconomic benefit.

Adding species previously not managed would potentially have indirect effects on the physical and/or biological/ecological environments if it resulted in new gear types, fishing areas, changes in the number of fish harvested or fishing effort not previously analyzed, but these routes are not expected for any of the species added in **Preferred Alternative 2**. However, future Council actions could affect the physical and the biological/ecological environments. For example, for newly added species, the Council could take action to reduce harvest of these species or change allowable harvest methods in a manner that changes effects to the these environments.

Like **Alternative 1**, **Preferred Alternative 2** would continue to manage species that are susceptible to excess fishing pressure and/or vulnerable to environmental conditions (e.g., species classified as overfished [Nassau, goliath grouper], species with harvest prohibitions due to ecological importance [midnight, rainbow, blue parrotfish], species with seasonal closures or size limits [queen conch, spiny lobster and select snappers and groupers]). Unlike **Alternative 1, Preferred Alternative 2** has the flexibility to include species that that were not included in the previous FMPs, but are currently considered to be biologically vulnerable or ecologically important (e.g., the ESA-listed manta ray; sea cucumbers, sea urchins). **Preferred Alternative 2** would also benefit the biological/ecological environment indirectly by establishing catch limits (not directly in this action, but later in Action 4) for highly targeted stocks that are currently without management measures, like dolphin and wahoo, thus providing a more comprehensive management of the Puerto Rico coral reef ecosystem. With respect to ESA listed species, **Preferred Alternative 2** would include for management all corals, sea cucumbers, and sea urchins, which could reduce direct (habitat) and indirect (grazers) effects to ESA coral critical habitat.

When compared to the no action **Alternative 1**, **Preferred Alternative 2** could in the future create a short-term socio-economic burden to fishermen that fish for those stocks newly added to management. This would occur if management measures applied to those newly added species, including for example ACLs, trip limits, or size limits result in a reduction in the allowable harvest or an increase in the effort required to obtain that harvest. However, in the long term, positive effects would be expected as the management measures work to prevent overfishing while achieving, on a continuing basis, the OY from the fishery as prescribed in NS1 of the Magnuson-Stevens Act.

When compared to the no action **Alternative 1**, **Preferred Alternative 2** would be more beneficial administratively because it would direct resources to the management and protection of species that occur in federally managed waters and that are therefore responsive to federal management measures.

Anticipated effects from application of **Alternative 3** would be similar to those described for **Preferred Alternative 2**. The actual direct or indirect effects of applying **Alternative 3** would depend on the criteria selected and the order those criteria are applied, both of which are unknown at this time. The list of species selected under **Alternative 3** could be either very inclusive if all species for which landings data are available were included, or minimal if only those species determined to be overfished or undergoing overfishing, or likely to become overfished or subject to overfishing were included. Both of these scenarios would be expected to have increased administrative effects when compared to **Alternative 1**, as the current management would need to be altered greatly. It is more difficult to compare effects of **Alternative 3** to **Preferred Alternative 2**, but they would generally not be as beneficial to the environments of Puerto Rico unless the list of species selected was very similar or identical to the one generated under **Preferred Alternative 2**, as the Council and its panel of experts used the best information available to populate that list.

In summary, relative to **Alternative 1** and **Alternative 3**, **Preferred Alternative 2** would be more beneficial to the human environment because it would (1) direct resources to the management and protection of species that in the highest need of conservation and management; (2) allow inclusion of species that have not been previously subject to conservation and management; and (3) remove current management measures in place for species that are not targeted in federal waters. That reorganization of species to be managed would increase the likelihood of sustainable harvest, as a means both to enhance food security for the island of Puerto Rico and to rebuild and sustain the natural ecological balance of the coral reef ecosystem within the context of sustainable harvest.

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## 2.3 Action 3: Compose Stock Complexes and Identify Indicator Stocks as Appropriate

Through Action 3, the Council would determine, for species selected for management in Action 2 (Preferred Alternative 2), whether those species are managed as individual stocks or within a stock complex, and if the latter then whether the species is assigned as an indicator stock, is governed by an indicator stock, or is managed as a group within the complex. As with Action 2, this action follows from selecting Alternative 2 in Action 1 and proceeding with establishing a Puerto Rico FMP composed of measures pertinent to Puerto Rico.

### 2.3.1 Proposed Alternatives for Action 3

**Alternative 1.** No Action. In the Puerto Rico FMP, created in Action 1, retain the stock complex arrangements previously established in the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs for stocks that would continue to be managed under the Puerto Rico FMP. For stocks not previously included in the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs, but which will be managed under the Puerto Rico FMP via Action 2, no stock complexes would be established and no indicator stocks assigned.

**Alternative 2.** Do not organize the species in the Puerto Rico FMP into stock complexes. Species selected for management in Action 2 would be managed as individual stocks.

**Preferred Alternative 3.** Manage species included for management in the Puerto Rico FMP as individual stocks or as stock complexes, based on scientific analysis, including one or more of the following: cluster analysis based on landings patterns; outcomes from the Southeast Data, Assessment, and Review (SEDAR) Caribbean Data Evaluation Workshop (2009) (only for species previously managed that would remain in the FMP); biological/life history similarities and vulnerability (for all species); and, expert opinion from the scientific and fishing communities (for all species).

**Alternative 4.** Where there are stock complexes, determine whether to assign one or more indicator stocks as follows:

**Preferred Sub-alternative 4a.** Indicator stocks would be used. One or more indicator stocks would be assigned within a stock complex based on the following criteria: percent of the catch, targeted, habitat co-occurrence, life history/vulnerability, catch co-occurrence, data, and market. For stock complexes for which harvest is allowed and for which one or more indicator stocks is assigned, stocks in the stock complex would be subject to AM as a group based on the ACL established for the indicator stock(s).

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**Preferred Sub-alternative 4b.** No indicator stock(s) would be assigned. For stock complexes for which harvest is allowed, stocks in the complex would be subject to AMs as a group based on the aggregate ACL derived from information on all of the stocks in the complex.

### 2.3.2 Discussion of Action 3 Alternatives

**Alternative 1** is the no action alternative. Stocks selected for management in Action 2 would be grouped according to the same stock/stock complex organization brought in under Action 1 from the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs (Table 2.3.1). Under **Alternative 1**, the stock complex organization would remain the same, but the composition of species within that complex may be reduced. For example, some stock complexes within the Puerto Rico FMP (established under Action 1, Preferred Alternative 2) were subsequently revised under Action 2, Preferred Alternative 2, as stocks within the complex were excluded based on *Criterion B*.

In data-limited situations, when it is not possible to specify reference points for individual stocks, as has been the case for federally managed stocks in Puerto Rico EEZ waters, some stocks have been grouped into stock complexes under each of the Council FMPs. The organization of the stock complexes under the four Council FMPs was based on biological, geographic, ecological, and/or economic characteristics. Many stock complexes were organized in this manner as an outcome of implementing the 2005 Caribbean Sustainable Fisheries Act Amendment (CFMC 2005), although the composition of some of these stock complexes changed upon implementation of the 2010 and 2011 Caribbean ACL Amendments (CFMC 2011a, b).

For some previously managed stocks, the stock/stock complex organization that would result from **Alternative 1** may not be based on the best currently available information, even if it was the best available information at the time the existing complexes were established. As a result, selecting **Alternative 1** could violate NS2 of the Magnuson-Stevens Act, which establishes that "[c]onservation and management measures shall be based upon the best scientific information available." 16 USC 1851(a)(2).

Additionally, stocks new to management under Action 2, Preferred Alternative 2 would be managed as individual stocks rather than grouped in a complex. Those stocks may have similar biological characteristics to stocks within a previously managed complex, which under NS1 would suggest that they be managed within the stock complex. However, under **Alternative 1**, they would not be organized into a stock complex, but would be managed as single stocks.

**Table 2.3.1.** Stock/stock complex organization under Action 3, **Alternative 1** for stocks that would be included for management as selected in Action 2, Preferred Alternative 2 in the Puerto Rico FMP (as established in Action 1).

Note: as a result of Action 2, Preferred Alternative 2, all species in the boxfish, filefish, goatfish, squirrelfish, and tilefish complexes as well as all of the aquarium trade species were removed from management, and thus those complexes would not be retained in Action 3, Alternative 1.

| Stocks/Stock complexes | Stocks that would be included in the Puerto Rico FMP |
|---|---|
| **Snappers**<br>Snapper 1 | Black, blackfin, silk, vermilion, wenchman |
| Snapper 2 | Cardinal, queen |
| Snapper 3[1] | Lane, mutton, dog, schoolmaster |
| Snapper 4 | Yellowtail |
| **Groupers**<br>Grouper 1 | Nassau |
| Grouper 2 | Goliath |
| Grouper 3 | Red hind, coney, graysby, rock hind |
| Grouper 4 | Black, red, tiger, yellowfin |
| Grouper 5 | Misty, yellowedge |
| **Acanthuridae – Surgeonfishes** | Blue tang, ocean surgeonfish, doctorfish |
| **Balistidae – Triggerfishes[2]** | Ocean triggerfish, Queen triggerfish |
| **Haemulidae – Grunts[3]** | White grunt |
| **Labridae – Wrasses** | Hogfish, puddingwife, Spanish hogfish |
| **Pomacanthidae - Angelfishes** | Queen, gray, French angelfish |
| **Scaridae – Parrotfishes[4]** | Blue, midnight, rainbow, queen<br>princess, redtail, stoplight, redband, striped |
| **Class Holothuroidea - Sea Cucumbers[5]** | Holothuria spp. |
| **Class Echinoidea - Sea Urchins[5]** | Long spined, purple, pencil, pin cushion, and sea egg urchins |
| **Queen conch** | Queen conch |
| **Spiny lobster** | Spiny lobster |
| **Corals** | Corals |

[1]The previously established SU3 also included gray and mahogany snapper. These species would be removed from management in Action 2, Preferred Alternative 2.
[2]The previously established Triggerfish complex included sargassum triggerfish and the black durgon. These species would be removed from management in Action 2, Preferred Alternative 2.
[3]The previously established Grunts complex also included margate, tomtate, bluestriped, and the French porkfish. These species would be removed from management in Action 2, Preferred Alternative 2.
[4]The previously established arrotfish complex included redfin parrotfish. This species would be removed from management in Action 2, Preferred Alternative 2.
[5]Sea cucumbers and some sea urchins species were included in the Coral FMP as part of the aquarium trade species. Aquarium trade species would be removed from management under Action 2, Preferred Alternative 2, and all species of sea cucumbers and sea urchins would be managed as two complexes under Action 2, Preferred Alternative 2.

**Alternative 1** would not be a preferred alternative if the Council implements Preferred Alternative 2 in Action 2 (Table 2.3.2), as species that were not previously managed in the Puerto Rico EEZ, would not be assigned into stock complexes. Based on Preferred Alternative 2 in Action 2, 18 finfish species would be new to management under the Puerto Rico FMP, along with multiple sea urchins, sea cucumbers, and all corals, including deep-water corals and mesophotic corals (Table 2.3.2). Prior to taking action to revise the species list in Action 2, the Puerto Rico FMP would have only included some species of sea urchins, sea cucumbers, and corals, as under the Coral FMP. Those species that would be newly added to the Puerto Rico FMP under Preferred Alternative 2 of Action 2 may share biological, geographic, ecological,

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and/or economic similarities with those species that would remain under federal management and/or share similarities with some of the other newly added species and therefore, it could be beneficial to group those species into stock complexes. However, **Alternative 1** would not group these species.

**Table 2.3.2.** New stocks to be included for management in the Puerto Rico FMP based on Action 2, Preferred Alternative 2**.** These species would not be organized into stock complexes under Action 3, Alternative 1.

| Family | Species common name |
|---|---|
| Snappers | Cubera snapper |
| Groupers | Yellowmouth |
| Triggerfishes | Gray triggerfish |
| Jacks | Crevalle jack, African pompano, Rainbow runner |
| Eagle and Manta Rays | Manta ray, spotted eagle ray, southern sting ray |
| Mackerels and Tunas | Little tunny, Blackfin tuna, King mackerel, Cero, Wahoo |
| Tripletail | Tripletail |
| Barracudas | Great barracuda |
| Dolphin fishes | Dolphin, Pompano dolphin |
| Class Holothuroidea - Sea Cucumbers[1] | All species |
| Class Echinoidea - Sea Urchins[1] | All species |

[1]Some species of sea cucumbers and sea urchins were previously managed as aquarium trade species in the Coral FMP.

**Alternative 2** proposes that all stocks included in the Puerto Rico FMP be managed individually. None would be organized into stock complexes. Under **Alternative 2** some stocks may be appropriately managed as individual stocks, such as the queen conch and spiny lobster, because of their unique and individual characteristics. Additionally, many of the stocks that would be included for management in the Puerto Rico FMP have issues with species identification (reported as a group or easily and often mis-identified) or unreliable landings through time (due to the rarity of the species or lack of targeted fishing effort). For those stocks, there may not be enough information available to establish management reference points and management measure proxies required under the Magnuson-Stevens Act or included in the NS guidelines for fishery management. The revised NS1 guidelines state that stocks may be grouped into complexes for various reasons, including "where there is insufficient data to measure a stock's status relative to SDC [status determination criteria]," 50 CFR 600.310(d)(2)(i). Under **Alternative 2,** those reference points would have to be established for each individual stock, even if there is insufficient information to set SDC at the individual stock level or to monitor stock performance with respect to those SDC. Additionally, setting an individual ACL for the stocks with highly variable landings may result in frequent ACL overages because of the highly variable landings characteristic of those stocks, resulting in unnecessary application of AMs. In general, AMs create socio-economic burdens on the fishing communities and additional

workload burdens on fishery managers and enforcement officers, so they must be applied in the most effective and conscientious manner.

**Preferred Alternative 3** would manage stocks individually or as stock complexes, as appropriate, based on scientific analysis, including one or more of the following: cluster analysis based on landings patterns; outcomes from the SEDAR Caribbean Data Evaluation Workshop (2009) (only for species previously managed that would remain in the FMP); biological/life history similarities and vulnerability (for all species); and, expert opinion from the scientific and fishing communities (for all species). This analysis is consistent with the revised NS1 guidelines, which explain that, where practical, stocks grouped into a complex should be sufficiently similar in geographic distribution, life history characteristics, and vulnerabilities to fishing pressure such that the impact of management actions on the stocks included in a complex is similar (50 CFR 600.310(d)(2)(i)). In addition, the guidelines indicate that the vulnerability of individual stocks should be considered when determining if a particular stock complex should be established or reorganized, or if a particular stock should be included in a complex (*Id*).

In contrast to **Alternative 2**, **Preferred Alternative 3** provides managers with the flexibility to choose to manage stocks individually or as a complex, depending on the information available and the goals of the management plan. As discussed under **Alternative 2**, grouping stocks into complexes allows management reference points to be specified for the complex as a whole, which can be particularly helpful in data-limited situations when it is not possible to evaluate an individual stock's status relative to status determination criteria or to otherwise specify management reference points at the individual stock level (50 CFR 600.310(d)(2)(i)). Grouping non-targeted or data-poor stocks into complexes helps buffer uncertainty in individual landings histories, mitigates issues with species identification, and may reduce the likelihood of unnecessary implementation of AMs. In contrast, species such as spiny lobster and queen conch share few if any attributes with any other species proposed for management in the Puerto Rico FMP. These species are best managed as individual stocks, thereby ensuring to the greatest degree possible that management measures reflect their unique characteristics and are not unduly influenced by species that may share (for example) geographic or cultural affinities but fundamentally differ in their biological and/or fishery characteristics. In these cases, the Council has the option under **Preferred Alternative 3** to establish single stock management for those species that are harvested using methods that specifically target that species, have a unique life history, are physically separated from other stocks, are classified as overfished or undergoing overfishing, are in rebuilding plans, or are targeted by fishermen independent of other species.

The Council's SSC and the Puerto Rico DAP met on several occasions to discuss grouping species into complexes as prescribed under **Preferred Alternative 3** and provided recommendations to the Council regarding if and how stocks should be grouped into a complex. Criteria discussed when considering whether to group a set of stocks into a complex included the

composition of the existing stock complexes, life history information (*i.e.*, habitat and depth, including federal versus territorial waters), fishery information (*i.e.*, gear and if the stock is targeted or bycatch), if members of the stock might be ciguatoxic, and if (and when) the stock was specifically included on commercial landings forms and/or as part of recreational intercept survey interviews. A combined SSC/DAP meeting occurred from March 15-17, 2016, at which the SSC and DAP members discussed groupings using the methods discussed above. Members of the Puerto Rico DAP and SSC evaluated all of the species proposed for management in the Puerto Rico FMP (resulting from the application of Preferred Alternative 2 in Action 2) to determine if they should be managed as a single stock or as part of a stock complex. The resultant stocks (for individual species) and stock complexes (for groups of species) were presented to the Council at their March 17, 2016, meeting.

Further review of the stock complexes occurred at the SSC's February 2017 meeting and at the Puerto Rico DAP's March 2017 meeting. The recommendations were then finalized at the April 2017 SSC meeting.

**Preferred Alternative 3** would result in 18 single species/individual stocks and 19 stock complexes (Table 2.3.3). A discussion of how the stocks were composed under **Preferred Alternative 3** and how that organization compares to results from **Alternatives 1** and **2** can be found below.

**Table 2.3.3.** Stocks and stock complexes resulting from Preferred Alternative 3 of Action 3 in the Puerto Rico FMP.

| Family or Class | Stock/Stock Complexes | Species Name | Common Name; Nombre en español |
|---|---|---|---|
| Strombidae -- True conchs | Queen conch | *Lobatus (Strombus) gigas* | Queen conch; carrucho |
| Palinuridae -- Spiny lobster | Spiny Lobster | *Panulirus argus* | Caribbean spiny lobster; langosta espinosa |
| Lutjanidae -- Snappers | Snapper 1 | *Apsilus dentatus* | Black snapper; pargo prieto |
| | | *Lutjanus buccanella* | Blackfin snapper; alinegra |
| | | *Lutjanus vivanus* | Silk snapper; chillo (ojo amarillo) |
| | | *Rhomboplites aurorubens* | Vermilion snapper; chilla rubia, besugo |
| | | *Pristipomoides aquilonaris* | Wenchman; limosnera, muniama de adentro |
| | Snapper 2 | *Pristipomoides macrophthalmus* | Cardinal snapper; muniama de afuera |
| | | *Etelis oculatus* | Queen snapper; cartucho |
| | Snapper 3 | *Lutjanus synagris* | Lane snapper; arrayao |
| | Snapper 4 | *Lutjanus analis* | Mutton snapper; sama |

| | | | |
|---|---|---|---|
| | | *Lutjanus jocu*<br>*Lutjanus apodus* | Dog snapper; pargo colorao<br>Schoolmaster; pargo amarillo |
| | Snapper 5 | *Ocyurus chrysurus* | Yellowtail snapper; colirubia |
| | Snapper 6 | *Lutjanus cyanopterus* | Cubera snapper; pargo mulato |
| Serranidae -- Groupers | Grouper 1 | *Epinephelus striatus* | Nassau Grouper; mero cherna |
| | Grouper2 | *Epinephelus itajara* | Goliath grouper; mero batata |
| | Grouper 3 | *Cephalopholis cruentata*<br>*Cephalopholis fulva* | Graysby; mantequilla<br>Coney; mantequilla |
| | Grouper 4 | *Mycteroperca bonaci*<br>*Epinephelus morio*<br>*Mycteroperca tigris*<br>*Mycteroperca venenosa*<br>*Mycteroperca interstitialis* | Black grouper; mero prieto<br>Red grouper; mero rojo<br>Tiger grouper; tigre<br>Yellowfin grouper; guajil<br>Yellowmouth grouper; guajil boquiamarillo |
| | Grouper 5 | *Hyporthodus flavolimbatus*<br>*Hyporthodus mystacinus* | Yellowedge grouper; guajil amarillo<br>Misty grouper; guasa |
| | Grouper 6 | *Epinephelus guttatus*<br>*Epinephelus adscensionis* | Red hind; cabrilla<br>Rock hind; cabra mora |
| Scaridae -- Parrotfishes | Parrotfish 1 | *Scarus coeruleus*<br>*Scarus coelestinus*<br>*Scarus guacamaia* | Blue parrotfish; brindao<br>Midnight parrotfish; judío<br>Rainbow parrotfish; guacamayo |
| | Parrotfish 2 | *Scarus vetula*<br>*Scarus taeniopterus*<br>*Sparisoma chrysopterum*<br>*Sparisoma viride*<br>*Sparisoma aurofrenatum*<br>*Scarus iseri* | Queen parrotfish; loro reina<br>Princess parrotfish; princesa<br>Redtail parrotfish; loro colirrojo<br>Stoplight parrotfish ; loro verde<br>Redband parrotfish; loro banda colorada<br>Striped parrotfish; loro rayado |
| Acanthuridae -- Surgeonfishes | Surgeonfish | *Acanthurus coeruleus*<br>*Acanthurus tractus*<br>*Acanthurus chirurgus* | Blue tang; barbero<br>Ocean surgeonfish, médico<br>Doctorfish; cirujano |
| Balistidae -- Triggerfishes | Triggerfish | *Canthidermis sufflamen*<br>*Balistes vetula*<br>*Balistes capriscus* | Ocean triggerfish; turco<br>Queen triggerfish; peje puerco<br>Gray triggerfish; peje puerco blanco |
| Labridae -- Wrasses | Wrasse 1 | *Lachnolaimus maximus* | Hogfish; capitán |

| | | | |
|---|---|---|---|
| | Wrasse 2 | *Halichoeres radiatus*<br>*Bodianus rufus* | Puddingwife; capitán de piedra<br>Spanish hogfish; loro capitán |
| Pomacanthidae -- Angelfishes | Angelfish | *Holacanthus ciliaris*<br>*Pomacanthus arcuatus*<br>*Pomacanthus paru* | Queen angelfish; isabelita<br>Gray angelfish; isabelita gris<br>French angelfish; isabelita negra |
| Sphyraenidae -- Barracudas | Barracuda | *Sphyraena barracuda* | Great barracuda; picúa |
| Lobotidae -- Tripletail | Tripletail | *Lobotes surinamensis* | Tripletail; viajacas del mar |
| Myliobatidae – Manta and Spotted Eagle Rays | Rays 1 | *Manta birostris* | Manta; manta |
| | Rays 2 | *Aetobatus narinari* | Spotted eagle ray; chucho |
| Dasyatidae – Sting rays | Rays 3 | *Dasyatis americana* | Southern sting ray; raya |
| Haemulidae -- Grunts | Grunts | *Haemulon plumierii* | White grunt; cachicata, boquicolorao |
| Carangidae -- Jacks | Jack 1 | *Caranx hippos* | Crevalle Jack; jurel amarillo |
| | Jack 2 | *Alectis ciliaris* | African pompano; pampano |
| | Jack 3 | *Elagatis bipinnulata* | Rainbow runner; salmon |
| Coryphaenidae – Dolphinfish | Dolphinfish | *Coryphaena hippurus*<br>*Coryphaena equiselis* | Dolphin; dorado<br>Pompano dolphin; doradito |
| Scombridae – Mackerels and tunas | Tuna | *Euthynnus alletteratus* | Little tunny; bonito |
| | | *Thunnus atlanticus* | Blackfin tuna; albacora |
| | Mackerel | *Scomberomorus cavalla* | King mackerel; sierra carite |
| | | *Scomberomorus regalis* | Cero; sierra alasana |
| | Wahoo | *Acanthocybium solandri* | Wahoo; peto |
| Classs Holothuroidea – Sea Cucumbers | Cucumbers | All (several families and species) | Sea cucumbers; pepinos de mar |
| Class Echinoidea -- Sea Urchins | Urchins | All (several families and species) | Sea urchins; erizos |
| All Corals (soft, hard, mesophotic, deep-water) | Corals | Several families and species | Corals; corales |

The stock complexes selected in **Preferred Alternative 3** were supported by the outcomes from a semi-quantitative productivity/susceptibility analysis (PSA) conducted by the SSC in cooperation with the SEFSC. The PSA process used scores from a variety of biological and fishery attributes (see Appendix H) to categorize the relative biological productivity and fishery susceptibility of each stock included in the management plan. Although the SSC developed the PSA approach for deriving reference points, they recognized its utility for validating outcomes from the stock complex assignment process. The productivity score was of value in assessing the similarities in integrated biological characteristics (see Appendix H) of those stocks included in a common complex. Similarly, the susceptibility score provided insights into the relative exposure of the individual stocks comprising a complex to direct (e.g., gear) and indirect (e.g.,

management strategy) components of the fishery (see Appendix H). Evaluating the productivity and susceptibility scores ensures that, to the greatest possible extent, the resultant stock complex arrangements met MSA guidance regarding the formulation and performance of stock complexes. Specifically, application of those scores served to ensure that, where practical, stocks grouped into a complex should be sufficiently similar in geographic distribution, life history characteristics, and vulnerabilities to fishing pressure such that the impact of management actions on the stocks included in a complex is similar (50 CFR 600.310(d)(2)(i)). In addition, the guidelines indicate that the vulnerability of individual stocks should be considered when determining if a particular stock complex should be established or reorganized, or if a particular stock should be included in a complex (50 CFR 600.310(d)(2)(i)). In the following paragraphs, the rationale applied by the Puerto Rico DAP and the SSC in recommending each stock/stock complex, as accepted by the Council, is described and compared relative to the applicable productivity and susceptibility scores (Table 2.3.4).

**Table 2.3.4.** Results of the PSA for stocks included in the Puerto Rico FMP. Those stocks with bold print would be the designated indicator stock for the complex if the Council selects Action 3, Preferred Sub-alternative 4a for that complex.

| Scientific Name | Common Name | Stock / Complex | Productivity | Susceptibility |
|---|---|---|---|---|
| *Panulirus argus* | Caribbean spiny lobster | Spiny Lobster | High | Low/Moderate |
| *Lobatus gigas* | Queen conch | QC | Low/Moderate | High |
| *Apsilus dentatus* | Black snapper | S1 | Moderate/High | Low/Moderate |
| *Lutjanus buccanella* | Blackfin snapper | S1 | Moderate/High | Low/Moderate |
| ***Lutjanus vivanus*** | **Silk snapper** | **S1** | **Moderate/High** | **Low/Moderate** |
| *Rhomboplites aurorubens* | Vermilion snapper | S1 | Moderate/High | Low/Moderate |
| *Pristipomoides aquilonaris* | Wenchman | S1 | Moderate/High | Low/Moderate |
| *Pristipomoides macrophthalmus* | Cardinal | S2 | High | Low/Moderate |
| ***Etelis oculatus*** | **Queen snapper** | **S2** | **High** | **Low/Moderate** |
| *Lutjanus synagris* | Lane snapper | S3 | Moderate | Moderate |
| ***Lutjanus analis*** | **Mutton snapper** | **S4** | **Low/Moderate** | **Low/Moderate** |
| *Lutjanus jocu* | Dog snapper | S4 | Low/Moderate | Low/Moderate |
| *Lutjanus apodus* | Schoolmaster | S4 | Low/Moderate | Low/Moderate |
| *Ocyurus chrysurus* | Yellowtail snapper | S5 | Moderate/High | Moderate |
| *Lutjanus cyanopterus* | Cubera | S6 | Moderate | Moderate |
| *Epinephelus striatus* | Nassau Grouper | G1 | Low | High |
| *Epinephelus itajara* | Goliath grouper | G2 | Low | High |
| ***Epinephelus fulvus*** | **Coney** | **G3** | **High** | **Low/Moderate** |
| *Epinephelus cruentatus* | Graysby | G3 | Moderate/High | Low |

| Scientific Name | Common Name | Stock / Complex | Productivity | Susceptibility |
|---|---|---|---|---|
| *Mycteroperca bonaci* | Black grouper | G4 | Low | Moderate/High |
| *Epinephelus morio* | Red grouper | G4 | Low | Moderate/High |
| *Mycteroperca tigris* | Tiger grouper | G4 | Low | Moderate/High |
| *Mycteroperca venenosa* | Yellowfin grouper | G4 | Low | Moderate/High |
| *Mycteroperca interstitialis* | Yellowmouth grouper | G4 | Low | Moderate/High |
| *Epinephelus mystacinus* | Misty grouper | G5 | Low | Moderate |
| *Epinephelus flavolimbatus* | Yellowedge grouper | G5 | Low | Low |
| ***Epinephelus guttatus*** | **Red hind** | **G6** | **Moderate/High** | **Low/Moderate** |
| *Epinephelus adscensionis* | Rock hind | G6 | Moderate/High | Low |
| *Scarus coeruleus* | Blue parrotfish | Parrot 1 | Moderate | High |
| *Scarus coelestinus* | Midnight parrotfish | Parrot 1 | Moderate | High |
| *Scarus guacamaia* | Rainbow parrotfish | Parrot 1 | Moderate | High |
| *Scarus taeniopterus* | Princess parrotfish | Parrot 2 | High | Low |
| *Scarus vetula* | Queen parrotfish | Parrot 2 | High | Low |
| *Sparisoma chrysopterum* | Redtail parrotfish | Parrot 2 | High | Low |
| *Sparisoma viride* | Stoplight parrotfish | Parrot 2 | High | Low |
| *Sparisoma aurofrenatum* | Redband parrotfish | Parrot 2 | High | Low |
| *Scarus croicensis* | Striped parrotfish | Parrot 2 | High | Low |
| *Acanthurus coeruleus* | Blue tang | Surgeon | High | Low |
| *Acanthurus bahianus* | Ocean surgeonfish | Surgeon | High | Low |
| *Acanthurus chirurgus* | Doctorfish | Surgeon | High | Low |
| *Canthidermis sufflamen* | Ocean triggerfish | Trigger | Moderate | Low |
| ***Balistes vetula*** | **Queen triggerfish** | **Trigger** | **Moderate** | **Low/Moderate** |
| *Balistes capriscus* | Gray triggerfish | Trigger | Moderate | Low |
| *Lachnolaimus maximus* | Hogfish | Wrasse 1 | Moderate | Moderate |
| *Halichoeres radiatus* | Puddingwife | Wrasse 2 | High | Low |
| *Bodianus rufus* | Spanish hogfish | Wrasse 2 | High | Low |
| *Holacanthus ciliaris* | Queen angelfish | Angelfish | High | Low |
| *Pomacanthus arcuatus* | Gray angelfish | Angelfish | Moderate | Low |
| *Pomacanthus paru* | French angelfish | Angelfish | Moderate/High | Low |
| *Sphyraena barracuda* | Great barracuda | Barracuda | Moderate/High | Low |
| *Lobotes surinamensis* | Tripletail | Tripletail | High | Low |
| *Manta birostris* | Manta | Rays 1 | Low | Moderate/High |
| *Aetobatus narinari* | Spotted eagle ray | Rays 2 | Low | Moderate/High |
| *Dasyatis americana* | Sting ray | Rays 3 | Low | High |
| *Haemulon plumieri* | White grunt | Grunts | High | Moderate |
| *Caranx hippos* | Crevalle | J1 | High | Moderate |
| *Alectis ciliaris* | African Pompano | J2 | Moderate/High | Low |
| *Elagatis bipinnulata* | Rainbow runner | J3 | High | Low |
| ***Coryphaena hippurus*** | **Dolphin** | **Dorado** | **High** | **Low** |

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| Scientific Name | Common Name | Stock / Complex | Productivity | Susceptibility |
|---|---|---|---|---|
| *Coryphaena equiselis* | Pompano dolphin | Dorado | High | Low |
| *Euthynnus alletteratus* | Little tunny | Tuna | High | Low |
| *Thunnus atlanticus* | Blackfin tuna | Tuna | High | Low |
| *Scomberomorus cavalla* | King mackerel | Mackerel | Moderate | Low |
| *Scomberomorus regalis* | Cero | Mackerel | Moderate/High | Low |
| *Acanthocybium solandri* | Wahoo | Wahoo | Moderate/High | Low |
| - | Cucumbers | Cucumbers | Low | High |
| - | Urchins | Urchins | Moderate | High |
| - | Corals | Corals | - | High |

**Snapper Stocks/Stock Complexes**

Under **Preferred Alternative 3**, the snappers included for management in the Puerto Rico FMP would be managed as two individual stocks and four stock complexes, as follows:

<u>Snapper 1</u>

The Snapper 1 complex would be composed of black, blackfin, silk, vermilion, and wenchman snappers. This stock complex organization would be the same under **Preferred Alternative 3** and **Alternative 1**, as this is how the complex was managed under the Council's Reef Fish FMP, but differs from **Alternative 2** (individual stock management). Snapper 1 includes snappers that inhabit relatively shallow to mid-depth water and that are commonly caught together. Silk snapper is the predominantly targeted stock in the complex. Testimony at Council meetings indicated that the fishery for species included in Snapper 1 is very valuable and the market demand substantial. Natural mortality for the members of this complex may exceed fishing mortality and larger individuals are not usually targeted (160$^{th}$ Council meeting minutes 2017). Outcomes from the PSA supported the composition of the Snapper 1 complex. All members expressed moderate to high productivity along with low to moderate susceptibility to the fishery.

At their March 2017 meeting, members of the Puerto Rico DAP expressed concern regarding the inclusion of wenchman in Snapper 1. They noted differences in market demand for this fish, ranging from low to no demand on the west coast to a higher demand on the south coast. They also stated that fishermen use different gear types to harvest wenchman, and that wenchman are caught in shallower waters than other species in the unit. However, the SSC recommended continuing management of wenchman as part of the Snapper 1. The SSC explained that wenchman is rarely caught and, as a result, there are insufficient data to warrant an assessment based on the history of landings. For this reason, the SSC reasoned that wenchman should be managed in a complex with other species for which information is available to guide management. As to the appropriate complex, the SSC noted that although wenchman may be caught in shallower waters than other stocks in this complex, it has some similar life history

traits to those stocks. For example, the stocks in Snapper 1 have similar productivity. That the markets for the stocks differed did not affect whether it is appropriate, from a biological perspective, to group the stocks together. However, since wenchman is rarely caught, the SSC determined that it is unlikely that fishermen would overfish wenchman, another reason it would be appropriate to manage wenchman within a complex, as opposed to individually. The SSC's recommendation is consistent with a similar evaluation included in the 2010 Caribbean ACL Amendment (CFMC 2011a). In the 2010 Caribbean ACL Amendment, the Council determined that wenchman is most closely associated with the species included in Snapper 1, as compared to stocks in other stock complexes, and thus that including wenchman in Snapper 1 is ecologically defensible as well as managerially defensible given the limited information available to manage wenchman alone. At their April 2017 meeting, the Council accepted the SSC recommendations for this stock complex in Puerto Rico.

Snapper 2

The Snapper 2 stock complex would be composed of cardinal and queen snapper. Both the Council's SSC and Puerto Rico DAP supported continuing to manage these species together because they are deep-water species that are harvested together. Additionally, the PSA scored both species as highly productive and of low to moderate susceptibility. This stock complex organization would be the same under **Preferred Alternative 3** and **Alternative 1** as this is how the complex was previously managed under the Council's Reef Fish FMP, but differs than **Alternative 2** (individual stock management).

Snapper 3

Lane snapper would be the only species in Snapper 3. Lane snapper was previously managed as part of a stock complex with mutton snapper and other shallow water snappers in the Reef Fish FMP, including dog snapper and schoolmaster (**Alternative 1**)[16]. Members of the Puerto Rico DAP recommended managing lane snapper as a single stock given that it is targeted and harvested independently from other snapper species. The SSC agreed with that recommendation. Moreover, outcomes from the PSA support separating lane snapper from mutton snapper, dog snapper, and schoolmaster because the former expresses moderate productivity and susceptibility whereas the other three express low to moderate scores on each. For lane snapper, this management organization would be identical to that realized if **Alternative 2** was instead applied because both result in lane snapper being managed as an individual stock.

Snapper 4

[16] Under the Reef Fish FMP, the Snapper Unit 3 complex consisted of lane snapper, mutton snapper, dog snapper, schoolmaster, gray snapper, and mahogany snapper. These latter two species—gray snapper and mahogany snapper—were not included in the FMP under Action 2, Preferred Alternative 2. This action is limited to grouping species selected for management in Action 2, and **Alternative 1** maintains the complex groupings, as applied to the stocks for which management is continued under the Puerto Rico FMP.

The Snapper 4 complex would be composed of mutton snapper, dog snapper, and schoolmaster. Members of the Puerto Rico DAP recommended that mutton snapper should be managed as a single stock because it occurs in different habitats than schoolmaster and dog snapper. The SSC, however, recommended continuing to manage these three species as one stock complex. This approach is similar to current management under **Alternative 1**. Under **Alternative 1**, mutton snapper, dog snapper, and schoolmaster would be managed together in a complex with lane snapper. Under **Preferred Alternative 3**, however, lane snapper would be included in a complex on its own, for the reasons explained above, and mutton snapper, dog snapper, and schoolmaster would be managed in a complex. Limited information is available about schoolmaster and dog snapper compared to mutton snapper. Schoolmaster and dog snapper do not appear on the catch reporting forms, limiting catch information to that written in by the fishermen. Thus, it would be beneficial to manage these stocks with another stock for which additional information on which to guide management is available. The PSA outcomes indicate that all three species express relatively low to moderate productivity and susceptibility scores, and thus it is appropriate to manage them within the same complex.

<u>Snapper 5</u>

Yellowtail snapper would be the only stock in Snapper 5 as this species is targeted independently from other managed snappers. Productivity of yellowtail snapper is moderate to high, and it expresses a moderate susceptibility to the fishery. The approach to stock management proposed under **Preferred Alternative 3** would be the same as under **Alternative 1** as this species historically has been managed in a complex by itself under the Council's Reef Fish FMP. It is also consistent with **Alternative 2** because both outcomes result in individual stock management.

<u>Snapper 6</u>

Cubera snapper would be the only species managed in the Snapper 6 complex. The cubera snapper would be newly added to federal management in the Puerto Rico FMP as an outcome of Action 2, Preferred Alternative 2. This species is targeted independently from the other snapper species proposed for management in the Puerto Rico FMP. Cubera snapper are considered difficult to catch because they prefer live bait and are primarily caught with hook-and-line or spear gear, although juveniles may be taken in traps. In Puerto Rico, commercial fishermen may target juvenile cubera, but the larger adult cubera (50-60 lb) are considered to be ciguatoxic. Although there are reports of a market for cubera snapper on the north coast of Puerto Rico, they are generally not targeted for consumption. Large cubera snapper are found nearshore, can be taken easily in aggregations, and may be targeted as a trophy fish in the recreational fishery. They express moderate productivity and susceptibility, an outcome similar to that for lane snapper but otherwise unique from the other snapper species proposed for management. The approach to stock management proposed under **Preferred Alternative 3** would differ from the approach under **Alternative 1,** as cubera snapper is new to management and **Alternative 1** does

not group stocks that are new to management. **Preferred Alternative 3** is consistent with **Alternative 2** because both outcomes result in individual stock management.

**Grouper Stocks/Stock Complexes**

Under **Preferred Alternative 3**, groupers (Family Serranidae) would be managed under two individual stocks and four stock complexes.

Grouper 1 and Grouper 2

Grouper 1 would consist of Nassau grouper and Grouper 2 would consist of goliath grouper. Nassau grouper and goliath grouper are each currently under rebuilding plans and managed with harvest prohibitions throughout the U.S. Caribbean EEZ; and these management measures would not change under the new Puerto Rico FMP. Both stocks scored low with respect to productivity and high with respect to fishery susceptibility in the PSA. Management of these species as two individual stocks would be similar under **Preferred Alternative 3**, **Alternative 1**, and **Alternative 2**.

Grouper 3

Under **Preferred Alternative 3**, the Grouper 3 complex would be composed of graysby and coney. This management approach would differ from that proposed in **Alternative 1** because these species historically have been managed together in a complex that also included red hind and rock hind. The SSC recommended separating coney and graysby from rock hind and red hind due to differences in life history attributes. The SSC explained that coney and graysby are smaller-sized groupers that co-occur during certain life stages and that have productivity rates that are generally considered to differ from the hinds. As further discussed for Grouper 6 below, the PSA outcomes do not fully support this perception regarding productivity because all four stocks were assigned either high (coney) or moderate/high (the graysby, red hind, rock hind) productivity. However, the differences in where the species co-occur supports separating coney and graysby from red and rock hind. Thus, based on the SSC's recommendation, application of **Preferred Alternative 3** would result in Grouper 3 being composed of graysby and coney, with Grouper 6 composed of rock hind and red hind (see below). This outcome differs from that resulting from application of **Alternative 2**, under which all four stocks would be managed individually.

Grouper 4

Under **Preferred Alternative 3**, the Grouper 4 stock complex would be composed of the black, red, tiger, yellowfin, and yellowmouth groupers. This stock complex organization is similar but not identical to **Alternative 1**, as these species, with the exception of the yellowmouth grouper, were managed together in the Council's Reef Fish FMP. The yellowmouth grouper is newly proposed for management in the Puerto Rico FMP as an outcome of Action 2, Preferred Alternative 2, and thus is not assigned to a stock complex in **Alternative 1**. The SSC

recommended including yellowmouth grouper in Grouper 4 because it is a deep-water species, as are the other groupers that would comprise this complex. The DAP agreed with this organization, and the PSA outcomes are supportive of grouping these stocks together in a single complex as all five species express low susceptibility to the fishery and moderate to high productivity. This grouping differs from the **Alternative 2** outcome, where all species would be managed as individual stocks.

Grouper 5

The Grouper 5 complex would be composed of two deep-water species, misty and yellowedge grouper. The DAP and SSC noted that neither of these species is targeted and both are considered bycatch from the deepwater snapper fishery. They also noted that misty and yellowedge co-occur and thus are amenable to management as a unit. The PSA outcomes were generally in agreement although, whereas both misty and yellowedge expressed low productivity, misty scored as moderately susceptible to the fishery whereas yellowedge scored low in that regard. Thus, the species have slightly different vulnerability to fishing pressure. However, this difference does not warrant managing the species separately, given their habitat co-occurrence and that both are bycatch in the same fishery. Management of these species under **Preferred Alternative 3** is not different than under **Alternative 1** as these species were managed together in the Council's Reef Fish FMP. Management differs from **Alternative 2** where all species would be managed as individual stocks.

Grouper 6

Under **Preferred Alternative 3**, the Grouper 6 stock complex would be composed of the red hind and rock hind groupers. As noted above, these two species historically have been managed within a single complex, along with coney and graysby, in the Council's Reef Fish FMP (**Alternative 1**). At their March 2017 meeting, the Puerto Rico DAP recommended that red hind be managed as an individual stock because of its economic value and that rock hind be managed with the coney and the graysby. However, the SSC recommended pairing red hind and rock hind in a new stock complex because their life history characteristics are more similar to one another than to coney and graysby. The two hind species are of similar size and are generally larger than coney and graysby, the hind species are found at the shelf edge in the same habitat, and the hind species aggregate to spawn in the same areas, meaning they are likely to be caught together. The SSC also concluded the hinds express different productivity rates relative to coney and graysby. This conclusion differs slightly from both the productivity scores from the PSA, because all four stocks scored similarly with respect to both productivity, as discussed above in the section on Grouper 3. These groupings differ from the **Alternative 2** outcomes, where all four would be managed as individual stocks.

**Parrotfish Stock Complexes**

Under **Preferred Alternative 3**, parrotfish species (Family Scaridae) would be managed within two separate stock complexes. The three stocks for which harvest is prohibited (midnight, rainbow, blue) in the Puerto Rico EEZ would be grouped into Parrotfish 1 whereas those six stocks available for harvest would constitute Parrotfish 2.

Parrotfish 1

The three large-bodied species of parrotfish, namely midnight, blue, and rainbow parrotfish, would be managed within Parrotfish 1 based on **Preferred Alternative 3**. Both the SSC and the Puerto Rico DAP agreed that these three species should be managed together. Each of these stocks was at one time relatively abundant in Puerto Rico waters but all three are now rarely seen. A prohibition on their harvest from all waters within the U.S. Caribbean EEZ, including Puerto Rico EEZ, waters was instituted in 2012 as an outcome of the 2010 Caribbean ACL Amendment (CFMC 2011a). That prohibition would remain in place under the Puerto Rico FMP. Moreover, the PSA classified all three as moderately productive and highly susceptible to the fishery, further warranting their grouping into a single complex.

Parrotfish 2

Stocks of queen, princess, redtail, stoplight, redband, and striped parrotfish would be managed within a single complex under **Preferred Alternative 3**. Although these species generally fall within two separate size ranges, they all occur in the same habitat and are commonly fished using the same gear under the same circumstances, Thus, the SSC recommended managing these stocks together in within a single complex and the Puerto Rico DAP concurred. The PSA resulted in all six being classified as having high productivity and a low susceptibility to the fishery.

The parrotfish stock complex organization resulting from application of **Preferred Alternative 3** differs from the arrangement that would result from application of **Alternative 1**, which proposes all parrotfish managed under the Puerto Rico FMP (in accordance with Action 2, Preferred Alternative 2) be managed within a single complex, as is done under the Reef Fish FMP. As is noted above, redfin parrotfish is no longer being managed under Action 2, Preferred Alternative 2 and this species was not grouped into a complex in any of the alternatives in Action 3. The preferred outcome also differs from that resulting from application of **Alternative 2**, where all nine stocks would be managed individually.

**Surgeonfish Stock Complex**

Under **Preferred Alternative 3**, the three species of surgeonfish proposed for inclusion in the Puerto Rico FMP (blue tang, ocean surgeonfish, doctorfish) would be managed within a single stock complex. In the U.S. Caribbean region, these species commonly occur in small to moderately sized schools, typically in association with coral reef habitat. Surgeonfish are not

targeted by commercial or recreational fishers, but instead are most commonly caught as bycatch in traps, nets, and hand lines. However, all three stocks serve an important ecological function as grazers in the coral reef ecosystem, which served as the basis for their proposed inclusion in the Puerto Rico FMP (see Section 2.2.3). Both the SSC and the Puerto Rico DAP recommended continuing to group the three surgeonfish stocks in a single complex as is done under the Reef Fish FMP. That approach is consistent with PSA outcomes, which indicate that all three stocks express high productivity and low susceptibility to the fishery. This organization of the complex is identical to that proposed in **Alternative 1**, but differs from the **Alternative 2** outcome of managing each of the surgeonfish species as individual stocks.

**Triggerfish Stock Complex**

Under **Preferred Alternative 3**, the three species of triggerfish proposed for inclusion in the Puerto Rico FMP under Action 2, **Preferred Alternative 2** (ocean, queen, and gray) would be managed within a single complex. The SSC recommended managing ocean and gray triggerfish together in a single complex with queen triggerfish because of the limited information available about ocean and gray triggerfish upon which to manage them separately. Landings information for the commercial harvest of queen triggerfish are the only data available as this is the only triggerfish species that appears in the catch report forms. The SSC noted that there are differences in these stocks' pattern of vertical distribution within the coral reef complex. However, given the lack of available data about ocean and gray triggerfish to inform management, it is appropriate to manage these stocks in a complex with another stock that shares similar productivity attributes (all three are moderately productive) and fishery susceptibility (low for ocean and gray triggerfish and low to moderate for queen triggerfish) and for which information is available to inform management. The Puerto Rico DAP also recommended this arrangement of the complex. The composition of the triggerfish complex resulting from **Preferred Alternative 3** differs from that proposed in **Alternative 1** because historically the complex included sargassum triggerfish, which is not proposed for management in the Puerto Rico FMP. **Alternative 1** also does not include the newly added gray triggerfish. The complex composition resulting from **Preferred Alternative 3** also differs from **Alternative 2**, where all species would be managed as individual stocks.

**Wrasse Stocks/Stock Complexes**

Under **Preferred Alternative 3**, the three wrasse stocks (Family Labridae) proposed for inclusion in the Puerto Rico FMP would be managed as one individual stock (hogfish) and one stock complex (puddingwife and Spanish hogfish).

<u>Wrasses 1</u>

As noted above, under **Preferred Alternative 3**, Wrasses 1 would be composed of hogfish only. Commercially, hogfish is the most valuable and commonly targeted of the wrasse species as well

as one of the primary targets for recreational spear fishermen. Both the SSC and the Puerto Rico DAP recommended hogfish be managed as an individual stock, distinct from both puddingwife and Spanish hogfish. Hogfish are substantially larger than either of the other two species and are slower growing, rendering the stock slightly more vulnerable. Results from the PSA support this approach, as hogfish express moderate productivity and a moderate susceptibility to the fishery, whereas puddingwife and Spanish hogfish expressed high productivity and low susceptibility to the fishery. The construct resulting from **Preferred Alternative 3** would be the same as that resulting from **Alternative 2** (individual stock management) for hogfish alone, but would differ from the **Alternative 1** outcome, the latter of which would result in the three species of wrasses being organized into a single complex as under the Reef Fish FMP.

Wrasses 2

Under **Preferred Alternative 3**, puddingwife and Spanish hogfish would comprise the Wrasses 2 stock complex. Neither puddingwife nor Spanish hogfish are generally targeted by the commercial fishery, although both are bycatch in the reef fish trap fishery. Their shared status as non-targeted, bycatch stocks, distinct from the targeted hogfish, supports managing them within a common complex. Both the SSC and the DAP recommended this management organization. Grouping them into a single complex, and distinguishing them from hogfish, also is supported by the PSA, which indicates that both stocks express high productivity and a low susceptibility to the fishery, whereas hogfish has a moderate productivity and a moderate susceptibility. **Preferred Alternative 3** differs from **Alternative 2** because the latter results in all three stocks being managed individually and differs from **Alternative 1** because the three species of wrasses in the Puerto Rico FMP (hogfish, puddingwife, and Spanish hogfish) were previously managed within a single stock complex.

**Angelfishes Stock Complex**

Under **Preferred Alternative 3**, the gray, queen, and French angelfishes (Family Pomacanthidae) would comprise a single stock complex. Both the SSC and the DAP recommended this management organization. All three angelfish species were identified as being in need of conservation and management in Action 2 based on Criterion C, specifically their ecological importance to the coral reef ecosystem. Angelfish graze sponges, thereby clearing space for recruitment of coral propagules in a manner similar to that recognized for parrotfish and surgeonfish. They are not a target of commercial or recreational fishermen. Although none of the species is included on the Puerto Rico commercial reporting form, landings of all three species (rarely exceeding a few hundred pounds total within any year) are occasionally written in. Although they differ in productivity, all three are moderately to highly productive, and all three exhibit low susceptibility to the fishery. Given their similar productivity and susceptibility, and that none of the three stocks is targeted, the SSC recommended they be managed together. The approach proposed in **Preferred Alternative 3**

continues the historic organization and is therefore no different from how they would be organized under **Alternative 1**. The proposed approach does differ from that resulting from selection of **Alternative 2**, which would manage each stock on an individual basis.

### Grunt Stock

Under **Preferred Alternative 3**, the only species of grunts proposed for management in the Puerto Rico FMP is white grunt. By default, white grunt would be managed as an individual stock. This would be the same as management resulting from **Alternative 2**. It also is the same as **Alternative 1**. Although the white grunt was historically managed in a stock complex with several other species of grunts (margate, tomtate, bluestriped grunt, French grunt, porkfish) in the Reef Fish FMP, those other grunt species were excluded from management in the Puerto Rico FMP based on Action 2, Preferred Alternative 2, Criterion B because expert analysis of the best scientific information available revealed that these grunt species occur infrequently in federal waters. **Alternative 1** maintains the prior stock complex groupings, but updates those groupings to reflect the stocks to be managed under the Puerto Rico FMP as a result of Action 2, Preferred Alternative 2. Thus, under **Alternative 1**, the grunt complex would be made up of the only grunt selected for management, the white grunt.

### Jack Stocks

Three species of jacks (Family Carangidae) were selected for management based on Action 2, Preferred Alternative 2, Criterion D, including crevalle jack, African pompano, and rainbow runner. Each is proposed to be managed as an individual stock in the Puerto Rico FMP. Crevalle jack would comprise Jacks 1, African pompano would comprise Jacks 2, and rainbow runner would comprise Jacks 3 under **Preferred Alternative 3**. The Puerto Rico DAP supported separately managing the three stocks, and the SSC agreed. Although some catch (hundreds of pounds) of all three stocks has been reported by commercial fishermen during 2000-2016, the predominance of catch is from the recreational fishery (thousands of pounds). According to DAP testimony, the primary location of the recreational catch differs among the three stocks. Crevalle jack is commonly harvested closer to shore and around mangrove channels, African pompano is more commonly caught off the beach, and rainbow runner is more common in open water, although the inclusion of all three species reflects frequent harvest from all three stocks in Puerto Rico EEZ waters as well. Separately managing the three stocks reflects the PSA outcomes as well. The PSA distinguished African pompano from both crevalle jack and rainbow runner because the former was less productive. Crevalle jack and rainbow runner had differing vulnerabilities, though, as the former has moderate fishery susceptibility and the latter has low fishery susceptibility. For these stocks, **Preferred Alternative 3** would provide the same outcome as would result from application of **Alternative 2** (individual stock management). In contrast, the outcome from **Preferred Alternative 3** differs from the **Alternative 1** outcome because **Alternative 1** would not group the jacks to be managed under the Puerto Rico FMP.

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Alternative 1 maintains the prior complex groupings, as applicable to the species that are continuing to be managed under the Puerto Rico FMP. Under the Council's Reef Fish FMP, the Jacks complex included the blue runner, horse-eye jack, black jack, almaco jack, bar jack, greater amberjack, and yellow jack. These other jack species were classified as not being in need of conservation and management in Action 2, Preferred Alternative 2, Criterion B, because expert analysis of the best scientific information available revealed that each of those seven species occur infrequently in Puerto Rico EEZ waters.

**Barracuda Stock**

Under **Preferred Alternative 3**, the great barracuda would be managed as an individual stock. Both the SSC and the DAP recommended this management organization. Although two other species of Sphyraenidae (guaguanche and sennet) occur in U.S. Caribbean waters, neither was identified as being in need of conservation and management in Action 2, Preferred Alternative 2, and no other species identified as being in need of conservation and management in Puerto Rico EEZ waters are similar biologically or in the fishery to this unique mid-level sit-and-wait predator. This stock arrangement would be similar to management resulting from **Alternative 2** but would differ from the **Alternative 1** outcome as this species would be new to management under the Puerto Rico FMP, and Alternative 1 does not group species that are new to management.

**Tripletail Stock**

Under **Preferred Alternative 3**, the tripletail would be managed as an individual stock. As with the great barracuda, the tripletail occupies a relatively unique ecological niche relative to any other species identified as being in need of conservation and management in the Puerto Rico EEZ. Both the SSC and the DAP recommended this management organization. This would be similar to management resulting from **Alternative 2** but would differ from the **Alternative 1** outcome as this species would be new to management under the Puerto Rico FMP and Alternative 1 does not group species that are new to management.

**Dorado (Dolphinfish) Stock Complex**

Under **Preferred Alternative 3**, the dorado (dolphinfish) and pompano dolphin would be managed together within a single complex. The two species share life history characteristics, scored identically in the PSA for both productivity (high) and susceptibility (low), and both are recreationally important species. The grouping resulting from **Preferred Alternative 3** differs from the **Alternative 2** outcome, which calls for management as individual stocks, and also differs from the **Alternative 1** outcome because both of these species would be new to management in the Puerto Rico FMP, and **Alternative 1** does not group species that are new to management.

**Tuna, Mackerel, Wahoo Stocks/Complexes**

Under **Preferred Alternative 3**, species in the Scombridae family would be managed as two stock complexes and one individual stock, as follows.

Under **Preferred Alternative 3**, little tunny and blackfin tuna would comprise the Tunas complex. At their March 2017 meeting, the Puerto Rico DAP recommended little tunny and blackfin tuna be managed as individual stocks because fishing methods differ (blackfin tuna is more pelagic) and they generally do not occur together during the fishing season so they are not harvested together. The SSC, however, recommended at their April 2017 meeting that these two stocks be managed within a single complex. The SSC noted that the two stocks are found together, at the same locations and same time within the fishing season, and that both stocks are frequent catch of both commercial and recreational fishermen. Also supporting this grouping is the common outcomes from the PSA. Both were classified as being highly productive, with a low susceptibility to the fishery, and therefore they are suited to a common management approach.

<u>Mackerels</u>

Under **Preferred Alternative 3**, the king mackerel and the cero would be managed within the Mackerels complex. Both are relatively wide ranging pelagic predators, both are common targets for offshore fishermen, and landings from each stock have been relatively similar in recent years (e.g., roughly 30,000 pounds of each from the commercial fishery in 2015). At their March 2017 meeting, the Puerto Rico DAP recommended these two species be managed separately because fishermen generally target one or the other so they constitute two fisheries. However, as with the Tunas complex, the SSC recommended combining king and cero mackerel into a single Mackerels complex reflecting the many commonalities between the two species rather than their few differences. Outcomes from the PSA support the combined approach, as both species are moderately productive (cero ranked moderate to high) and both possess low susceptibility to the fishery.

<u>Wahoo</u>

Under **Preferred Alternative 3**, the wahoo would be managed as an individual stock. As noted above, the Puerto Rico DAP recommended managing all five of these pelagic species within a common complex, but in the case of wahoo the SSC emphasized it being a less “coastal” pelagic species than the other four and particularly the mackerels. Specifically, the SSC considered wahoo to be an insular “slope” species common in the Mona Passage whereas the cero was a “shelf” species. The two members proposed for the Tuna complex similarly range widely, but differed from the wahoo with respect to the PSA outcomes. The Tunas ranked as highly productive and of low susceptibility to the fishery. Although the wahoo also was of low susceptibility to the fishery, it was ranked as less productive. The SSC also pointed out that wahoo tends to be a more solitary species than any of the other four.

Managing the tuna and mackerel species as a stock complex differs from **Alternative 2**, which proposes species to be managed individually. Managing wahoo individually under **Preferred Alternative 3**, however, is the same outcome as **Alternative 2**. **Alternative 1** does not group any of these five species (the tunas, mackerels, and wahoo) as all would be new to management under the Puerto Rico FMP**.**

**Ray Stocks**

Under **Preferred Alternative 3**, the three species of rays that would be included in the Puerto Rico FMP in Action 2 would be managed as the following individual stocks: Rays 1 (manta ray), Rays 2 (spotted eagle ray), and Rays 3 (southern sting ray).

Management of these species as individual stocks was recommended by both the Puerto Rico DAP and the SSC. The Puerto Rico DAP noted that the ray species are poorly understood, are not included on landings forms so harvest data is minimal, are generally not targeted and have limited economic value although they are valuable for tourism purposes, and are harvested using different methods. The SSC concurred, noting that each of the three has unique life history characteristics and different "ecologies". Outcomes from the PSA indicated low productivity for all three species, and moderate/high (manta ray and spotted eagle ray) to high (sting ray) fishery susceptibility. For these three stocks, the **Preferred Alternative 3** outcome would be the same as that resulting from **Alternative 2** (individual stock management) but would differ from the **Alternative 1** outcome because all three species would be new to management under the Puerto Rico FMP.

**Sea Cucumbers Stock Complex**

At their August 19-20, 2015, meeting, the Council moved to include sea cucumbers in the Puerto Rico FMP, with the intent of including all species of sea cucumbers occurring in the Puerto Rico EEZ in this stock complex to avoid overexploitation of these ecologically important species. Under **Preferred Alternative 3**, all sea cucumbers (Class Holothuridae) would be managed in the Sea Cucumbers stock complex, including *Holothuroidea mexicana*, a species valuable for consumption in certain foreign markets. A class-level PSA indicated that sea cucumber stocks are of low productivity and high susceptibility to the fishery, a combination requiring careful and conservative management particularly within a framework of limited information on their species-specific distribution and abundance patterns. Management of sea cucumbers under **Preferred Alternative 3** would be similar to **Alternative 1** as these species are currently managed as a stock complex as part of the aquarium trade complex within the Coral FMP. It is not known how many individual species of sea cucumbers occur in and are available for harvest from the Puerto Rico EEZ; their harvest is recorded under the generic name "sea cucumber."

Thus, it would not be possible to establish individual stock management for each species of sea cucumber, as proposed under **Alternative 2**.

**Sea Urchins Stock Complex**

At their August 19-20, 2015, meeting, the Council moved to include sea urchins in the Puerto Rico FMP, with the intent of including all species of sea urchins occurring in the Puerto Rico EEZ in this stock complex to avoid overexploitation of these ecologically important species. All **s**ea urchins in Class Echinoidea would be managed in the Sea Urchins stock complex. Species in this complex would include the long-spined urchin *Diadema antillarum*, the pencil urchin *Eucidaris tribuloides*, and the sea egg *Tripneustes ventricosus*. A class-level PSA indicated that sea urchin stocks are of moderate productivity and high susceptibility to the fishery. A precautionary approach to management is therefore advised, requiring conservative management particularly within a framework of limited information on their species-specific distribution and abundance patterns. **Preferred Alternative 3** is not comparable to **Alternative 1** because only select urchin species are currently included in the Coral FMP as part of the aquarium trade species. Nor is **Preferred Alternative 3** comparable to **Alternative 2** because it is not known how many individual species of sea urchin occur in and are available for harvest from the Puerto Rico EEZ. Thus, it would not be possible to establish individual stock management for each species of sea urchins under management, as proposed under **Alternative 2**.

**Corals Stock Complex**

At their August 19-20, 2015, meeting, the Council moved that all corals present in the EEZ of Puerto Rico (soft, hard, mesophotic, and deepwater corals) be included for management in the Puerto Rico FMP. The Council decided to continue managing the corals for which harvest had been prohibited under the Coral FMP under Criterion A and, at this meeting, expanded the scope of corals to be managed under the Puerto Rico FMP to include all corals present in the EEZ off Puerto Rico. This comprehensive approach to managing coral species ensures that cryptic species (those that are difficult to tell apart) as well as any as yet unidentified or undescribed species that may be vulnerable to exploitation are included in management. Coral constitute the foundation of most (if not almost all) Puerto Rico EEZ fisheries, along with the wealth of other ecological, economic, and cultural contributions they provide the region. The Puerto Rico DAP, the SSC, and the Council are in agreement that management is essential and must be anticipatory. The PSA assigned a high fishery susceptibility to the coral group, but no productivity score was assigned due to the diverse and in many cases unknown biology of the many species constituting the Corals complex. **Preferred Alternative 3** differs from **Alternative 1** because the Coral FMP only includes a select number of coral species, none of which are deepwater species. The inclusion of all coral species present in the Puerto Rico EEZ under **Preferred Alternative 3** is broader. **Preferred Alternative 3** also differs from **Alternative 2**, which would manage each species independently.

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**Indicator Stocks**

Under **Alternative 4**, the Council can choose whether or not to select indicator stocks for the stock complexes proposed in **Preferred Alternative 3**. The NS1 guidelines define an indicator stock as a stock with measurable status determination criteria (SDC)[17] that can be used to help manage and evaluate more poorly known stocks that are in a stock complex (50 CFR 600.310(d)(2)(ii)(A)). The NS1 guidelines state that, "where practicable, stock complexes should include one or more indicator stocks (each of which has SDC and ACLs). Otherwise, stock complexes may be comprised of: Several stocks without an indicator stock (with SDC and an ACL for the complex as a whole), or one or more indicator stocks (each of which has SDC and management objectives) with an ACL for the complex as a whole." 50 CFR 600.310(d)(2)(ii)(B)). The guidelines provide that "[i]f an indicator stock is used to evaluate the status of a complex, it should be representative of the typical vulnerability of stocks within the complex" (50 CFR 600.310(d)(2)(ii)(C)). Furthermore, "[i]f the stocks within a stock complex have a wide range of vulnerability, they should be reorganized into different stock complexes that have similar vulnerabilities; otherwise the indicator stock should be chosen to represent the more vulnerable stocks within the complex." 50 CFR 600.310(d)(2)(ii)(C). However, in instances where an indicator stock is less vulnerable than other members of the complex, the guidelines provide that management measures should be more conservative so that the more vulnerable members of the complex are not at risk from the fishery 50 CFR 600.310(d)(2)(ii)(C).

More than one indicator stock can be selected to provide more information about the status of the complex. (50 CFR 600.310(d)(2)(ii)(D)). When one or more indicators are used, Councils should periodically re-evaluate available quantitative or qualitative information (e.g., catch trends, changes in vulnerability, fish health indices, etc.) to determine if the stocks within the complex are being sustainably managed (50 CFR 600.310(d)(2)(ii)(B)).

By following these guidelines, NMFS believes that using one or more indicator stocks in a stock complex would not increase the risk of overfishing other stocks within the complex. In addition, when developing the guidelines, NMFS explained that in cases where the status of the stocks within a complex is generally unknown, the use of an indicator would likely reduce the probability that stocks within the complex experience overfishing. Thus, NMFS explained that use of stock complexes and indicator stocks in accordance with the NS guidelines can serve a useful role in managing data poor stocks and/or stocks that cannot be targeted independently of one another. Finally, the guidelines recommend the use of indicator stocks to reduce the likelihood of overfishing in cases of high scientific uncertainty among stocks within a complex, and also recommend that Councils use more conservative management measures in cases where

[17]Status determination criteria (SDC) mean the measurable and objective factors, MFMT, OFL, and MSST, or their proxies, that are used to determine if overfishing has occurred, or if the stock or stock complex is overfished (50 CFR 600.310(e)(2)(i)(A)); Appendix E.

it is not possible to use the most vulnerable stock within a complex as an indicator (81 FR 71858, 71866, Oct. 16, 2016).

**Alternative 4, Sub-alternative 4a** allows for the selection of one or more indicator stocks in those cases where stocks are being managed within a stock complex. **Alternative 4, Sub-alternative 4a** was selected as the preferred alternative for the Snapper 1, Snapper 2, Snapper 4, Grouper 3, Grouper 6, triggerfish, and dolphinfish stock complexes. The SSC identified seven criteria (defined below) to guide the selection of an indicator stock for each of these stock complexes. All or a subset of these seven criteria were used by the SSC in their process of selecting one or more indicators for each of the stock complexes to which **Alternative 4, Sub-alternative 4a** was applied. Under **Alternative 4, Sub-alternative 4a**, the ABC and ACL for the stock complex would be derived from the indicator species. The stocks in the stock complex would be subject to AMs as a group, based on the average landings of the indicator stock during the most recent three years of available landings data (see Chapter 10).

a) Percent Catch: Indicator stock represents a predominant component of the complex's catch;
b) Targeted: Indicator stock is specifically pursued by the fishery;
c) Life History/Vulnerability: Life history characteristics or the vulnerability of the indicator stock is representative of the complex or is more vulnerable than that of other members of the complex (where the vulnerabilities of the complex differed);
d) Habitat Co-occurrence: Indicator stock occurs in the same habitat as the others in the complex;
e) Catch Co-occurrence: Indicator stock co-occurs in the catch with other members of the complex;
f) Data: Amount of information on the indicator stock is sufficient for providing catch advice and establishing SDC;
g) Market: Indicator stock is considered to have equal market value relative to other species.

The SSC recommended one or more indicator stocks for each of these complexes based on the best available scientific information, input from the Puerto Rico DAP, and the expert opinion of the SSC members. Below is a summary of the indicator stock(s) chosen for each of the stock complexes for which the Council selected **Alternative 4, Sub-alternative 4a** as the preferred alternative.

For Snapper 1, silk snapper was recommended by the SSC as the indicator stock because it constitutes a high percentage of the Snapper 1 catch, it is the targeted stock in the complex, and it is one of the most important fishery species in Puerto Rico EEZ waters. Additionally, it co-occurs in the habitat and in the catch with other stocks in the complex (black, blackfin,

vermilion, and wenchman). Furthermore, because it is targeted, listed on the commercial reporting form, and frequently reported in the landings, it is a likely candidate for successful assessment. The PSA outcome revealed silk snapper to be equally productive (moderate/high) and equally susceptible to the fishery (low/moderate) as the other stocks in the complex and therefore possesses representative vulnerability.

The queen snapper was recommended by the SSC as an appropriate indicator for S2. That stock represents a substantial majority of the reported S2 catch, whereas the other member of the complex (cardinal snapper) is essentially bycatch in the queen snapper fishery. The PSA revealed equal productivity (high) and fishery susceptibility (low/moderate) for both stocks in this complex.

For the Snapper 4 group, composed of mutton snapper, dog snapper, and schoolmaster, mutton snapper was chosen as the indicator because it is the primary target of fishermen within this complex. Mutton snapper aggregates to spawn, increasing its susceptibility, and thus vulnerability to the fishery, although this susceptibility is managed with a closed harvest season from April 1 through June each year, and within an additional area closed to harvest during the month of March. These measures will be maintained in the Puerto Rico FMP. In addition, both dog snapper and schoolmaster are of low market value in Puerto Rico because of risk of ciguatera. Thus, neither species is generally targeted by fishermen, and this is especially true of the larger specimens. Only mutton snapper is on the catch report forms, and thus mutton snapper provides the best information upon which management measures can be based. As with both Snapper 1 and Snapper 2, the PSA revealed equal productivity (low/moderate) and fishery susceptibility (low/moderate) for all three stocks constituting the S4 complex.

Grouper 3 includes coney and graysby. The SSC recommended coney as the indicator. Coney best met the decision criteria based upon available information, including contributing the majority of the reported catch and being generally the larger of the two species. Additionally, the PSA outcomes revealed coney to be equally or more vulnerable to the fishery and therefore the more conservative of the two stocks with which to manage the complex.

Grouper 6 includes red hind and rock hind. Red hind was recommended by the SSC as the appropriate indicator stock for this complex because it dominates catches whereas rock hind contributes much less frequently. The PSA outcome supports the choice of red hind as the indicator stock, revealing both stocks to be equally (moderate/high) productive, but red hind was the more susceptible of the two stocks to the fishery (low/moderate for red hind versus low for rock hind). This outcome reflects the tendency of red hind to form spawning aggregations and the fact that fishermen are well aware of the locations of those aggregations. However, closures are in place to protect those spawning aggregations, instigated by the fishermen and based on

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their awareness of the timing and location of red hind spawning aggregations. These closures were considered when assessing the susceptibility of red hind to the fishery.

For the Triggerfish complex, queen triggerfish was chosen as the indicator species. Queen triggerfish is not a primary target species, but the SSC did note that when spearfishermen encounter a queen triggerfish they generally take it. This contrasts with the gray and ocean triggerfish, which the SSC distinguished as being of lower susceptibility. In addition, there is no market in Puerto Rico for ocean triggerfish. The SSC therefore concluded that the queen triggerfish is the most vulnerable of the three species included in this stock complex, a comment supported by the PSA outcomes. All three stocks ranked as being moderately productive, but whereas the ocean and gray triggerfish were scored as low with respect to fishery susceptibility the queen triggerfish was scored as low/moderate. In addition, queen trigger fish is the only triggerfish species that appears in the catch report forms. Thus, the best available information upon which to manage the complex comes from the queen triggerfish, making queen triggerfish an appropriate indicator.

For the Dorado complex, which is composed of dolphinfish and pompano dolphin, the SSC determined that dolphinfish met all seven criteria listed above, and strongly recommended this species as the indicator stock for this complex. Dolphinfish is one of the most commonly landed species by recreational fishermen, contributes substantial landings from the commercial fishery, is highly productive, and is wide-ranging. Both dolphinfish and pompano dolphin were assigned high productivity and low susceptibility scores in the PSA.

**Alternative 4, Sub-Alternative 4b** was selected as the preferred alternative for those stock complexes for which none of the seven criteria was useful to make a determination, landings information for any of the species in the complex did not allow for a clear definition of an indicator stock, or the composition of the complex was balanced and therefore required no indicator to be assigned. This includes the Grouper 4, Grouper 5, Parrotfish 1, Parrotfish 2, Surgeonfish, Wrasses 2, Angelfish, Tuna, and Mackerel complexes. For Grouper 4 and 5, no indicator species was selected because these groupers are more incidental catch than targeted catch, and thus there was no specifically targeted grouper that should serve as the indicator for the complex. For the two stock complexes of parrotfish (Parrotfish 1 and Parrotfish 2), no indicator species was recommended by the SSC or selected. An indicator species was not selected for Parrotfish 1 because these stocks are managed together with a harvest restriction. Harvest of each of these species is prohibited. For those stocks in Parrotfish 2 there is no species-specific data collected, thus none of the stocks in the complex could be consider a good indicator. Species-specific data is also not being currently collected for the Surgeonfish, Wrasses 2, and Angelfish stock complexes respectively; therefore no good indicator could be selected for these complexes. No indicator species recommendation was made for the mackerel stock complex (king mackerel and cero) because, neither would be a good proxy for the other.

**Sub-alternative 4b** would also be applied to those stock complexes for which harvest is set as zero in Action 4 and thus determined to be vulnerable to overfishing, including the Parrotfish 1, Sea Cucumbers, Sea Urchins, and Corals complexes.

**Comparison of Action 3 Alternatives and Summary of Effects**

**Alternative 1** would continue management of those stocks that were previously managed within the same stock complexes as under the existing FMPs. This Alternative reflects current management as closely as possible; however, species that will no longer be managed as a result of Action 2 would be removed from the complexes, and species that are new to management as a result of Action 2 would not be organized into complexes.

**Alternative 1** is not expected to have additional direct physical, biological/ecological, economic, or social effects as it is largely administrative and because, to the extent possible, it would not alter current management. However, **Alternative 1** would have indirect biological effects as it would not allow for those stocks/stock complexes to be updated in order to reflect the most current or best information available. Similarly, **Alternative 1** would not include the option to establish stock complexes for species new to management. These limitations could directly increase the administrative burden associated with managing stocks and stock complexes, especially if the current management measures result in frequent administrative actions, such as the application of AMs. Without reliable and consistent data, particularly for those newly added species that would not be assigned to a complex as appropriate, the reference points that are established and AMs that could follow may create closures and other problems that disrupt current fishing patterns. Each of these outcomes would likely result in negative indirect economic and social effects associated with lost harvest opportunity and resultant fishing community impacts.

Under **Alternative 2**, each stock would be managed individually regardless of the amount of data available for that stock, or whether there are similarities among two or more stocks in life history or fishing practices that would allow those stocks to be more effectively managed as a unit. When compared to **Alternative 1** and **Preferred Alternative 3**, **Alternative 2** would likely have the greatest direct and indirect effects on the physical, biological/ecological, economic, social, and administrative environments, and those effects would be expected to be negative in most respects. The least impactful direct and indirect effects would be on the physical environment, because impacts of fishing activities on the physical environment (i.e., the habitat, particularly that constituting the coral reef) would remain relatively constant regardless of the distribution (or not) of stocks among complexes.

Direct impact could be expected from **Alternative 2** via bycatch-related overharvest of a stock experiencing regulatory closure as the fishermen pursue those coincident stocks not governed by

the regulatory closure. Economically, managing at the level of individual stock is likely to result in more regulatory discards and lost financial benefit than that which would occur under **Alternative 1** or **Preferred Alternative 3**. Hence, benefits associated with **Alternative 2** are less than those of **Alternative 1 or Preferred Alternative 3**. Similarly with regard to social effects, any outcomes that result in more frequent application of management measures, particularly those that reduce access to a stock and particularly if that access is limited in an overly precautionary manner, would have indirect effects on the fishing communities reliant on those stocks. Administratively, tracking the performance of many individual stocks rather than fewer stock complexes requires considerably more administrative effort, likely would require more individual management actions, and would require a greater level of enforcement. Additionally, the resultant stock-specific management measures could potentially be insufficient and inefficient, resulting in more frequent and potentially overly precautionary future actions.

In contrast to **Alternative 2**, **Preferred Alternative 3** provides managers with the flexibility to choose to manage stocks individually or as a complex, depending on the information available and the goals of the management plan. **Preferred Alternative 3** would be expected to have beneficial effects resulting from allowing the species to be managed either as individual stocks or as stock complexes using the best available information. There may be some short-term administrative effects associated with creating new management measures for the new stocks/stock complexes. However, the long-term administrative effects of **Preferred Alternative 3** would be expected to be more beneficial than **Alternative 1** or **Alternative 2** because the flexibility of this alternative allows for the stocks/stock complexes to be best tailored for the Puerto Rico fisheries. **Preferred Alternative 3** ensures the process includes consideration of all managed stocks, in direct opposition to **Alternative 2**, that allows no grouping, and **Alternative 1**, which limits the number of stocks available for grouping. That tailoring should result in the establishment of more appropriate management measures, which would in turn result in fewer unnecessary ACLs exceeded or AMs applied. There is likely a better chance of setting ACLs that would provide adequate protection of the stock with **Preferred Alternative 3** than with **Alternative 2** which, through time, would provide greater indirect economic benefits. **Preferred Alternative 3** therefore provides the direct and indirect benefits to the physical, biological/ecological, economic, and social environment largely denied by **Alternative 2** and limited by **Alternative 1**.

**Alternative 4** would build upon the benefits of **Preferred Alternative 3,** as the stocks and stock complexes would remain the same as selected under **Preferred Alternative 3**, but an indicator species could be selected (**Preferred Sub-alternative 4a**) or not selected (**Preferred Sub-alternative 4b**) depending on the information available for the stocks in the stock complex.

All effects would be expected to be identical between **Preferred Alternative 3** and **Preferred Sub-alternative 4b**, because not choosing an indicator for all stock complexes results in the

same list as **Preferred Alternative 3**. In contrast, **Preferred Sub-alternative 4a** may result in a greater benefit to the physical, biological/ecological, economic, social, and administrative environments. Essentially, selecting an indicator species that is targeted by the fishery, best represents the vulnerability of the other species in the complex, or otherwise meets the criteria established above, would provide more conservative management for all the stocks in the complex, because management measures, including ACLs and AMs, would be tailored to the indicator. Conversely, if an appropriate indicator stock is available for the complex but is not assigned, the ACL would instead be based on the landings of all stocks in the complex, potentially allowing harvest to exceed a level that is not sustainable for some of the stocks within the complex, especially those that may be most vulnerable to fishing pressure. However, not all stock complexes have the necessary data or information available to establish an indicator species, or in other ways are inappropriate or not in need of indicator assignment. In instances where all the stocks in the complex are infrequently landed, or are landed at low levels, selecting an indicator species could result in an ACL that was so low that it was easily exceeded, thereby triggering AMs and prohibiting harvest of the other stocks in the complex, which may be able to withstand a higher rate of harvest. Using an established set of criteria, the Council's SSC determined, for each stock complex, whether or not an indicator species would provide additional benefits as discussed above, specifically to the biological/ecological and administrative (i.e., management) environments. Those benefits then extend to the physical environment by ensuring that species caught together are managed together and fishing activity would respond accordingly to minimize fishing impacts to the environment. Benefits also extend to the economic environment by increasing the likelihood that implementation of management measures is appropriate and necessary, to the social environment by reducing the likelihood of overly precautionary management interventions, and to the administrative environment by reducing the number of stocks for which landings must be monitored against the ACL and by reducing the frequency of management interventions particularly with respect to ACL overages.

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## 2.4 Action 4: Establish Status Determination Criteria and Management Reference Points

The Magnuson-Stevens Act requires each federal FMP to assess and specify the present and probable future condition of, and the maximum sustainable yield (MSY) and optimum yield (OY) from, the fishery, and include a summary of the information utilized in making such specification" (16 U.S.C. 1853(a)(3)). The MSY is the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological and environmental conditions and fishery technological characteristics (e.g., gear selectivity), and the distribution of catch among fleets (50 CFR 600.310(e)(1)(i)(A)). To guide effective management, the Magnuson-Stevens Act also requires FMPs to specify objective and measurable criteria for determining stock status (*i.e.*, status determination criteria (SDC)), specifically whether the stock is overfished or undergoing overfishing (16 U.S.C. 1853(a)(10)).

**Status determination Criteria and Management Reference Point**

**Maximum Sustainable Yield (MSY)** – The largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological, environmental conditions and fishing technology characteristics (e.g., gear characteristics) and the distribution of catch among fleets.

**Maximum Fishing Mortality Threshold (MFMT)** – The level of fishing mortality (F), on an annual basis, above which overfishing is occurring. The MFMT or reasonable proxy may be expressed either as a single number (a fishing mortality rate or F value), or as a function of spawning biomass or other measure of reproductive potential.

**Overfishing Limit (OFL)** – the annual amount of catch that corresponds to the estimate of MFMT applied to a stock or stock complex's abundance and is expressed in terms of numbers or weight of fish.

**Minimum Stock Size Threshold (MSST)** – The biomass level below which the capacity of the stock to produce MSY on a continuing basis has been jeopardized. A stock or stock complex is considered **overfished** when its biomass has declined below MSST.

The National Marine Fisheries Service (NMFS) guidelines regarding this statutory requirement describe those SDC to include: 1) the maximum fishing mortality threshold (MFMT) and associated overfishing limit (OFL) or their proxies, indicative of an annual harvest level that jeopardizes the capacity of the stock or stock complex to produce MSY on a continuing basis (i.e., overfishing), and; 2) the minimum stock size threshold (MSST), or its proxy, indicative of a level of biomass below which the capacity of the stock or stock complex to produce MSY on a continuing basis has been jeopardized (i.e., overfished) (50 CFR 600.310(e)(2)(i)(B)-(F)).

When data are not available to specify SDC based on MSY or MSY proxies, NMFS guidelines at 50 CFR 600.310(e)(2)(ii) also provide that alternative types of SDC that promote sustainability of the stock or stock complex can be used. If alternative types of SDC are used, a Fishery Management Council should explain how the approach would promote sustainability of the stock or stock complex on a long-term basis. Appendix F provides an overview of the National

Standard 1 Guidelines including a description of each of the SDC and management reference points in this action. Chapter 5 also provides more information about the resulting SDC and management reference points for stocks in the Puerto Rico FMP.

Action 4 describes alternative approaches for establishing SDC and management reference points. Four alternatives are included. As with Action 3, this action follows from selecting Alternative 2 in Action 1 and proceeding with establishment of a Puerto Rico FMP composed of those regulations and measures included in the Reef Fish, Spiny Lobster, Queen Conch and Coral FMPs that are pertinent to Puerto Rico. The reference points are developed for the stocks or stock complexes to be managed under the Puerto Rico FMP, as selected in Action 2 and 3. Where the complex would be managed with an indicator stock, reference points were developed for the indicator, as described below. **Alternatives 1** and **4**, and **Preferred Alternative 3**, provide different approaches to setting SDC and reference points. Both **Preferred Alternative 3** and **Alternative 4** include a stepwise process for setting the management reference points and/or SDC. **Preferred Alternative 2** considers whether reference points are developed based on available information from the commercial and recreational fishing sectors, and ACLs are specified by sector.

### 2.4.1 Proposed Alternatives for Action 4

**Alternative 1**. No action. In the Puerto Rico FMP, as created in Action 1, retain the management reference point values and SDC (MSY, OFL, ABC, OY, ACL) specified in the 2010 and 2011 Caribbean ACL Amendments, as applicable. Retain the definitions for the MFMT and MSST specified in the 2005 Sustainable Fisheries Act Amendment (CFMC 2005).

**Preferred Alternative 2**. Where data are available, use sector (i.e., commercial, recreational) information to establish reference points and SDC and set ACLs by sector. Reference points (MSY, ABC) and SDC would apply to the fishery, accounting for recreational and commercial information, but ACLs would apply at the sector level. Where separate sector landings data are not available for comparison to the sector ACL, there would not be separate sector ACLs. Instead, the ACLs for the sector with appropriate available landings data would be the applicable ACLs and would govern the application of AMs.

**Preferred Alternative 3**. Apply the three-step process described below to define MSY (or its proxy), SDC, ABC, and ACL for each stock or stock complex in the Puerto Rico FMP.

***Preferred Alternative 3 - Step 1:*** Adopt and apply the ABC CR described in Table 2.4.1.

**Table 2.4.1.** Caribbean Fishery Management Council Acceptable Biological Catch Control Rule from Action 4, Preferred Alternative 3.

| **Tier 1: Data Rich** | |
|---|---|
| **Condition for Use** | Full stage-structured stock assessment available with reliable time series on (1) catch, (2) stage composition, and (3) index of abundance. The assessment provides estimates of minimum stock size threshold (MSST), maximum fishing mortality threshold (MFMT), and the probability density function (PDF) of the overfishing limit (OFL). |
| **MSY** | MSY = long-term yield at $F_{MSY}$ (or, $MSY_{proxy}$ = long-term yield at $F_{MSY}$ proxy); assumes spawner-recruit relationship known. |
| **SDC** | MFMT = $F_{MSY}$ or proxy<br>MSST = 0.75*Spawning Stock Biomass $(SSB)_{MFMT}$<br>OFL = Catch at MFMT |
| **ABC** | ABC = OFL as reduced (buffered) by scientific uncertainty[1] and reflecting the acceptable probability of overfishing[2]. The buffer is applied to the PDF of OFL ($\sigma$), where the PDF is determined from the assessment (where $\sigma > \sigma_{min}$) [3].<br>ABC= *d* * OFL where *d* = { Scalar if $B \geq B_{MSY}$ ; Scalar * $(B-B_{critical}) / (B_{MSY}- B_{critical})$ if $B < B_{MSY}$ }<br>Scalar = 1 if acceptable probability of overfishing is specified (<0.5), < 1 if not specified (=0.5).<br>$B_{critical}$ is defined as the minimum level of depletion at which fishing would be allowed. |
| | [1]Scientific uncertainty would take into account, but not be limited to, the species life history and ecological function.<br>[2]Acceptable probability of overfishing determined by Council.<br>[3] $\sigma_{min}$ could be equal to coefficient of variation; $\sigma_{min}$ is in a log scale. |
| **Tier 2: Data Moderate** | |
| **Condition for Use, MSY, SDC** | Data-moderate approaches where two of the three time series (catch, stage composition, and index of abundance) are deemed informative by the assessment process, and the assessment can provide MSST, MFMT, and PDF of OFL. |
| **ABC** | Same as Tier 1, but variation of the PDF of OFL ($\sigma$) must be greater than 1.5 $\sigma_{min}$ (in principle there should be more uncertainty with data-moderate approaches than data-rich approaches). |
| **Tier 3: Data Limited: Accepted Assessment Available** | |
| **Condition for Use** | Relatively data-limited or out-of-date assessments |
| **MSY** | $MSY_{proxy}$ = long-term yield at proxy for $F_{MSY}$ |
| **SDC** | MFMT = $F_{MSY}$ proxy<br>MSST = 0.75* $SSB_{MFMT}$<br>OFL = Catch at MFMT |
| **ABC** | ABC determined from OFL as reduced (buffered) by scientific uncertainty[4] and reflecting the acceptable probability of overfishing[2]<br>a. Where the buffer is applied to the PDF of OFL when the PDF is determined from the assessment (with $\sigma \geq 2\sigma_{min}$)<br>**OR**<br>b. Where ABC = buffer * OFL, where buffer must be $\leq$ 0.9 |

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| | |
|---|---|
| | [4]Scientific uncertainty would take into account, but not be limited to, the species life history and ecological function, the perceived level of depletion, and vulnerability of the stock to collapse.<br>[2]Acceptable probability of overfishing determined by Council. |
| **Tier 4: Data Limited: No Accepted Assessment Available** | |
| **MSY** | $MSY_{proxy}$ = long-term yield at proxy for $F_{MSY}$[5]. |
| **SDC** | MFMT = $F_{MSY}$ proxy<br>MSST = 0.75* $SSB_{MFMT}$<br>OFL = unknown[6] |
| **Tier 4a** | No accepted[7] assessment, but the stock has relatively low vulnerability to fishing pressure. A stock's vulnerability to fishing pressure is a combination of its productivity and its susceptibility to the fishery. Productivity refers to the capacity of the stock to produce MSY and to recover if the population is depleted. Susceptibility is the potential for the stock to be impacted by the fishery. If SSC consensus[8] cannot be reached on the use of Tier 4a, Tier 4b should be used. |
| **Conditions for Use** | |
| **SYL** | The SYL is the maximum level of landings that can be sustained over the long term give. Used when information is not available to determine the MSY or corresponding reference points.<br>SYL = Scalar * ***75th percentile*** of reference period landings, where the reference period of landings is chosen by the Council, as recommended by the SSC in consultation with the SEFSC.<br>Scalar ≤3 depending on perceived degree of exploitation, life history and ecological function. |
| **ABC** | ABC = buffer * SYL, where buffer must be ≤ 0.9 (e.g., 0.9, 0.8, 0.75, 0.70…) based on the SSC's determination of scientific uncertainty.[7] |
| **Tier 4b** | No accepted[7] assessment, but the stock has relatively high vulnerability to fishing pressure (see definition in Tier 4a Condition for Use), or SSC consensus[7] cannot be reached on the use of Tier 4a. The ABC for a Tier 4b stock cannot exceed the mean landings during the reference period. |
| **Conditions for Use** | |
| **SYL** | SYL = Scalar * ***mean*** of the reference period landings, where the reference period of landings is chosen by the Council, as recommended by the SSC in consultation with the SEFSC[9].<br>Scalar < 2 depending on perceived degree of exploitation, life history, and ecological function. |
| **ABC** | ABC = buffer * SYL, where buffer must be ≤ 0.9 (e.g., 0.9, 0.8, 0.75, 0.70…) based on the SSC's determination of scientific uncertainty[10]. |
| | [5] MSY ≥ SYL.<br>[6] SYL is a proxy for OFL.<br>[7] Accepted means that the assessment was approved by the SSC as being appropriate for management purposes.<br>[8]The SSC defines consensus as having 2/3 of the participating members in favor of a Tier 4a assignment, otherwise the assignment would be Tier 4b of the ABC CR.<br>[9] See Appendix H for an explanation of how the SYL is calculated.<br>[10]Scientific uncertainty would take into account, but not be limited to, deficiencies in landings data, availability of ancillary data, species life history, and ecological function, perceived level of depletion, and vulnerability of the stock to collapse. |

* Note: Tiers 1-3 of the ABC CR would produce stock specific MSY, MFMT, MSST, OFL, and ABC, Only the ACL, ACT, and OY (as defined in this document) would be sector-specific.

***Preferred Alternative 3 - <u>Step 2:</u>*** Establish the proxy that would be used when $F_{MSY}$ cannot be determined:

**Sub-alternative 3a**. The proxy for $F_{MSY} = F_{max}$

**Sub-alternative 3b**. The proxy for $F_{MSY} = F_{40\%SPR}$

**Preferred Sub-alternative 3c**. The proxy for $F_{MSY} = F_{30\%SPR}$

***Preferred Alternative 3 - Step 3. OY and ACL:*** Determine the OY and the ACL based on the formula in one of the sub-alternatives below and the ABC established in **Preferred Alternative 3, Step 1** above.

**Sub-alternative 3d**. OY = ACL = ABC

**Sub-alternative 3e (Preferred for all except angelfish, parrotfish, surgeonfish)**. OY = ACL = ABC x 0.95

**Sub-alternative 3f**. OY = ACL = ABC x 0.90

**Sub-alternative 3g (Preferred for angelfish, parrotfish, surgeonfish)**. OY = ACL = ABC x 0.85

**Sub-alternative 3h**. OY = ACL = ABC x 0.75

**Sub-alternative 3i**. OY = ACL = 0

**Alternative 4.** Apply the four-step process used in the 2010 Caribbean ACL Amendment and/or the 2011 Caribbean ACL Amendment, as applicable, to set management reference points and/or SDC for a stock or stock complex in the Puerto Rico FMP as described in the sub-alternatives below. Choose a sub-alternative from each step, in order (1-4), for each stock or stock complex.

***Alternative 4 - Step 1*. Time Series:** select a time series of landings data to establish management reference points for a stock or stock complex, as applicable. A different sub-alternative can be chosen for each stock or stock complex and/or for each fishing sector.

**Sub-alternative 4a.** Use the longest year sequence of reliable[18] landings data available to set management reference points, as applicable.

**Sub-alternative 4b.** Use the longest time series of pre-Caribbean Sustainable Fisheries Act (SFA) Amendment (CFMC 2005) landings data that is considered to be consistently reliable[19] to set management reference points.

**Sub-alternative 4c.** Use 2012-2016 as the most recent five years of available landings data to set management reference points.

**Sub-alternative 4d.** Use another year sequence, as recommended by the Council's SSC, to set management reference points.

***Alternative 4 - Step 2*. $\mathbf{MSY_{proxy}}$:** establish the $MSY_{proxy}$ as described by any of the sub-alternatives below. A different sub-alternative can be chosen for each stock or stock complex

[18] Defined in both the 2010 and 2011 Caribbean ACL Amendments as: more recent time-series landings data that are more reliable than baseline but that are affected by recent regulatory changes.
[19] Defined in both the 2010 and 2011 Caribbean ACL Amendments as: reflects landings prior to implementation of the Caribbean SFA Amendment in 2005, thereby approximating sustainable yield.

and/or for each fishing sector. The OFL would be set equal to the $MSY_{proxy}$ resulting from this alternative ($MSY_{proxy}$ = OFL).

**Sub-alternative 4e.** Median annual landings from the year sequence selected in Alternative 4, Step 1.

**Sub-alternative 4f.** Mean annual landings from the year sequence selected in Alternative 4, Step 1.

**Sub-alternative 4g.** For the recreational sector, use the maximum of a single year of recreational landings x 3 during the year sequence selected in Alternative 4, Step 1.

***Alternative 4 - Step 3*. Acceptable Biological Catch:** establish the ABC as described by any of the sub-alternatives below and the OFL established in Alternative 4, Step 2. A different sub-alternative may be chosen for each stock or stock complex and/or for each fishing sector.

**Sub-alternative 4h.** Do not specify an ABC Control Rule. Adopt the ABC recommended by the Council's SSC. The SSC would develop the ABC on an ad hoc basis for each stock or stock complex. A different sub-alternative may be chosen for each stock or stock complex and/or for each fishing sector.

**Sub-alternative 4i.** Adopt an ABC Control Rule where ABC = OFL.

**Sub-alternative 4j.** Adopt an ABC Control Rule where ABC = OFL x 0.90.

**Sub-alternative 4k.** Adopt an ABC Control Rule where ABC = OFL x 0.85.

**Sub-alternative 4l.** Adopt an ABC Control Rule where ABC = OFL x 0.75.

***Alternative 4 - Step 4*. Annual Catch Limit and Optimum Yield:** Determine the ACL based on the formula in one of the sub-alternatives below and the ABC established in Alternative 4, Step 3. The OY would be set equal to the ACL resulting from this alternative (OY = ACL). A different sub-alternative may be chosen for each stock or stock complex and/or for each fishing sector.

**Sub-alternative 4m.** OY = ACL = ABC

**Sub-alternative 4n.** OY = ACL = ABC x 0.95

**Sub-alternative 4o.** OY = ACL = ABC x 0.90

**Sub-alternative 4p.** OY = ACL = ABC x 0.85

**Sub-alternative 4q.** OY = ACL = ABC x 0.75

**Sub-alternative 4r.** OY = ACL = 0

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### 2.4.2 Discussion of Action 4 Alternatives

**Alternative 1** is the no action alternative. Established values of the SDC and reference points, including the $MSY_{proxy}$, OFL, ABC, and ACL, would be retained from the 2010 Caribbean ACL Amendment (CFMC 2011a) and the 2011 Caribbean ACL Amendment (CFMC 2011b). The procedures used to derive the values provided in those amendments are incorporated by reference and summarized in Appendix G. **Alternative 1** would also retain the definitions for MFMT and MSST that were specified in the 2005 Caribbean SFA Amendment (CFMC 2005).

Reference points established in the 2010 and 2011 Caribbean ACL Amendments should be updated to be consistent with the composition (Action 2) and organization (Action 3) of managed stocks as proposed in Action 2. That update would also allow the inclusion of more up-to-date landings data which better reflects recent fishing effort and landings. Improvements in commercial and recreational landings data resulting from monitoring program upgrades in the region would not be incorporated into the reference points brought over under **Alternative 1**. Following closely from the preceding point, new analytical methods for establishing reference points and SDC for data-limited stocks have become available since implementation of the 2010 and 2011 Caribbean ACL Amendments (Carruthers et al. 2014). Those new methods would not be applied if the process described in **Alternative 1** was chosen for implementation.

As described in Action 2 of this document, a primary reason for revising federal fisheries management in the Puerto Rico EEZ would be to shift the management focus away from stocks occurring primarily in waters under Commonwealth jurisdiction toward stocks occurring in and harvested from Puerto Rico EEZ waters under federal jurisdiction. As a result of this shift, many stocks would no longer qualify as federally managed stocks. Moreover, no reference points would be established for those stocks that would be added to federal management through Preferred Alternative 2 of Action 2, as required by the Magnuson-Stevens Act.

Compared to the preferred alternative, the approach taken in **Alternative 1** is less consistent with NMFS' revised NS1 guidance on developing reference points in the data-limited context, and the opinion on the best scientific approach recommended by scientific experts. The NS1 guidelines provide flexibility when data are not available to specify SDCs based on MSY or MSY proxies. In those cases, the guidelines provide that the plan can specify alternative types of SDC that promote the sustainability of the stock or stock complex, as long as the SDC allow for an evaluation of stock status and as long as the plan contains other required elements, such as MSY, ACLs, and AMs, and identifies overfishing and overfished thresholds. The Southeast Fisheries Science Center (SEFSC) guidance to the Council is that, because the Council does not have successful outputs from a quantitative assessment model, quantitative values for either MSY or OFL should not be set for stocks or stock complexes in the Puerto Rico EEZ. Instead, the SEFSC recommends relying on proxies for MSY and OFL based on qualitative estimates of

fishing mortality rates and biomass expected when achieving MSY, and on a newly-developed metric called the sustainable yield level (SYL). Application of **Alternative 1** establishes an $MSY_{proxy}$ for all managed species and equates OFL to that $MSY_{proxy}$. Such outcomes do not reflect current thinking on the ways to set reference points in the data limited context in the Puerto Rico EEZ.

**Preferred Alternative 2** would allow the Council to separately manage the commercial and recreational fishing sectors operating in Puerto Rico EEZ waters. Establishing sector-specific ACLs, based on reference points applicable to the fishery, responds to concerns expressed by representatives from both sectors that setting a single suite of reference points is unfair and economically untenable because either sector is then subject to the performance of the other sector. This defeats the incentive for either sector to manage their harvest sustainably and reduces the ability of fishermen to monitor and manage their fishing activities accordingly. However, in those situations when landings data from both sectors are not available, reference points cannot account for separate sector landings, and ACLs would be set for the stock or stock complex as a whole based on available landings. Management decisions would be based on a comparison of landings data against that ACL. This would occur, for example, in the case of managed invertebrate species not included in the Marine Recreational Information Program (MRIP) sampling program (i.e., spiny lobster, queen conch) or in the case of an interruption in availability of landings data, and would continue for the duration of the data interruption. In the case of conch and spiny lobster, the only available landings information comes from the commercial sector and reference points are set at the stock level for conch and spiny lobster based on those commercial landings. Available landings from the reference sector are then compared to that ACL, but the AM operates on both sectors.

In Puerto Rico, the MRIP has been underway in various formats since 2000. That program obtains estimates of recreational harvest of finfish species from statistically based telephone surveys and face-to-face intercepts of recreational fishermen. Invertebrate species such as queen conch and spiny lobster are not included in the program. Based on the availability of landings estimates provided by the recreational sampling program, coupled with historic and ongoing data derived from the Puerto Rico commercial landings data collection program, the Council in their 2010 and 2011 Caribbean ACL Amendments established separate ACLs and AMs for the finfish components of the commercial and recreational sectors. In 2017, the Council revised their sector management approach to require that an AM be applied only in the event that the total (combined commercial and recreational) ACL was exceeded (CFMC 2017).

**Preferred Alternative 3** reflects the work of the Council's ABC CR Working Group, which in coordination with the Council's SSC, developed the ABC CR described in Step 1. The ABC CR in Step 1 of **Preferred Alternative 3** contains four tiers to be used by the SSC in specifying ABC recommendations and other management reference points for stocks managed by the

Council in the Puerto Rico FMP. Depending on the tier: MSY = long-term yield at $F_{MSY}$ (or, $MSY_{proxy}$ = long-term yield at $F_{MSYproxy}$); MFMT = $F_{MSY}$ (or $F_{MSYproxy}$); OFL = catch at MFMT; and MSST = 0.75*Spawning Stock Biomass (SSB) at $F_{MSY\ (or\ MSYproxy)}$ or proxy ($SSB_{MSY}$ or proxy). The choice of which of the four tiers to apply, and the degree to which MSY (or its proxy) and SDC can be quantitatively established, depend on the type and validity of assessment data available. Beginning with Tier 4 and moving up the tier levels, successful application of each tier requires an increasing amount of information. However, even the data rich and data moderate Tiers 1 and 2 may rely on MSY proxies in those cases when spawner-recruit relationships cannot be well-estimated. Data limitations (discussed in Appendix M) require the use of MSY proxies in Tiers 3 and 4. In Tier 4, the most data-limited of the options, an MSY proxy, MFMT, and MSST are defined with respect to assumptions about fishing mortality rate and biomass, but cannot be quantified due to data limitations. In addition, Tier 4 introduces the SYL. The SYL (discussed in Appendix H) is the maximum level of landings that can be sustained over the long term. It is intended to be used when the information or resources needed to produce a quantitative stock assessment are not available to determine the MSY or corresponding reference point such as the OFL. As such, the SYL may be determined on the basis of historic landings patterns, Productivity Susceptibility Analyses, or other available information including expert opinion. Because OFL and MSY cannot be quantified in Tier 4, the SYL would be used as a proxy for OFL and MSY would be greater than or equal to the SYL.

The SYL is an equilibrium (long-term) concept. This is in contrast to OFL, which is a non-equilibrium (short-term) quantity defined as the annual amount of catch that corresponds to the estimate of the MFMT applied to a stock's abundance. The value of OFL thus increases or decreases in accordance with the abundance of the stock, and MSY is the long-term average of such catches. OFLs are set accounting for this variation and are intended to represent the annual metric that corresponds to MSY. The SYL, as a long-term average, can be considered to be a minimum estimate of MSY, and it is intended to ensure a stock is maintained at a sustainable level until the stock's status relative to formal stock assessment-based MSY-related reference points can be determined. Thus, SYL would be used to understand the sustainability of the fishery. While landings in excess of SYL would not establish that overfishing is occurring, they would indicate that catch could be above a sustainable level and would need to be investigated to determine whether overfishing is occurring, and whether, as a result of continued SYL exceedances, the stock or stock complex would become overfished.

Tier 4 of the ABC CR would enable the Council to comply with the Magnuson-Stevens Act requirement "to assess and specify…the maximum sustainable yield and optimum yields from the fishery" (16 U.S.C. 1853(a)(3)), and to specify SDC, when data are not available to apply either Tier 1, 2, or 3.

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The process and rationale for applying Tier 4 of the ABC CR are described in Appendix H.

**Preferred Alternative 3** would define a *three-step process* to establish SDC and allowable harvest levels (i.e., ACLs) for managed stocks caught in the Puerto Rico EEZ. In *Step 1*, the Council's ABC CR, composed of four tiers designed to respond to different levels of data availability, results in reference point estimates culminating in an ABC for each managed stock. *Step 2* establishes a proxy to use when $F_{MSY}$ cannot be determined under the tiers to specify MSY and MFMT. *Step 3* then applies a reduction factor, which reflects the Council's estimate of management uncertainty and is specific to each stock or stock complex, to the resultant ABC to establish the ACL for that stock or stock complex.

*Preferred Alternative 3, Step 1*:

Step 1 would require application of the Council's four-tier ABC CR. As mentioned above, for stocks/stock complexes with valid assessments, CR Tiers 1, 2, or 3 would be applied, depending on the extent of data used in the assessment and the fishing mortality level (F) at MSY or its spawning potential ratio (SPR)-based proxy chosen by the Council. In contrast, Tier 4 would be applied when inadequate data are available with which to assess stock status. Within Tier 4, a SYL would first be defined based on the product of the 75$^{th}$ percentile (Tier 4a) or mean (Tier 4b) of the landings during a reference period and an adjustment scalar (See Appendix H). That SYL is then reduced to the ABC using a buffer that reflects the SSC's determination of scientific uncertainty associated with the data used to calculate SYL.

Tiers 1-3 of the ABC CR each require inputs from a quantitative assessment of stock status. Tier 1 is applicable in a data-rich environment that supports a full stage-structured stock assessment dependent on the availability of reliable time series of catch, stage composition, and index of abundance. Inputs to the ABC CR, from the stage-structured assessment, include MSST, MFMT, and the PDF of the OFL. Both OFL and ABC are derived by applying assessment outcomes within the ABC CR process, tempered by consideration of scientific uncertainty and a Council-defined risk of overfishing. Tier 1 outcomes are characterized by a minimal level of parameter uncertainty relative to the following tiers. Tier 2 is applicable in a data-moderate environment where two of the three time series described above are deemed informative. The approach and outcomes are the same as for the Tier 1 approach, but a higher level of parameter uncertainty is associated with those outcomes. Tier 3 is applicable in a data-limited environment that remains supportive of a quantitative assessment, but may also be applicable in the case of an out-of-date assessment. The data-limited assessment is expected to provide MFMT but it is likely MSST would be unknown. The OFL remains a quantitative output, but the ABC is more strongly constrained by application of conservative estimates of scientific uncertainty and risk of overfishing as determined by the Council. Tier 3 of the ABC CR results in a higher level of

parameter uncertainty relative to Tiers 1 and 2. Note that for each of Tiers 1-3, MSY also may be quantified from the assessment, assuming the spawner-recruit relationship is well estimated, but is not a necessary requirement of the ABC CR process to produce OFL and ABC estimates.

Tier 4 is applicable in situations where an accepted quantitative assessment is not available, which is the present case for all stocks proposed for management in the Puerto Rico FMP. Defining reference points within this tier instead relies on landings data, ancillary information on the species in question such as life history traits and characteristics of the fishery, and expert opinion. Two sub-tiers are defined within Tier 4. Tier 4a is applicable when the Council's SSC determines the stock has a relatively low or moderate vulnerability to fishing pressure. A stock's vulnerability to fishing pressure reflects a combination of its biological productivity and its susceptibility to the fishery (Patrick et al. 2009); 50 CFR 600.310(b)(4). Tier 4b is applied when the Council's SSC determines the stock has relatively high vulnerability to fishing pressure or when SSC consensus (= 2/3 or more members concur) cannot be reached on the use of Tier 4a. Additional information about the process to apply Tier 4 can be found in Appendix H.

*Preferred Alternative 3, Step 2*:

In the ABC CR specified in Step 1 of **Preferred Alternative 3**, MSY is equal to the yield at $F_{MSY}$. However, each tier of the ABC CR indicates that a $F_{MSY}$ proxy can be used in situations where $F_{MSY}$ cannot be estimated. The Magnuson-Stevens Act allows for the use of proxies in situations where MSY-related parameters cannot be estimated from available data, or when estimated values are determined to be unreliable. **Preferred Alternative 3**, Step 2 specifies a proxy to use when $F_{MSY}$ cannot be determined.

Step 2 provides three sub-alternatives for setting an $F_{MSY}$ proxy based on various fishing mortality rates. The $F_{MSY}$ proxies identified in **Sub-alternative**s **3a-c**, which are commonly used in fisheries management, can be easily calculated because relatively few data are required. The $F_{MSY}$ proxy specified in **Sub-alternative 3a** ($F_{MAX}$) is derived from yield-per-recruit (YPR) analyses. $F_{MAX}$ is the fully-recruited fishing mortality rate, which produces the maximum YPR; whereas, $F_{MSY}$ is the fishing mortality that maximizes the sustainable yield. $F_{MAX}$ is one of the earliest measures used as a proxy for $F_{MSY}$. $F_{MAX}$ is always greater than or equal to $F_{MSY}$; however, because it does not account for the fact that recruitment must decline at low spawning stock sizes, it is often believed to be an overestimate of $F_{MSY}$ (Gabriel and Mace 1999).

The $F_{MSY}$ proxies identified in **Sub-alternatives 3b** and **3c (Preferred)** are calculated from spawning-stock-biomass-per-recruit (SPR) analyses. Under conditions of no fishing mortality, 100% of a stock's spawning potential is obtained. A fishing mortality rate denoted by $F_{40\%SPR}$ (**Sub-alternative 3b**) or $F_{30\%SPR}$ (**Preferred Sub-alternative 3c**) would allow stock to attain 40% or 30%, respectively, of the maximum spawning potential, which would have been obtained

under conditions of no fishing mortality. Thus, as fishing mortality rates increase, spawning stock biomass per recruit decrease as more spawning opportunities are lost over the lifetime of the cohort.

$F_{30\%SPR}$ is the most commonly used $F_{MSY}$ proxy for data poor snapper-grouper species managed by the South Atlantic Fishery Management Council (South Atlantic Council; SAFMC 1998). In addition, the $F_{30\%SPR}$ was selected by the South Atlantic Council as the $F_{MSY}$ proxy for South Atlantic red snapper (SAFMC 2010). Gabriel and Mace (1999) recommend that fishing mortality rates in the range $F_{30\%SPR}$ to $F_{40\%SPR}$ be used as general default proxies for $F_{MSY}$ where $F_{30\%SPR}$ used for stocks believed to have relatively high resilience to overfishing and $F_{40\%SPR}$ for stocks believed to have low to moderate resilience to overfishing.

*Preferred Alternative 3, Step 3*:

Fisheries in the EEZ around Puerto Rico will be managed by the Council and NMFS based on ACLs and AMs. The ACL can equal the SSC's ABC recommendation, but in the U.S. Caribbean region the ACL (previously specified in the species-specific plans) has generally been reduced from the ABC to account for management uncertainty. Management uncertainty refers to uncertainty in the ability of managers to constrain catch so the ACL is not exceeded, and the uncertainty in quantifying the true catch amounts (i.e., estimation errors). The sources of management uncertainty could include: late catch reporting; misreporting; underreporting of catches; lack of sufficient in-season management, including in-season closure authority; or other factors.

In Step 3 of **Preferred alternative 3**, the Council is considering six alternative reduction buffers to account for management uncertainty in the transition from ABC to ACL, ranging from no buffer reduction (**Sub-alternative 3d**), through reduction multipliers of 0.95 (**Preferred Sub-alternative 3e**), 0.90 (**Sub-alternative 3f**), 0.85 (**Preferred Sub-alternative 3g**), 0.75 (**Sub-alternative 3h**), and a 0.00 multiplier resulting in an ACL = 0 (**Sub-alternative 3i**). The Council may choose a different sub-alternative for each stock, stock complex, and/or fishing sector (see Appendix H), reflecting their understanding of the effectiveness and response time of management measures. Similar to the 2010 and 2011 Caribbean ACL Amendments, OY would be set equal to the ACL.

**Sub-alternative 3d** would specify an ACL equal to the ABC. This sub-alternative assumes no management uncertainty.

**Preferred Sub-alternative 3e**, the Council's preferred sub-alternative for all managed stocks except angelfish, parrotfish and surgeonfish, would specify an ACL equal to the ABC x 0.95. This sub-alternative assumes a thorough, but not complete, understanding of the factors

influencing management decisions and the ability to apply those decisions in a timely and effective manner.

**Sub-alternative 3f** would specify an ACL equal to the ABC x 0.90. This level of reduction to account for management uncertainty was previously used by the Council when establishing an ACL for those stocks identified as not undergoing overfishing in the 2011 Caribbean ACL Amendment.

**Preferred Sub-alternative 3g**, the Council's preferred sub-alternative for angelfish, parrotfish and surgeonfish, would specify an ACL equal to the ABC x 0.85. This level of reduction to account for management uncertainty was previously used by the Council when establishing an ACL for those stocks identified as undergoing overfishing in the 2010 Caribbean ACL Amendment.

**Sub-alternative 3h** would specify an ACL equal to the ABC x 0.75. This level of reduction to account for management uncertainty was previously used by the Council when establishing an ACL for those stocks identified as being of ecological importance to the coral reef ecosystem in both the 2010 and 2011 Caribbean ACL Amendments.

**Sub-alternative 3i** would specify an ACL equal to the ABC x 0. This level of reduction to account for management uncertainty would be applied when the ability to manage the stock is minimal, or for those stocks for which any level of management is inadequate to ensure the continued stability and resilience of the coral reef ecosystem upon which the federally managed species considered in the Puerto Rico FMP depend.

**Alternative 4** uses the stepwise process for establishing references points in the 2010 and 2011 Caribbean ACL Amendments, but allows for the selection of sub-alternative combinations that may result in SDC and reference point outcomes that differ from those presently in place for federally managed stocks. This contrasts with the outcomes from **Alternative 1**, which result in the direct transfer of SDC and/or reference points established in the 2010 and 2011 Caribbean ACL Amendments and presently in place.

Step 1 of **Alternative 4** would identify a year sequence of commercial or recreational landings to be used as the baseline for establishing SDC and reference points. The chosen year sequence should represent a period of stable and sustainable landings, as defined and discussed in the 2010 and 2011 Caribbean ACL Amendments. The year sequence chosen for each of the commercial and recreational sectors pursuing a particular stock could differ. Similarly, the year sequence chosen for each of the various stocks identified as in need of conservation and management in Action 2 and then classified into complexes (including identification of indicator stocks) in Action 3 may differ. Even if the Council chose in Action 4 **Alternative 2** to not establish

separate reference points for each of the recreational and commercial sectors, landings from both sectors must still be accounted for when setting SDC and management reference points. Step 1 of **Alternative 4** includes four sub-alternatives, and each is described in turn below.

**Sub-alternative 4a** would use the longest year sequence of reliable landings data available to set management reference points, as applicable. As described in the 2011 Caribbean ACL Amendment (See Appendix G), the Council determined that landings for Puerto Rico's commercial fishing sector were not reliable prior to 1988 because reporting characteristics and data acquisition methodologies were not clearly understood or established prior to that year. Although issues regarding lack of reporting, under-reporting, and mis-reporting are inherent to landings data in Puerto Rico, a process has been established for determining an adjustment factor to account for these deficiencies. The adjustment factor is determined by staff at the PR-DNER Fisheries Research Laboratory, based on intercept sampling of commercial fishermen as they return from a fishing trip. The intercept-based catch estimate is then compared to the fisher's self-reported data along with the number of licensed fishermen actually reporting their landings, and a ratio of actual to reported catch determined. This ratio, averaged over all fishermen for all fishing days throughout the year, is then applied to the year-end reported catch for each stock or stock complex to provide an adjusted commercial catch level. Between 1988 and 2002, a single adjustment factor was determined for the entire island of Puerto Rico. Since 2003, separate adjustment factors have been determined for each of the North, West, South, and East coasts of the island. In any case, those adjusted commercial landings data are then used in the fishery management process.

Although the Council has determined that 1988 is the earliest year for which reliable commercial fishery landings are available, commercial landings data are not available as far back as 1988 for some stocks or stock complexes. This may result, for example, from the lack of inclusion of a stock, or of some or all members of a stock complex, on the commercial landings reporting form until a later date. In that case, the start year of reported landings would equate to the first full fishing year (i.e., January – December) for which the stock(s) was (were) included on the commercial landings reporting form. Because the data collection process, and the calculation of an adjustment factor, was considered to be reliable for all years post-1988, those commercial landings data would be considered to be reliable and therefore used when calculating an MSY proxy according to the procedures of **Alternative 4**, Step 2.

Reliable recreational landings data first became available in Puerto Rico beginning in 2000, when the MRFSS was fully implemented on the island. The MRFSS approach involves interviewing recreational fishermen as they return to the dock to obtain information on their catch and effort during that fishing trip. Because all fishermen cannot be interviewed as they return from every trip, a second component of the MRFSS approach is a telephone-based survey of the island's population to determine what percentage of the population fishes recreationally

and how frequently they do so. By then multiplying the intercept catch-per-trip estimates by the survey estimates of total effort, and estimate of total recreational catch for each stock can be derived. That product then comprises the estimate of recreational landings by year for each stock. The MRFSS program is now referred to as MRIP, although in Puerto Rico there is no substantive difference in the approach used.

For all stocks and for both the commercial and recreational sector, the end year for the longest period of reliable catch data is 2016, the most recent year for which a complete compilation of landings data is available.

**Sub-alternative 4b** would use the longest time series of pre-Caribbean SFA Amendment landings data that is considered to be consistently reliable to set management reference points. The Caribbean SFA Amendment, implemented in 2005 (CFMC 2005), instituted a variety of new management measures for federal waters in the U.S. Caribbean region. The specific details regarding those management measures are incorporated here by reference, the salient point for the purpose of **Sub-alternative 4b** is that the year 2005 represents a shift in federal fishery management in the region. This proposed sub-alternative calls for only using commercial landings data reported during 1988-2005, and recreational landings data reported during 2000-2005, for determining reference points. It is noted, however, that throughout the history of fishing activity in Puerto Rico waters, many factors have influenced fisher behavior and fishing success, including various changes to the regulatory regime along with other influences such as hurricanes and shifting markets. Thus, while implementation of the 2005 Caribbean SFA Amendment was a noteworthy event, other events are equally or perhaps even more influential to fishermen and the fish populations upon which they depend. Within that context, the value of choosing 2005 as a demarcation is not clear.

**Sub-alternative 4c** would use the most recent five years (2012-2016) of available landings data to set SDC and management reference points for a stock. This sub-alternative has value because it reflects the most recent commercial and recreational fishing activity in Puerto Rico. However, the most recent period of Puerto Rico commercial and recreational fishing activity may not represent a period of stable landings and almost certainly does not represent a period suitable for representing the MSY proxy. At least two reasons explain this under-representation of the MSY proxy. First, Puerto Rico shared in the global economic downturn that began around 2008, reducing market opportunities for the fishermen that resulted in reduced fishing activity. Second, and more specifically with regard to this sub-alternative, both the 2011 and 2012 Caribbean ACL Amendments were implemented beginning in January 2012, and these revisions to the Puerto Rico federal fishery management regime placed upper limits on the allowable catch of each federally managed stock. By definition, those caps reduced harvest below the MSY proxy. That outcome is legitimate and appropriate, but not necessarily for determining an MSY proxy. If such an approach is taken, the long-term outcome would be a constantly declining

allowable catch level, as each new iteration of reference points would result in the new MSY proxy being brought down to the existing allowable catch level, and the new allowable catch level being equal to or below that revised MSY proxy. Because uncertainty is inherent in fisheries management, the latter would be the most common outcome.

**Sub-alternative 4d** would use another (presently undefined) year sequence, based on a recommendation of the Council's SSC, to set management reference points for a stock. The implications of this sub-alternative cannot be fully analyzed until the SSC identifies the year sequence to be used. It is likely, however, that the chosen year sequence would fall between 1988 and 2016. The SSC has already determined that landings data acquired prior to 1988 are not reliable, so it is unlikely the SSC would choose any years prior to 1988 for use in reference point determinations. At the other end of the landings data spectrum, even if Puerto Rico landings data more recent than 2016 became available, those landings data would be unrepresentative and substantially lower than a typical year due to the impacts of Hurricanes Irma and Maria on the island in 2017, its inhabitants, and the markets that support fishing activity.

Step 2 of **Alternative 4** would establish an $MSY_{proxy}$ for a stock as described by any of the sub-alternatives described below. A different sub-alternative could be chosen for each stock and/or for each fishing sector. Following the procedures described in the 2010 and 2011 Caribbean ACL Amendments, the OFL would then be set equal to the $MSY_{proxy}$ resulting from the chosen sub-alternative.

**Sub-alternative 4e** would establish an $MSY_{proxy}$ based on median annual landings derived from the year sequence selected in **Alternative 4** Step 1. When establishing SDC for some stocks in the 2012 Caribbean ACL Amendment, the SSC used the median rather than the mean of annual landings to account for a lack of landings information for those stocks. This was generally the case when few years of data were available for the stock, with the result that the mean calculated from those landings would be very low and likely unrepresentative of the capacity of the stock to produce MSY. In contrast, use of the median in such situations generally (but not always) would result in an outcome more representative of the stock's capacity to support harvest.

**Sub-alternative 4f** would establish an $MSY_{proxy}$ based on mean annual landings derived from the year sequence selected in **Alternative 4** Step 1. This is the most common approach historically used to establish an $MSY_{proxy}$ for federally managed commercial and recreational fish stocks in the U.S. Caribbean region. When a generally complete and stable fishery is operating, this approach best captures the capacity of the stock to support harvest if the year sequence chosen in **Alternative 4** Step 1 represents a period of stable and sustainable landings.

**Sub-alternative 4g** would establish an $MSY_{proxy}$ using a 3x multiplier of the maximum recreational landings during the chosen year sequence selected in **Alternative 4** Step 1. In the 2011 Caribbean ACL Amendment, the SSC chose a sub-alternative similar to this to establish the $MSY_{proxy}$ for some managed stocks because commercial landings data were not available during the chosen reference period. Specifically, that was the case for the commercial surgeonfish, angelfish, and tilefish units in Puerto Rico. Those stocks were not targeted and were primarily caught by commercial fishermen when using gear such as traps, nets, and hand lines to target other stocks. Additionally, one or more of those stocks was not specifically listed on Puerto Rico trip tickets used by commercial fishermen and, therefore, Puerto Rican fishermen were required to write in the names of these fish, and list the pounds caught, in the "Other" category on the form. Because of the low landings typical of these stocks during that reference period, at least partially due to their absence from the commercial reporting forms, adjusted commercial landings did not adequately reflect annual harvest patterns. Thus, a value of three times the maximum annual recreational landings during the chosen year sequence served as a proxy for sustainable annual harvest.

Step 3 of **Alternative 4** would establish the ABC as described by any of the sub-alternatives below and using the $MSY_{proxy}$ (=OFL) established in **Alternative 4** Step 2. A different sub-alternative may be chosen for each stock and/or for each fishing sector.

**Sub-alternative 4h** would not specify an ABC CR to be used for establishing the ABC from the $MSY_{proxy}$ (=OFL). Instead, the Council would adopt the ABC recommended by the SSC. The SSC would develop the ABC on an ad hoc basis for each stock. The SSC previously used this approach in the 2010 Caribbean ACL Amendment when setting management reference points for queen conch and some species of parrotfish.

**Sub-alternative 4i** would adopt an ABC CR where ABC = $MSY_{proxy}$ (=OFL). This sub-alternative assumes a complete understanding of the many factors involved in obtaining and understanding the scientific data used to determine the $MSY_{proxy}$ (=OFL). The factors taken into account when establishing scientific uncertainty were described in Step 2 of **Alternative 3**. This sub-alternative was previously used by the SSC when establishing management reference points for most stocks (except queen conch and some species of parrotfish) in both the 2010 and 2011 Caribbean ACL Amendments.

**Sub-alternatives 4j** through **4l** would adopt an ABC CR where ABC= $MSY_{proxy}$ (=OFL) x various buffer reductions including 0.90 (**Sub-alternative 4j**), 0.85 (**Sub-alternative 4k**), and 0.75 (**Sub-alternative 4l**). These buffer reductions represent an increasing level of scientific uncertainty resulting from variations in and the vagaries of the data upon which the $MSY_{proxy}$ (=OFL) was established. The factors taken into account when establishing scientific uncertainty were described in Step 2 of **Preferred Alternative 3** in Appendix H.

Step 4 of **Alternative 4** would establish the ACL based on the buffer reduction factor described in one of the sub-alternatives below and using the ABC established in **Alternative 4** Step 3. A different sub-alternative may be chosen for each stock and/or for each fishing sector. Reducing from the ABC to the ACL is designed to account for management uncertainty, as discussed in Step 2 of **Preferred Alternative 3**. **Sub-alternatives 4m-4r** are similar to **Sub-alternatives 3a-3f** in **Preferred Alternative 3**, and the discussion above applies in here as well. Following the procedures and logic included in the 2010 and 2011 Caribbean ACL Amendments, OY would be set equal to the ACL.

**Comparison of Action 4 Alternatives**

**Alternative 1**, the no action alternative, would result in the continuation of SDC and management reference points established in the 2010 and 2011 Caribbean ACL Amendments and the Caribbean SFA Amendment. Implementation of **Alternative 1** would be expected to have negative short- and long-term effects on the human environment, including the physical, biological/ecological, social, and economic environments. **Alternative 1** simply carries over the existing reference points and SDC. There is no allowance to respond to availability of additional data, and no opportunity to adapt to a changing suite of managed stocks. In particular, stocks newly added to the Puerto Rico FMP would not be accounted for in **Alternative 1**. This is not in compliance with the Magnuson-Stevens Act. Moreover, assuming Alternative 1 was legally viable, selecting it would create potential short- and long-term negative effects on the physical environment because harvest levels and associated fishing activities would not be specified, monitored, or managed for newly added stocks. This could result in higher levels of gear deployment, potentially including those presently employed gear types that may negatively impact the physical environment. That same lack of opportunity to monitor and manage harvest levels relative to established reference points likely would create negative short- and long-term effects on the biological/ecological environment by allowing overharvest and resultant depletion of target species, thereby reducing reproductive capacity and excessively altering ecological interactions such as grazing capacity. Those negative biological/ecological effects, and associated physical effects, likely would result in long-term negative effects on the social and economic environments due to decreased fishing opportunities and concomitant reductions in income and cultural vibrancy for the fishing communities dependent on those fishery resources. Negative effects would be made worse by establishing reference points based on the previous FMPs, without updating the values to account for new information. This could result in unnecessary management intervention resulting in inappropriate social and economic effects to fishing communities. Whether those effects are positive or negative, and the extent of the effect, would depend on the degree to which the reference point should be updated, and the direction of the change. For example, if the ACL is too low, the biological/ecological environment could benefit as a result of lower harvest levels, potentially resulting in a more viable reproductive

stock. In contrast, socioeconomic effects could be negative due to actual harvest falling below OY. Such effects may not be felt in the short-term, and in fact short-term social and economic effects might be positive. But in the long-term, depletion of fishery resources and resultant degradation of the habitats upon which those resources depend would have negative social and economic effects. Similarly, short-term administrative effects might be neutral because no additional action needs to be taken.

**Preferred Alternative 2** applies only at the level of reference points, because SDC are population-level parameters that allow no distinction between commercial and recreational fishing sectors. **Preferred Alternative 2** would be irrelevant if the no action **Alternative 1** was chosen because the reference points applied as a result of choosing **Alternative 1** already would be allocated between the recreational and commercial sectors. The decision to establish sector-specific reference points would influence the process of setting reference points as described in **Preferred Alternative 3**. The reference-point setting process described in **Preferred Alternative 3** applies to all stocks and stock complexes resulting from application of Actions 2 and 3, but includes no mechanism to allocate those reference points among fishing sectors. **Preferred Alternative 2** also would not apply in the event the Council chose **Alternative 4** as preferred. As with **Alternative 1**, separate recreational and commercial sectors would be inherent in **Alternative 4**, the distinction being that **Alternative 1** applies the existing reference point values to those stocks being carried forward from the previous management regime. In contrast, **Alternative 4** carries forward the process used to those existing reference points but allows new parameter values (e.g., new year sequences of landings data) to be used in the development of those reference points.

Establishing sector-specific reference points as proposed in **Preferred Alternative 2** would be inconsequential with respect to the biological/ecological environment because the total ACL would remain the same regardless of whether that total ACL was subdivided among the commercial and recreational sectors. Assuming a continuation of the pattern of sector-based fishing existing during the reference landings period upon which each sector's reference points were based, effects to the physical environment also would not be expected to change. Similarly for the social and economic environments, allocations reflect historic fishing patterns and by inference historic social practices and economic opportunities. These would not be expected to change. Effects on the administrative environment also would be minimal as administration of a sector-based management scheme would continue.

**Preferred Alternative 3** would replace the ABC CRs established in each of the 2010 and 2011 Caribbean ACL Amendments and provides a complete revision of references points relative to what would result from **Alternative 1**. With respect to **Alternative 4**, specific comparisons of quantitative outcomes cannot be made unless sub-alternatives are selected by the Council for each of the four steps included in the action. However, the process established by **Preferred**

**Alternative 3** would fundamentally differ from the process defined in **Alternative 4** regardless of the specific differences resulting from choice of sub-alternatives, and would provide explicit advantages relative to either **Alternative 1** or **4**. Compared with **Alternative 1**, **Preferred Alternative 3** provides access to more recent landings data, thereby ensuring to the greatest practicable extent that an appropriate period of stable and sustainable landings is identified. Although Step 1 of **Alternative 4** provides multiple sub-alternatives for choosing a year-sequence of landings, including optional outcomes that could be identical to the year-sequence outcome applied in **Preferred Alternative 3**, the latter alternative provides additional advantages and better meets the obligations of scientific rigor and quality. Most importantly, the tiered approached included in the **Preferred Alternative 3** ABC CR better positions the Council to take advantage of future improvements in data and analytical methodologies.

As commercial and recreational data collection initiatives begin to show results, the assessment process would advance from Tier 4 (no accepted assessment) to Tier 3 (data limited, but an accepted assessment is available) and eventually to Tier 2 (data moderate) and Tier 1 (data rich). No such capacity is provided by **Alternative 4**, which instead obligates a less rigorous approach based on statistics of landings data.

**Preferred Alternative 3** would be expected to have positive short- and long-term effects on the physical, biological/ecological, social, and economic environments associated with the Puerto Rico EEZ. Applying the best scientific information available through the action taken in **Preferred Alternative 3** would ensure that federally managed stocks are harvested sustainably while protecting reproductive capacity and maintaining effective ecological contributions. Establishing appropriate harvest reference points, taking into account both the biological needs and the ecological contributions of the stock as would be prescribed by **Preferred Alternative 3**, provides positive short- and long-term benefits to the physical and biological/ecological environment both directly by managing fishing effort and associated gear impacts and indirectly by managing the ecological integrity of the coral reef ecosystem.

The Council and their SSC applied considerable expertise and effort to the process of developing their ABC CR, establishing the process and protocols for implementing that ABC CR, and identifying the best available scientific data and expertise to be used in the ABC CR analytical process. That effort would ensure, to the greatest practicable extent, the most appropriate quantitative estimates of SYL and ABC to ensure sustainability of a stock or stock complex. The Council carefully considered the process applied by the SSC, along with the environment within which management would be applied, when assigning an appropriate buffer to derive the ACL from the ABC established by the SSC. These outcomes provide positive short- and long-term benefits to the biological/ecological environment by reducing the likelihood of stock depletion and by providing guideposts on (SYL) and limits to (ACL) indicative of potential negative trends in reproductive capacity and ecological function. Management measures implemented to

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achieve the harvest objectives set by the $F_{MSY}$ proxy would directly impact the biological environment in the form of controlling fishing effort. By being more conservative, **Sub-alternative 3b** would provide greater assurance overfishing would not occur and thus the biological benefits of **Sub-alternative 3b** would be greater than **Sub-alternatives 3a** and **3c** (**Preferred**).

Those positive short- and long-term biological/ecological effects, and the associated positive short- and long-term effects to the physical environment, translate to positive short- and long-term effects on the social and economic environments by stabilizing harvest and thereby increasing the predictability of harvest opportunities. **Sub-alternative 3b** would be expected to result in greater constraints on harvest than **Sub-alternatives 3a** and **3c** (**Preferred**) resulting in the greatest short-term negative socio-economic impacts.

Regarding administrative effects, in general, **Preferred Alternative 3** would be expected to result in minor negative short-term effects as effort is expended to modernize landings tracking protocols to account for establishment of new reference points and inclusion of new species.

**Alternative 4** would follow the SDC and reference point setting methodologies developed in the 2010 and 2011 Caribbean ACL Amendments. Those same methodologies were used to establish the SDC and reference points that would be applied if **Alternative 1** was chosen by the Council. The substantial differences between **Alternative 1** and **Alternative 4** include that the former is number-based, whereas, the latter is process-based and therefore provides for a wider range of outcomes. Additionally, the latter allows the process to be applied across the full suite of stocks and stock complexes (as appropriate) that would be chosen by the Council in Actions 2 and 3 of this EA whereas the former is constrained to only those stocks already under management in the Puerto Rico EEZ.

For each of **Preferred Alternative 3** and **Alternative 4**, the final step in the process of establishing reference points is to set the ACL. In both cases, the ACL is set by applying a reduction buffer to the ABC to account for uncertainty in the management process. These reduction alternatives reflect the process applied in the 2010 and 2011 Caribbean ACL Amendments. Under **Preferred Alternative 3**, Step 3, the Council identified **Sub-alternative 3e** (buffer coefficient = 0.95) as their preferred alternative for all stocks but parrotfish, angelfish, and surgeonfish, and **Sub-alternative 3g** (buffer coefficient = 0.85) for parrotfish, angelfish, and surgeonfish. This choice reflects two aspects of the uncertainty equation. First, the Council's SSC accounted to some degree for management uncertainty when establishing SYL to ABC (i.e., scientific uncertainty) reductions in their control rule. The SSC noted how factors that lead to management uncertainty, such as reporting issues, could lead to scientific uncertainty about what the data can demonstrate. Thus, the Council determined it was appropriate to apply a relatively minimal additional reduction to account for management uncertainty. Second, because

parrotfish, angelfish, and surgeonfish provide ecological services to the coral reef ecosystem, further buffer reductions were appropriate for those stocks. Those reductions are slightly less than the reductions inherent in **Alternative 1**. However, in both the 2010 and 2011 Caribbean ACL Amendments, no reduction from the OFL to the ABC was applied to account for scientific uncertainty. Thus, the full uncertainty reduction that would be applied under **Preferred Alternative 3**, Step 3, for all managed stocks, is more conservative when compared to the outcome inherent in **Alternative 1**. The range of reduction buffers included in **Preferred Alternative 3**, Step 3 is identical to the range of buffers included in **Alternative 4**, Step 4. Assuming the Council chose as their preferred alternative for **Alternative 4** the same buffer reduction options, the effects would be expected to be the same. Ultimately, the anticipated effects to the physical, biological/ecological, social, economic, and administrative environments would depend on the Council's choice of sub-alternative, although it would be expected that choice would be essentially the same regardless of the sub-alternative chosen because the uncertainty associated with the management process would not depend on the reference point alternative. The specific effects would depend on the choice of sub-alternative and cannot be fully analyzed prior to that Council decision. Suffice to say that, in general, the benefits to the physical and biological/ecological environments would be enhanced with a larger buffer between ABC and ACL, whereas, the benefits to the social and economic environments would be lessened with a larger buffer. Administrative effects likely would be neutral. In all cases, the OY would be set equal to the ACL.

Effects to the physical, biological/ecological, social, and economic environments resulting from implementation of **Alternative 4** would be expected to be more beneficial than those that would result from implementation of **Alternative 1** but less beneficial than those that would result from implementation of **Preferred Alternative 3**. Providing a mechanism for developing reference points for all managed stocks, as called for in **Alternative 4**, would result in positive effects, but the extent of those positive effects would be limited by an inability to consider and apply the best scientific information available and to update management as those data expand and improve. Unlike the tiered control rule in **Preferred Alternative 3**, **Alternative 4** does not provide different processes for deriving MSY, SDC, and reference points based on available information. Those relative effects apply across the suite of environments introduced above could result in unnecessary management intervention with potentially unnecessary negative social and economic effects to fishing communities. Short-term administrative effects would be negative but minor, due to the additional administrative effort to update regulations and public awareness documents.

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## 2.5 Action 5: Accountability Measures for Stocks and Stock Complexes

Through Action 5, the Council would re-establish AMs for previously managed stocks and stock complexes and establish AMs for stocks new to management in the Puerto Rico FMP. This action follows from selecting Preferred Alternative 2 in Action 1 and proceeding with establishing a Puerto Rico FMP, composed of measures contained in the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs that are pertinent to Puerto Rico, as modified in Actions 2-4. For a stock or stock complex, an AM would be triggered based on annual landings from the commercial and (where applicable) recreational fishing sectors. For the commercial sector, landings data are obtained from commercial catch reports, adjusted to account for under-reporting and mis-reporting. For the recreational sector, landings data are obtained from MRIP.

### 2.5.1 Proposed Alternatives for Action 5

**Alternative 1.** No Action. Do not revise the determinant for triggering an AM or the specific AM that would be applied to a stock or stock complex in the Puerto Rico FMP. The AMs applicable to reef fish, spiny lobster, queen conch, and coral resources established in the Council's Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs and that would be brought into the Puerto Rico FMP based on Action 1 Preferred Alternative 2 would continue to be applied to previously managed stocks/stock complexes in the Puerto Rico EEZ, as those stocks/stock complexes are organized following Actions 2 and 3. This action would not establish AMs for stocks/stock complexes that are new to management.

**Preferred Alternative 2**. For a stock/stock complex in the Puerto Rico FMP, trigger an AM if the total landings (commercial + recreational [as applicable]), as determined in one of the sub-alternatives below, exceeds the total ACL (commercial plus recreational, as applicable) for that stock/stock complex, unless NMFS' SEFSC determines the overage occurred because data collection/monitoring improved rather than because catch increased. The AM would be triggered only for the sector(s) that exceeded its applicable ACL. If an AM is triggered, NMFS would reduce the length of the fishing season for the applicable stock/stock complex for the applicable sector(s) the year following the overage determination by the amount necessary to ensure (to the greatest practicable extent) landings do not again exceed the ACL in the year of application. Any fishing season reduction resulting from an AM application would be applied from September 30 backward, toward the beginning of the fishing year. If the length of the required fishing season reduction exceeds the time period of January 1 through September 30, any additional fishing season reduction would be applied from October 1 forward, toward the end of the fishing year.

However, if applicable landings for one sector are not available for the averaging period, the sector would not be managed by a separate sector ACL. The ACL for the sector with available data would be the applicable ACL for the fishery. When landings exceed the applicable ACL for that stock/stock complex, the AM would be triggered, unless NMFS' SEFSC determines that the overage occurred because data collection/monitoring improved rather than because catch increased. The AM would operate to reduce the length of the fishing season for all sectors by the amount necessary to ensure (to the greatest practicable extent) landings do not again exceed the ACL in year of application. Any fishing season reduction resulting from an AM application would be applied on the same timeframe as above.

**Sub-alternative 2a**. A single year of applicable landings, beginning with the most recent available complete year of landings.

**Sub-alternative 2b.** A single year of applicable landings, beginning with the most recent available complete year of landings, then a 2-year average of applicable landings from that single year and the subsequent year, and thereafter a progressive running two-year average.

**Sub-alternative 2c**. A single year of applicable landings, beginning with the most recent available complete year of landings, then a 2-year average of applicable landings from that single year and the subsequent year, then a three-year average of applicable landings from those two years and the subsequent year, and thereafter a progressive running three-year average.

**Preferred Sub-alternative 2d.** A single year of applicable landings, using landings from 2018; then a single year of applicable landings, using landings from 2019; then a 2-year average of applicable landings from 2019 and the subsequent year (2019-2020); then a three-year average of applicable landings from those two years and the subsequent year (2019-2021); and thereafter a progressive running three-year average (2020-2022, 2021-2023, etc.). The Regional Administrator in consultation with the Council may deviate from the specific time sequences based on data availability.

**Preferred Alternative 3.** For the following pelagic stocks/stock complexes (dolphinfish, tunas, mackerel, tripletail, and wahoo) only, apply a two-step process to establish an ACT for each stock/stock complex that would be used as an AM (Step 1), and establish the determinant for triggering an AM (Step 2). Choose a sub-alternative from each step, for each stock.

***Alternative 3 - Step 1.*** Establish an ACT for each pelagic stock/stock complex, using any of Sub-Alternatives 3a-3c listed below, and use the established ACT as the AM.

**Preferred Sub-alternative 3a.** The ACT would be 90% of the applicable ACL.*

**Sub-alternative 3b**. The ACT would be 80% of the applicable ACL.*

**Sub-alternative 3c**. The ACT would be 70% of the applicable ACL.*
*The applicable ACL would either be the sector ACL, where landings data are available to manage by sector, or the ACL for the sector with available landings, which, per Action 4, Alternative 2, becomes the fishery ACL when landings in the other sector are not available.

***Alternative 3 - Step 2.*** Trigger an AM if the applicable landings (e.g., sector landings, where landings data are available to manage by sector, or the available landings where only one sector's landings are available, as discussed above), as determined in one of the sub-alternatives below, exceeds the ACT for that stock/stock complex. If an AM is triggered, the Council in consultation with the Southeast Fisheries Science Center (SEFSC) would assess whether corrective action is needed.

**Sub-alternative 3d**. A single year of applicable landings, beginning with the most recent available complete year of landings.

**Sub-alternative 3e.** A single year of applicable landings, beginning with the most recent available complete year of landings, then a 2-year average of applicable landings from that single year and the subsequent year, and thereafter a progressive running two-year average.

**Sub-alternative 3f**. A single year of applicable landings, beginning with the most recent available complete year of landings, then a 2-year average of applicable landings from that single year and the subsequent year, then a three-year average of applicable landings from those two years and the subsequent year, and thereafter a progressive running three-year average.

**Preferred Sub-alternative 3g.** A single year of applicable landings, using landings from 2018; then a single year of t applicable landings, using landings from 2019; then a 2-year average of applicable landings from 2019 and the subsequent year (2019-2020); then a three-year average of applicable landings from those two years and the subsequent year (2019-2021); and thereafter a progressive running three-year average (2020-2022, 2021-2023, etc.).

**Alternative 4.** Establish an in-season AM. Harvest of a stock or stock complex would be prohibited for the remainder of the fishing season when the applicable ACL for the stock/stock

complex is reached or projected to be reached. The applicable ACL would either be the sector ACL, where landings data are available to manage by sector, or the ACL for the sector with available landings, which, per Action 4, Alternative 2, becomes the fishery ACL when landings in the other sector are not available.

**Preferred Alternative 5.** For a stock with harvest prohibitions, the prohibition would serve as the AM.

### 2.5.2 Discussion of Action 5 Alternatives

Accountability measures are management controls to prevent ACLs, including sector ACLs, from being exceeded, and to correct or mitigate overages of the ACL if they occur. Accountability measures should address and minimize both the frequency and magnitude of overages and correct the problems that caused the overage in as short a time as possible. NMFS's guidelines identify two categories of AMs: in-season and post-season (50 CFR 600.310(g)(1)) (discussed in Appendix F).

Action 5 would re-establish AMs for previously managed stocks and stock complexes and, depending on the chosen alternative, establish AMs for stocks new to management in the Puerto Rico FMP. As identified in Action 2, Preferred Alternative 2, the proposed list of species to be managed under the Puerto Rico FMP would include queen conch, spiny lobster, 63 finfish species, sea cucumbers (Holothuroidea), sea urchins (Echinoidea), and all species of corals[20]. From these, 18 species of finfish would be new to federal management in the Puerto Rico FMP, as would be a number of the sea cucumbers, sea urchins, and corals that were not historically managed in the Coral FMP. In addition, if the preferred alternatives are implemented, the composition and organization of stock complexes would change as a result of Action 3 and new ACLs would be set (or revised) as a result of Action 4. By revising AMs as proposed in Action 5, the Council would ensure ACL overages are accounted for with responsive management actions, thereby minimizing the risk of overfishing while ensuring to the greatest possible degree that OY is achieved.

**Alternative 1**, the no action alternative, would not change the existing AMs for those stocks carried into the Puerto Rico FMP from the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs. The current determinant for triggering AMs, as well as the presently established response to an ACL overage, would continue to be applied to those stocks/stock complexes. However, AMs would not be established for those stocks/stock complexes newly added to the Puerto Rico

[20] At their 153rd Regular meeting, the Council moved to include all soft, hard, mesophotic, and deep water corals under the new island-based FMPs. This would include all species in Orders Scleractinia (hard corals), Alcyonacea (soft corals), and Antipatharia (black corals).

FMP, nor would a trigger for applying an AM be defined. These topics are further discussed below.

Under **Alternative 1**, an AM would be triggered for reef fish when the average of the most recent three years of landings[21] for a stock or stock complex exceeds the total (commercial + recreational) ACL established for that reef fish stock/stock complex. If either or both of the sector ACLs, and the total ACL, are exceeded, an AM would be applied to the sector(s) that experienced the overage. The AM would reduce the length of the fishing season in the year following the determination by the amount necessary to ensure that landings do not exceed the applicable ACL for the reef fish stock or stock complex. For reef fish, triggering an AM when the total ACL is exceeded, rather than simply when the sector-based ACL is exceeded, ensures to the greatest practicable degree that OY is achieved in the fishery. Regulatory Amendment 6 to the Reef Fish FMP: Triggering AMs in the Puerto Rico EEZ (CFMC 2017) implemented these changes in 2017. Prior to 2017, it was common for either the commercial or the recreational fishing sector to exceed their sector-specific ACL and have an AM applied, even though the total ACL was not exceeded because landings from the other sector fell below the assigned ACL. Because OY equates to the total ACL, and not the sector-specific ACLs that constitute that total, failure to achieve the total ACL equated to failure to achieve OY. To rectify this situation, the Council and NMFS revised the regulations so that an AM is applied only if the total ACL for a stock/stock complex is exceeded. If that total ACL is exceeded, an AM is applied to the sector that exceeded its assigned ACL; the length of the fishing season closure remains proportional to the extent to which that sector's ACL is exceeded. If both sectors exceeded their respective ACL, an AM would be applied to each, and the length of the fishing season closure for each sector would be proportional to the extent to which each sector exceeded their assigned ACL.

For spiny lobster, for which recreational catch is not tracked and therefore sector-specific landings data are not available, an AM would be triggered when the average of the most recent three years of commercial landings exceeds the ACL established for the stock. The stock ACL is based on the available commercial landings. The AM would apply equally to the commercial and recreational fishing sectors. The AM operates to reduce the length of the fishing season in the year following the determination by the amount necessary to ensure that landings do not exceed the ACL.

Under **Alternative 1** for both spiny lobster and reef fish, the trigger determination is conditional, in that if NMFS' SEFSC (in consultation with the Council and its SSC) determines the ACL exceedance resulted from enhanced data collection or monitoring rather than reflecting an actual increase in (adjusted) landings, an AM would not be triggered. This conditional clause responds

[21] With the exceptions of goliath grouper, Nassau grouper, midnight parrotfish, blue parrotfish, and rainbow parrotfish, ACLs are based on the combined landings from territorial and federal waters around Puerto Rico.

to continuing efforts by the Council, state agencies, NMFS, and the fishermen to improve reporting of both commercial and recreational landings data. Such reporting enhancements likely would increase reported and possibly adjusted landings (dependent on if and to what extent the adjustment factor reflects reporting enhancements), thereby pushing the three-year average used for comparison upward despite no increase in the actual harvest. The conditional clause is designed to ensure fishermen would not be subject to an AM for enhancements to data collection and reporting patterns.

Under **Alternative 1**, for both reef fish and spiny lobster, any fishing season reduction resulting from an AM application would be applied from September 30 backward toward the January 1 beginning of the fishing year. If the length of the required fishing season reduction exceeds the January 1 through September 30 time period, any additional fishing season reduction would be applied from October 1 forward, toward the end of the fishing year.

In the Puerto Rico EEZ, the harvest of queen conch and corals is prohibited under both the Queen Conch and Coral FMPs. If Preferred Alternative 2 of Action 1 is implemented, those harvest prohibitions would be carried over into the Puerto Rico FMP. The harvest prohibition serves as the AM in both the Queen Conch and Coral FMPs, and would continue to do so under **Alternative 5** of Action 5.

**Preferred Alternative 2** would use a stepwise temporal approach to calculate average landings for comparison against the applicable ACL. This contrasts with **Alternative 1**, which would use the most recent three years of landings data as the determinant to trigger an AM. **Sub-alternative 2a** would use the most recent single year of landings for comparison against the ACL. For example, assuming that the first year of operation under the Puerto Rico FMP is 2019, only landings data from the 2018 fishing year (assuming this is the most recent year of available and complete landings) would be compared against the applicable ACL to determine if an AM would be applied to any stock/stock complex in 2019. That single year approach would be continued into the future; only landings data from the 2019 fishing year would be compared against the applicable ACL to determine if an AM would be applied to any stock/stock complex in 2020. This stepwise, single-year approach would be continued into the future.

If **Sub-alternative 2b** is chosen, a single year of landings would be used during the first year of FMP operation, as in **Sub-alternative 2a**, but in the second year of operation an average of landings from the two most recent years of complete landings would be compared against the applicable ACL. The two-year averaging approach would then be continued in a stepwise fashion (i.e., a running two-year average) into the future. For example, assuming the first year of operation under the Puerto Rico FMP is 2019, only landings data from the 2018 fishing year (assuming this is the most recent year of available and complete landings) would be compared against the applicable ACL to determine if an AM would be applied to any stock/stock complex

in 2019. An average of landings from 2018 and 2019 would be compared against the applicable ACL to determine if an AM would be applied to any stock/stock complex in 2020. This stepwise, two-year running average approach would be continued into the future.

**Sub-alternative 2c** is similar to **Sub-alternative 2b**, but instead of using a two-year running average approach in the third year and into the future, a three-year average of landings would be compared against the applicable ACL. The three-year running average approach would then be continued into the future. As in the previous examples, if 2019 were to be the first year of Puerto Rico FMP operation, 2018 landings data would be used in the 2019 management year, 2018 and 2019 landings data would be used in the 2020 management year, 2018, 2019 and 2020 landings data would be used in the 2021 management year, and 2019, 2020, and 2021 landings data would be used in the 2022 management year. This stepwise, three-year running average approach would be continued into the future.

**Sub-Alternative 2d** differs from **Sub-Alternatives 2a-2c** in that **Sub-Alternative 2d** calls for a modified stepwise approach to determine if an AM would be triggered. Under **Sub-Alternative 2d**, landings data from 2018 alone would be compared against the applicable ACL to determine if an AM would be triggered during the first year (2019) of operation under the Puerto Rico FMP. In the second year of FMP operation (2020), landings data from 2019 alone would be compared against the applicable ACL to determine if an AM would be triggered. In the third year (2021) of FMP operation, an average of the landings from 2019 and 2020 would be compared against the applicable ACL. In the fourth year (2022) of operation, an average of the landings from 2019, 2020, and 2021 would be compared against the applicable ACL.
This stepwise, three-year running average approach would be continued into the future.
(e.g., 2020+2021+2022 for the 2023 operating year).

Regarding the choice of years to be used when averaging landings for comparison against the applicable ACL, using average landings provides benefits because of the variable nature of Puerto Rico fisheries. While a few stocks provide predominate harvest from the Puerto Rico EEZ, most harvested stocks contribute only a small proportion of the total landings. Additionally, the relative proportion of landings contributed by any single stock commonly varies from year to year, even in the case of those stocks providing large contributions. These fluctuations may result from biological (e.g., year-class variability) and economic (e.g., market demand) factors, either alone or in concert. Regardless, the fewer years of landings used, the more variable the resultant year-to-year comparison will be against the established ACL. An averaged time-series of landings would reduce the effects of the variability, and the longer the time-series the more the variation will be evened out. When using a single year of landings, the expected outcome would be more frequent exceedance of the ACL interspersed with years when the landings for any stock/stock complex fall well below the established ACL. Because some or all of the variability results from natural biological fluctuations, little biological/ecological

advantage is obtained from using a single year of landings for comparison against the ACL, whereas potentially substantial negative socioeconomic impacts would accrue resulting from more frequent AM applications. Overall, OY would be achieved less frequently when using a single year of landings for identifying an ACL overage. To a point, the longer the time-series, the more closely management will achieve OY. NMFS's NS1 guidelines allow for AMs based on multi-year average data for fisheries that have highly variable annual catches and suggest a three-year moving average could be appropriate to address variability (50 CFR 600.310(g)(5)). Three years is the longest time period considered in the **Preferred Alternative 2** (and **Alternative 4**) sub-alternatives.

For all sub-alternatives, **Preferred Alternative 2** also differs from **Alternative 1** in that the SEFSC would not consult with the Council and its SSC prior to making a determination that the ACL was exceeded due to enhanced data collection or monitoring rather than to an actual increase in landings. This revision reflects the authoritative position of the SEFSC with regard to changes in landings reporting characteristics in the U.S. Caribbean region. As with all management actions and events in the U.S. Caribbean region, the Council would be notified of any AM applications, but if **Preferred Alternative 2** were chosen for implementation there would be no obligation to consult with the Council and their SSC prior to making the determination that an ACL exceedance resulted from enhanced data collection and monitoring.

Regarding the application of AMs in response to an ACL overage, **Preferred Alternative 2** is very similar in most respects to **Alternative 1**. As discussed above for **Alternative 1**, with **Preferred Alternative 2,** when a sector-specific (if applicable) AM is triggered, application of that AM would result in a reduction in the length of the fishing season for the sector(s) (if applicable) exceeding its assigned ACL, in the year following the determination, by the amount necessary to ensure to the greatest practicable extent that such an overage would not occur again in the year following the determination. For stocks with sector-specific management, the AM would only be applied to the sector that actually exceeded its sector-specific ACL. The length of the AM-based closure would be proportional to the amount of the ACL overage. If both sectors exceeded their assigned ACL, the length of the AM-based closure for each sector would be proportional to the amount of the ACL overage for each sector. As discussed above, this approach to management anticipates that fishing effort, for either the commercial or recreational sector of the pertinent stock/stock complex, remains relatively constant between consecutive years (although not necessarily in the long-term). By adjusting the fishing year (i.e., reducing the length of the fishing season) to allow fishing at that level of anticipated effort for the number of days necessary to meet but not exceed the ACL, the Council would ensure the target stock or stock complex is harvested in a sustainable manner within the context of OY. The AM application process in **Preferred Alternative 2** could be applied to each of the managed stocks for which harvest is allowed in the Puerto Rico EEZ (reef fish, spiny lobster, and pelagic

stocks[22]). Similar to **Alternative 1**, any fishing season reduction resulting from application of an AM would be applied from September 30 backward, toward the beginning of the fishing year. If the length of the required fishing season reduction exceeds the time period of January 1 through September 30, any additional fishing season reduction would be applied from October 1 forward, toward the end of the fishing year.

**Preferred Alternative 3** applies specifically to some of the pelagic stocks new to management in the Puerto Rico EEZ. Based on Preferred Alternative 2 of Action 2 (species to manage in the FMP) and Preferred Alternatives 3 and 4 of Action 3 (stock organization), newly added pelagic stocks to which this alternative would apply include dolphinfish, pompano dolphinfish (dolphinfish stock complex), little tunny, blackfin tuna (tuna stock complex), king mackerel, cero mackerel (mackerel stock complex), tripletail, and wahoo. Landings data for these stocks are available, but it is unknown to what extent those landings data fully represent harvest of these pelagic stocks. Because these pelagic stocks were not previously managed in EEZ waters surrounding Puerto Rico, less emphasis was placed on data collection relative to those stocks previously under federal management. That approach to data collection may have failed to capture the temporally and spatially variable nature of these pelagic fisheries, both within the year due to migratory timing and fishing tournament events that target some or all of these stocks, and among years due to factors such as variation in inter-annual recruitment success and changing migratory pathways. As a result, while available landings provide guidance on a minimum level of sustainable harvest, those landings data may not provide adequate guidance concerning the capacity of the stock to support sustainable harvest. Within both the recreational and commercial sectors, dolphinfish represent one of the most commonly targeted and economically important of harvested stocks. Other members of the pelagic group are highly sought either as sportfish (e.g., king mackerel) or as bait for use in the pursuit of billfish such as marlin and sailfish (e.g., blackfin tuna). Reflecting these economic and cultural considerations, the Council requested a different approach to management of these newly added pelagic stocks until a more complete understanding of these important fisheries is obtained. **Preferred Alternative 3** provides that approach. Instead of applying an AM in the event of an ACL overage, and reducing the length of the fishing season, as proposed in **Alternatives 1** and **2 (Preferred)**, the Council would establish an ACT as a percentage of the ACL that would serve as the AM, based on one of the sub-alternatives in Step 1 of this alternative. An ACT is an amount of annual catch of a stock or stock complex that may appropriately serve as a management target for the fishery, and accounts for management uncertainty in controlling the catch at or below the ACL. NMFS's NS1 guidelines recommend the use of an ACT within the hierarchy of management reference points. For fisheries without in-season management control to prevents the ACL from being exceeded, it may be beneficial to utilize ACTs that are set below

[22] Pelagic stocks/stock complexes in the Puerto Rico FMP resulting from Action 2 are dolphinfish, mackerel, tunas, tripletail, and wahoo.

ACLs to better manage the risk of catches exceeding the ACL, and thus to reduce the probability of triggering the applicable AM.

Three sub-alternatives are provided in Step 1 of **Preferred Alternative 3** for setting the ACT relative to the total ACL. **Preferre**d **Sub-alternative 3a** would set the ACT at 90% of the total ACL, **Sub-alternative 3b** would set the ACT at 80% of the total ACL, and **Sub-alternative 3c** would set the ACT at 70% of the total ACL (Table 2.5.1). That range of alternative ACTs provides balance between management uncertainty and economic opportunity, with **Sub-alternative 3c** being more conservative in view of management uncertainty and **Preferred Sub-alternative 3a** being less conservative in view of economic opportunity.

**Table 2.5.1.** Annual catch targets (ACT) for pelagic stocks under each of the sub-alternatives in Preferred Alternative 3, based on the Council's preferred alternatives in Action 4 for establishing ACLs.

| Stock/Stock Complex | Commercial ACL | Recreational ACL | Total ACL | Sub_Alt 3a (Preferred) ACT Total ACL * 0.90 | Sub-Alt 3b ACT Total ACL * 0.80 | Sub-Alt 3c ACT Total ACL * 0.70 |
|---|---|---|---|---|---|---|
| Dolphin (Indicator) | 232,173 | 1,513,873 | 1,746,046 | 1,571,441 | 1,396,837 | 1,222,232 |
| Wahoo | 25,911 | 210,737 | 236,649 | 212,984 | 189,319 | 165,654 |
| Mackerel | 232,422 | 129,180 | 361,602 | 325,442 | 289,282 | 253,121 |
| Tunas | 82,779 | 34,485 | 117,263 | 105,537 | 93,811 | 82,084 |
| Tripletail | 270 | 39,005 | 39,275 | 35,348 | 31,420 | 27,808 |

Under **Preferred Alternative 3**, if the ACT established in Step 1 is exceeded based on one of the four trigger sub-alternatives in Step 2, the AM would be applied and the Council, in consultation with the SEFSC, would review the available data and evaluate what factors led to the exceedance and whether corrective action (such as an ACL revision) would be needed. **Sub-alternatives 3d-3g** of **Preferred Alternative 3** would use the same approach proposed in **Sub-alternatives 2a-2d** of **Preferred Alternative 2** to calculate average landings for comparison against the applicable ACT as the determinant to trigger an AM. This approach is discussed above for **Sub-alternatives 2a-2d**, and the reader is referred to that discussion as it would similarly apply to **Sub-alternatives 3d-3g**.

**Alternative 4** pertains to those stocks/stock complexes for which data are available to make an AM trigger determination within the fishing year. For stocks proposed for inclusion in the Puerto Rico FMP, in-season data are presently unavailable. State and federal efforts to improve the timing and extent of data acquisition for stocks harvested from the Puerto Rico EEZ continue, however, and those improvements may result in the availability of in-season data with

which to monitor and manage fishing activity. Until those improvements are realized, in-season management will not be possible.

**Preferred Alternative 5** addresses those stocks for which harvest would be prohibited based on the preferred alternatives identified in Action 4 that result in an ABC of zero. This alternative would apply to queen conch, Nassau grouper, goliath grouper, blue parrotfish, midnight parrotfish, rainbow parrotfish, manta ray, spotted eagle ray, southern stingray, sea cucumbers, sea urchins, and all managed corals. Under **Preferred Alternative 5** the harvest prohibition would serve as the required AM.

**Comparison of Action 5 Alternatives**

The Magnuson-Stevens Act requires that AMs be established for all federally managed stocks. When properly formulated and applied, AMs provide generally positive benefits to the human environment as they serve to manage fishing effort as a means to constrain harvest to a science-based level of sustainability. Both the short- and long-term effects are generally beneficial, as AMs provide protection from negative impacts to a stock resulting from overharvest. The biology of the individual stocks, the ecology of the coral reef ecosystem within which those stocks function, and the human community dependent on those stocks for their livelihood, all benefit from an effective management framework.

**Alternative 1** (no action) follows from choosing to transition to island-based management in Preferred Alternative 2 of Action 1, thereby creating a Puerto Rico FMP that retains AMs established in the existing species-based FMPs. However, **Alternative 1** would not be compliant with the requirements of the Magnuson-Stevens Act because it would not establish AMs for the species that are new to management. The species-based FMPs do not contain AMs for stocks or stock complexes that are new to management, and thus the AMs that are carried over would not address those entities. This would likely negatively affect the socioeconomic and biological/ecological environments by potentially failing to achieve OY or to minimize the risk of stock depletion due to a failure to properly manage harvest.

In contrast to outcomes from **Alternative 1**, outcomes resulting from application of **Preferred Alternative 2** or (if and when appropriate) **Alternative 4** would ensure AMs are properly structured for application to all stocks/stock complexes proposed for inclusion in the Puerto Rico FMP. Under **Preferred Alternative 2**, positive benefits to the biological/ecological environment would be realized because the length of the fishing season would be reduced to ensure that the landings do not exceed the ACL in the year following an ACL exceedance, thereby ensuring fishing effort is managed as necessary to prevent a subsequent exceedance of the ACL. These positive biological/ecological benefits translate directly into positive socioeconomic benefits resulting from a reliable and sustained resource base. The choice of sub-

alternative within **Preferred Alternative 2** could influence the frequency with which an AM-based fishing season reduction is implemented, and the length of that fishing season reduction, but the specific effects associated with each sub-alternative depend on the stock in question and the variability in landings associated with that stock. Without that information, it is difficult to assess the relative effects of each sub-alternative. **Alternative 4** achieves these same goals but more responsively by applying effort control in a pro-active rather than reactive manner. **Alternative 4** therefore provides enhanced benefits relative to **Preferred Alternative 2**, and much greater benefits relative to **Alternative 1** because of its broader applicability to all managed stocks or stock complexes, because it provides a mechanism to prevent ACL overages within the fishing year rather than responding in a subsequent year to an already realized ACL overage. As previously discussed, the Council, its federal and state partners, and its constituents embrace, and are working toward, fishery data collection and reporting mechanisms that would support in-season management. When those mechanisms are achieved for one or more stocks/stock complexes, application of **Alternative 4** will be feasible. Because such timely data reporting may be imminent for one or more stocks/stock complexes included in the Puerto Rico FMP, inclusion of **Alternative 4** is valid despite its present lack of applicability. In any case, both **Preferred Alternative 2** and **Alternative 4** provide the framework for managing fishing effort on all stocks/stock complexes proposed for inclusion in the Puerto Rico FMP. **Alternative 1** does not. Successful management of fishing effort on all managed stocks, to ensure a sustainable harvest, is the essence of fishery management, and brings to fruition the entirety of conceptual and analytical processes resulting from Actions 1-7 of this document.

Additional positive biological/ecological effects would be realized from re-establishing AMs for previously managed stocks and by establishing AMs for newly managed stocks, as proposed in **Alternatives 2 (Preferred)** and **4**. Again, **Alternative 4** is advantageous relative to **Alternative 2**, assuming a common choice of sub-alternative(s), because **Alternative 4** provides an anticipatory rather than a reactive response as would be the case with **Preferred Alternative 2**. The more natural population size distribution resulting from sustainable harvest would provide a biological benefit, ensuring reproductive interactions are maintained especially for the plethora of sequentially hermaphroditic reef fish occupying the U.S. Caribbean coral reef ecosystem. Similarly, enhancing the size distribution of managed stocks contributes to the ecological function of the coral reef complex, for example by maintaining essential (and size-dependent) grazing services provided by herbivores such as parrotfish and surgeonfish. Conversely a negative effect to both the biological/ecological and socioeconomic environments may result from the potential increase in regulatory discards of species caught during an AM closure while fishermen continue harvest of species not subject to the AM. Although it is the desire of fishermen and managers to ensure species caught as bycatch are returned to the water with minimal harm, the normal routine of those fish would be disturbed and their fate upon resubmergence is unknown.

**Preferred Alternative 5** equates the AM with a complete prohibition on harvest, as would result for several stocks from implementation of the Council's preferred alternatives for Action 4. Biological/ecological effects resulting from the application of **Preferred Alternative 5** would be positive and more substantial than those realized from any of the other Action 5 alternatives. But those benefits would only apply to stocks already assigned an ABC of zero based on the Council's preferred alternatives in Action 4. For the remainder of managed stocks, **Preferred Alternative 5** would not apply and no effects would therefore be realized. Similarly, for those stocks to which **Preferred Alternative 5** would apply, socioeconomic effects would be negative and more substantial than those realized from any of the other Action 5 alternatives, although that outcome already would be established in Action 4. It is possible that beneficial long-term biological/ecological and socioeconomic effects may be realized from a prohibition on harvest and equivalent AM, as that prohibition would allow rebuilding of depleted stocks to a level at which harvest is sustainable and ecological function revived. While these considerations apply to all stocks for which a prohibition on harvest would be in place, they are particularly pertinent to midnight, blue, and rainbow parrotfish. Historically, stocks of those three species have been harvested from the Puerto Rico EEZ by both commercial and recreational fishermen. Rebuilding those stocks to levels sufficient to again support harvest would therefore provide socioeconomic benefits to the fishing community and, to the extent those stocks are then sustainably managed at OY, also would provide enhanced biological/ecological benefits to the coral reef community via their unique contributions to grazing capacity.

Under **Preferred Alternative 3**, biological/ecological effects would likely be less beneficial relative to the other alternatives because the AM would not close harvest when triggered, risking potential depletion of the resource. Instead, it requires further action from the Council, as discussed below. In contrast, socioeconomic effects resulting from application of **Preferred Alternative 3** would be more beneficial relative to the other alternatives, at least in the short-term, because harvest would not be constrained without additional action from the Council. However, the Council would be expected to revise their management approach in response to recommendations from the SEFSC, with a reasonable expectation that those management revisions would benefit stock productivity in the long-term with resultant benefits to the biological/ecological and socioeconomic environments. **Sub-Alternative 3c** provides the most conservative response because the ACT trigger represents the smallest percentage of the ACL and therefore provides the greatest likelihood that the Council and the SEFSC would convene. That likelihood decreases with **Sub-Alternative 3b** and bottoms out with **Preferred Sub-Alternative 3a**. Note, however, that even **Preferred Sub-Alternative 3a** does not prevent a response, it simply requires the highest level of landings to invoke the Council's and SEFSC response.

In summary, **Alternative 4** of Action 5 provides the greatest overall benefit to the environment because only this alternative aims to ensure that AM implementation prevents an ACL

exceedance rather than simply responding to an ACL overage. Unfortunately, at the present time this is the least feasible alternative because in-season landings data are not available for Puerto Rico's commercial fisheries. Even though recreational landings data are available within the fishing year, it is total (commercial + recreational) landings that serve as the AM trigger determinant. In the case of reef fish, recreational landings do not suffice to determine if the ACL has been exceeded. In the case of spiny lobster, recreational landings are not a factor. In the case of reef fish, recreational landings do not suffice to determine if the ACL has been exceeded. In the case of spiny lobster, recreational landings are not a factor. While **Preferred Alternative 5** also aims to prevent rather than to respond to an ACL overage, that alternative simply reinforces an outcome proscribed in Action 4. **Preferred Alternative 5** uses the harvest prohibition, established by setting the ACL for a stock or stock complex at zero under Action 4, Preferred Alternative 3, as the AM. It does not result in particular in-season management, but it would provide the best approach for managing stocks for which harvest is prohibited. **Preferred Alternative 2** would provide biological/ecological and socioeconomic benefits similar to those provided by **Alternative 4**, but would do so based on a post-season rather than an in-season schedule. In most cases, because it is feasible within the reality of data availability, **Preferred Alternative 2** would provide the greatest overall benefit for those stocks for which harvest is allowed and data are sufficient to ensure a balanced approach to biological/ecological and socioeconomic outcomes. **Preferred Alternative 3** provides the greatest overall benefit for those stocks for which that balance is not well understood, specifically pelagic stocks newly added to management in the Puerto Rico FMP, because it would not result in unnecessary constraints to harvest for those prolific, wide-ranging stocks.

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## 2.6 Action 6: Describe and Identify EFH for Stocks not Previously Managed in the Puerto Rico Exclusive Economic Zone (EEZ)

This action follows from selecting Alternative 2 in Action 1 and proceeding with establishing a Puerto Rico FMP made up of measures pertinent to Puerto Rico. Through Action 6, the Council would describe and identify EFH for species that would be new to federal management in the Puerto Rico FMP. **Alternative 1** is the no action alternative which would result in not describing EFH for the proposed new species resulting from Action 2. **Preferred Alternative 2** would provide EFH designation for the new species proposed for federal management, following the same process used in the designation of EFH for all species in the fishery management units in the Reef Fish, Spiny Lobster, Queen Conch and Coral FMPs. **Alternative 3** provides alternative approaches to describing and identifying EFH. The approaches proposed in **Alternative 3**, however would not result in EFH designations at this time, due to the lack of data required by each of the approaches proposed under this alternative. These approaches were explored in the 2004 Final Environmental Impact Statement (EIS) for the Generic EFH Amendment (2004 EFH Final EIS [FEIS]) for describing and identifying EFH that could be used depending on data availability. At that time, the Council also was unable to use these means due to data limitations. All species managed by the Council to date have EFH designations. **Per Action 1, Preferred Alternative 2**, the Puerto Rico FMP retains EFH designations for all previously managed species in Puerto Rico. For those species in the Reef Fish, Queen Conch, Spiny Lobster and Coral FMPs, EFH in the US Caribbean consists of all waters from mean high water to the outer boundary of the EEZ – habitats used by eggs and larvae – (Figure 2.2; 2004 EFH-FEIS) and all substrates from mean high water to 100 fathoms depth – used by other life stages – (Figure 2.41; 2004 EFH-FEIS), shown in the aggregate as Figure 2.39 (2004 EFH-FEIS)." Therefore, there is no need to provide new EFH designations for those species and this action does not address those species. All current EFH include wetlands, mangroves, seagrass, benthic algal plains, mixed submerged aquatic vegetation (SAV), drift algae, coral reefs, sand-shell, mud and soft bottom habitats, hard bottom habitat and rubble.

### 2.6.1 Proposed Alternatives for Action 6

**Alternative 1.** No action. Do not describe and identify EFH for species not previously managed in federal waters of Puerto Rico.

**Preferred Alternative 2.** Describe and identify EFH for the species not previously managed according to functional relationships between life history stages of federally-managed species and Puerto Rico marine and estuarine habitats, based on best available information from the literature, landings data, fishery-independent surveys and expert opinion (Appendix H).

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**Alternative 3.** Use other information to describe and identify EFH for species not previously managed in federal waters of Puerto Rico, including:

1) Designating EFH based on distribution data (distribution of habitat types, fish species and fishing effort) (*Level 1 data – surveys of presence/absence; simple habitat/species associations)*;

2) Designating EFH based on habitat-related densities of the species (EFH would be defined as the area where the density or relative abundance of a species life stage is above a threshold level) *(Level 2 – Survey/fishery related catch per unit effort as proxy for density; or spatial modeling of probability of occurrence, or other forms of habitat suitability models)*;

3) Designating EFH based on data on growth, reproduction, or survival rates within habitats (*Level 3 – obtained from tagging data (growth), fecundity data by area*);

4) Designating EFH based on production rates by habitat (*Level 4*).

5) Habitat suitability models (*uses habitat suitability modeling prepared by National Ocean Service to infer information about species distribution, and possibly relative density (i.e. assuming that habitats with a higher suitability support greater abundances of a species life stage))*;

### 2.6.2 Discussion of Action 6 Alternatives

Under the Magnuson-Stevens Act, Councils, under the required provisions in the development of FMPs, have to "describe and identify essential fish habitat for the fishery based on the guidelines established by the Secretary under section 305(b)(1)(A), minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat;" (16 USC 1853(a)(7)). The alternatives considered provide compliance with the provisions of the Act to describe and identify EFH. These alternatives have been previously considered for all species in the Council's FMPs. In describing and identifying EFH and taking action to minimize adverse effects on such habitat caused by fishing, the Council considered the best scientific information available.

As identified in Action 2 (Preferred Alternative 2), the draft list of species to be managed under the Puerto Rico FMP includes queen conch (1 species), spiny lobster (1 species), 63 finfish species, sea cucumbers, sea urchins, and all species of coral. From these, 18 species of finfish are new to federal management. The species-based FMPs included many species of sea cucumbers, sea urchins, and corals, but that the Puerto Rico FMP will include all species. The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) requires that each FMP describe and identify EFH for each fishery. Thus, this action would identify and describe EFH for the proposed invertebrates mentioned above and the 18 fish

species new to federal management including cubera snapper, yellowmouth grouper, gray triggerfish, crevalle jack, African pompano, rainbow runner, manta, spotted eagle ray, sting ray, little tunny, blackfin tuna, king mackerel, cero, wahoo, tripletail, great barracuda, dolphin, and pompano dolphin. The information on habitat for all new species is included in Appendix H The remaining species identified for inclusion in the Puerto Rico FMP in Action 2 (Preferred Alternative 2) were previously managed under the Caribbean Fishery Management Council's (Council) Reef Fish, Queen Conch, Spiny Lobster, and Coral FMPs and already have existing EFH designations. These existing designations would be evaluated during the ongoing EFH 5-year Review.[23]

The Magnuson-Stevens Act defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." 16 USC 1802(10). NMFS EFH guidelines require maps depicting areas of proposed EFH for each alternative, and strongly encourage maps of proposed Habitat Areas of Particular Concern (HAPCs) for each alternative. The most significant impediments to describing and identifying EFH and mapping the extent of EFH have been the lack of information on species distributions and the paucity of habitat mapping information deeper than about 25 m (82 ft), the limited information available from mesophotic reefs (30-50 m [98-164 ft]) and the limited data on pelagic species in the region.

Under **Alternative 1** (No Action), the Council would not be complying with the requirements of the Magnuson-Stevens Act for the new species proposed for federal management. EFH would not be described and identified for 18 species of finfish, and the species of cucumbers, sea urchins, and corals new to management in the Puerto Rico FMP. The new finfish species for which EFH designations would not be provided include: Snapper 6, cubera snapper (*Lutjanus cyanopterus)*; the new species included in Grouper 4, yellowmouth grouper (*Mycteroperca intersticialis*); the new species included in the Triggerfish complex, gray triggerfish (*Balistes capriscus*); the three new jack stocks, crevalle or Jacks 1 (*Caranx hippos*), African pompano or Jacks 2 (*Alectis cilaris*), and rainbow runner or Jacks 3 (*Elegastis bipinnulata*). These six species co-occur with the reef fish species already under management in federal waters and included in the Reef Fish fishery management units. The jack species in the family Carangidae are usually described as coastal pelagics but their habitat is within that previously described and identified in the Reef Fish FMP (CFMC 2005). Jacks are found hovering over coral reef areas, in the water column and also feeding over seagrass beds. Although their habitat is already designated as EFH, it is designated as EFH for other species. The FMP, however, has to describe and identify EFH for each managed species.

[23] Under the Magnuson-Stevens Act, an FMP is required to both identify EFH and minimize to the extent practicable adverse effects on such habitat caused by fishing (16 USC 1853(a)(7)). The need to include an action to prevent, mitigate, or minimize adverse effects on EFH for species not previously managed in Puerto Rico federal waters will depend on the results of the analysis of the gear and techniques used to fish for those new species.

The other species proposed for management and for which EFH designations would not be determined under **Alternative 1** are: great barracuda (*Sphyraena barracuda*); two dolphin fish species in the family Coryphaenidae, dolphin and pompano dolphin (*Coryphaena hippurus* and *C. equiselis*); tripletail (*Lobotes surinamensis*); mackerels and tunas, and wahoo within three stock complexes in the Family Scombridae (Tuna complex: *Euthynnus alleteratus*- little tunny, *Thunnus atlanticus* – blackfin tuna or bonito in Spanish; Mackerel complex: *Scomberomorus cavalla* – king mackerel, *S. regalis* – cero mackerel; and Wahoo: *Acanthocybium solandri* – wahoo). These species are identified as coastal migratory pelagic fish and although their habitat also overlaps that of the reef fish (both the species already under management and the newly proposed reef fish species), the Council has not described or identified EFH for these species.

There are additionally three new species of manta and rays in the Families Myliobatidae (eagle and manta rays) and Dasyatidae (southern sting ray) proposed for federal management for which EFH has not been designated by the Council.

**Alternative 1** also would not identify EFH for any new species of sea cucumbers, sea urchins, and corals that have not been previously under management in the federal waters, within the Puerto Rico EEZ.

**Preferred Alternative 2** would describe and identify EFH according to functional relationships between life history stages of federally-managed species and Puerto Rico marine and estuarine habitats based on best available information from the literature, landings data, fishery-independent surveys and expert opinion... This alternative is the same as the preferred alternative of in the 2005 Caribbean Sustainable Fisheries Act Amendment (Caribbean SFA Amendment) that described and identified EFH as the functional relationships between life history stages of federally-managed species and Caribbean marine and estuarine habitats (CFMC 2005) based on the functional relationships for life stages and habitat types that might be regarded as meriting special attention for their importance to managed species. The M-S Act defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." These are the functions that marine and estuarine habitats support. Under this **Preferred Alternative 2**, the distribution of species and life stages is inferred from information on these the functional relationships. It may be possible to use information on ecological relationships to infer that some portions of the distribution range are more important than others for the sustainability of the species. This alternative therefore incorporates all available information for describing and identifying EFH for all managed species. All available information will be assessed to describe EFH for all managed species. However, little information exists on relationships between habitat, abundance, and distribution for many of the life stages of managed species in the US Caribbean. Lack of information might prevent precise mapping of the various habitats, habitat-related densities, or other ecological information covered under this **Preferred Alternative 2.** Confining EFH designation to only mapped habitat

areas would omit areas of habitat yet to be identified, and leave undesignated and without the protection afforded by EFH provisions, areas that may be essential to fish production. We do not know the difference between the distribution of the species over its life stages, and which areas within that distribution are EFH, therefore we are identifying all areas where the species are distributed as EFH.

However, potential habitats were mapped using maximum depth limits as boundaries. For practical purposes, and in accordance with the precautionary approach, describing and identifying EFH under this **Preferred Alternative 2** will be applied as broadly as possible. For each species, the habitats used by species and life stage are presented in Tables 2.6.1 to 2.6.3 and Appendix B. Tables 2.6.1, 2.6.2, and 2.6.3 are built from information in Appendix H. Mapping of the habitats occurs as described in Methodology Section 2.1.3.3.3 of the 2004 EFH-EIS. These maps build a composite EFH for each FMP from the individual EFH of all species and life stages under each FMP for which information on the functional relationship of species/life stages and habitat is available. Although species have been removed from the species-based FMPs, the maps are still adequate for the stocks and stocks complexes proposed for management.
EFH is identified as a result of applying **Preferred Alternative 2** using the information provided in Appendix H. The available data are too sparse to define boundaries of species distribution and habitat needs within the Puerto Rico EEZ. As a result, and because of the relatively small size of the area covered distribution of a species/life stage was modeled as its "potential" distribution. This was assumed to be any habitat with which the species/life stage associates, everywhere that that habitat occurs in the Puerto Rico EEZ. The maps shown in the 2004 EFH EIS include now in aggregate form all species proposed, the complete EEZ for the pelagic life stages (eggs and larvae) and the potential for habitats used by the juveniles and adults.
In the species-based FMPs, the Council stated that fishable habitat existed to 100-fathoms, however, this estimate is being re-evaluated as the fisheries have been expanding into deeper waters and as research and exploration continue in the deep-waters around Puerto Rico and the USVI. However, the data are not available except to continue to determine maximum depth of species seen and the habitat in which they are found. However, the majority of the exploration being conducted in the U.S. Caribbean is well beyond the 100-fathom depth leaving a gap in the data needed to re-evaluate the definition of fishable habitat.

Fishable habitat to 100 fathoms was defined to be used as a proxy for the maximum depth of where the species could be found and the maximum depth of potential usable habitats. Beyond this depth there is very limited information.

Appendix H lists the description of habitats used by the species identified as reef fish or closely associated with coral reefs and that belong to families for which EFH had been previously designated are: cubera snapper, yellowmouth grouper, gray triggerfish, and the jacks (crevalle jack, African pompano, rainbow runner). Although crevalle jack, African pompano, rainbow

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runner, giant manta ray, spotted eagle ray, and southern sting ray are more like pelagic species that inhabit the water column, these species are still closely associated with coral reef habitats as are reef fish.
The pelagic species in the barracuda, dolphinfish, tuna, mackerel, wahoo stocks/stock complexes feed on a very wide variety of fish, including several life stages of reef fish. These species are considered part of the coral-based, reef-associated fisheries, occupying the water column above these reef habitats near the shelf edge.

The two species of the tunas proposed for federal management are little tunny – *Euthynnus alletteratus* (Rafinesque 1810) and blackfin tuna – *Thunus atlanticus* (Lesson 1830). These species are found in the western Atlantic Ocean extending their range from New England through the Caribbean to Brazil. This distribution is shared by many of the species being considered for management. These species are seasonally present in the Puerto Rico EEZ. These species have a very wide distribution through the tropical and subtropical waters on both sides of the Atlantic, including the Mediterranean, Caribbean, and Gulf of Mexico.

**Preferred Alternative 2** specifies EFH by life stage, based on available distribution information by life stage, and its habitat needs by life stage. Under **Preferred Alternative 2**, the distribution of species and life stages is inferred from information the distribution of species and life stages is inferred from information about the areas that the species uses to support spawning, breeding, feeding, or growth to maturity.

The information on Appendix N can be summarized in the following tables describing, with very limited data, the life history stage by habitat developed from the available information on each species throughout its range. The information presented on the distribution of the species is not derived from a systematic presence/absence sampling and in many instances scientific reports have very small samples sizes. Further there are limited data on the distribution of habitats and the conditions of these habitats. Much of the information available is from geographical ranges to the north of the area of interest (Puerto Rico) with environmental conditions different from those found locally. All references are included in Appendix H. Information on eggs and larvae are generally at the family level (e.g., Serranidae for groupers) because the information is lacking on species-specific identification of larvae from local waters. Sargassum appears to be an important habitat for a number of species newly proposed for management and both the presence of the habitat and the fish are seasonal (e.g., dolphin fish). Changes in the environmental conditions influence the presence and permanence of the habitat in the local waters. Among the environmental and oceanographic conditions affecting Sargassum for example are winds, eddies, tidal changes and currents. Ageing of Sargassum will also influence the timing of its presence on the surface waters locally. These factors determine the amount of time the Sargassum will remain afloat.

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**Table 2.6.1.** Species new to management under the Puerto Rico FMP and their habitats per life stage. The information on this table is summarized from Appendix H. (MCD=Marine Conservation District, south of St. Thomas is the only No-Take area. The connectivity between this area and eastern Puerto Rico is currently being examined, Coral Reef Conservation Program Grant FY17.) The habitats described in the literature constitute in a broad and precautionary way EFH.

| Family | Species | Common Name | Unit | Eggs | Larvae | postlarvae | Juveniles | Adults | Spawning Adults |
|---|---|---|---|---|---|---|---|---|---|
| **Lutjanidae - Snappers** | *Lutjanus cyanopterus* | Cubera (PR) | SU6 | Pelagic | Pelagic | | Mangrove, reef | Rocky bottom, Reef, El Seco | Coral Bank Reefs |
| **Serranidae- Groupers** | *Mycteorperca interstitialis* | Yellowmouth grouper | GU4 | Pelagic | Pelagic | Pelagic | Mangrove, reef | rocky, coral; MCD; Mona; | Reef, rocky, coral; Grammanik Bank |
| **Balistidae- Triggerfishes** | *Balistes capriscus* | Gray triggerfish | Triggerfish | Demersal/Nets | Pelagic | | Sargasso, reefs, pelagic, flotsam | reefs, marine and brackish | Nest building/reefs |
| **Sphyraenidae - Barracudas** | *Sphyraena barracuda* | Great barracuda | Barracuda | Pelagic | Pelagic | Pelagic | Mangrove/Pelagic | Mangrove/Pelagic | Pelagic |
| **Lobotidae -- Tripletail** | *Lobotes surinamensis* | Tripletail | Tripletail | Pelagic | Pelagic | Pelagic | Pelagic | Pelagic | Pelagic |
| **Myliobatidae -- Eagle and manta rays** | *Manta birostris* | Manta | Rays Unit 1 | ovoviparity | | | Pelagic | Pelagic | Internal fertilization/Pelagic |
| | *Aetobatus narinari* | Spotted eagle ray | Rays Unit 2 | ovoviparity | | | Pelagic/epibenthic feeding | Pelagic/epibenthic feeding | Pelagic - ovoviviparous, internal fertilization |
| **Dasyatidae - Stingrays** | *Dasyatis americana* | Sting ray | Rays Unit 3 | ovoviparity | | | sand/silt/epibenthic feeding | sand/silt bottoms/epibenthic feeding/euryhaline/esturine | sand/silt bottoms; pairs; aplacental viviprity |
| **Carangidae--Jacks** | *Caranx hippos* | Crevalle | Jack Unit 1 | Pelagic | Pelagic | | Pelagic, reef, muddy bottom, brackish | Pelagic, reef, brackish | |
| | *Alectis ciliaris* | African Pompano | Jack Unit 2 | Pelagic | Pelagic | | Pelagic, reef | Pelagic, reef | |
| | *Elagatis bipinnulata* | Rainbow runner | Jack Unit 3 | Pelagic | Pelagic, floatsam | | Pelagic, reef, flotsam | Pelagic, reef, flotsam | |
| **Coryphaenidae - Dolphin fish PR/STT/STX** | *Coryphaena hippurus* | Dolphin | Dolphinfish | Pelagic | Pelagic, floatsam, Sargassum | Pelagic | Pelagic/migratory/no temperature barrier/Sargassum/floatsam | Pelagic/migratory/Sargassum/ flotsam/weed lines/trap buoys | Pelagic/wide geographic range |
| | *Coryphaena equiselis* | Pompano dolphin | Dolphinfish | Pelagic | Pelagic | Pelagic | Pelagic/migratory | Pelagic | Pelagic |
| **Scombridae -- Mackerels and tunas** | *Euthynnus alletteratus* | Little tunny | Tuna | Pelagic | Pelagic/ oceanic | Pelagic | Pelagic/prey aggregations | Pelagic/prey aggregations | Pelagic |
| | *Thunnus atlanticus* | Blackfin tuna | Tuna | Pelagic | Pelagic/ oceanic | Pelagic | Pelagic/prey aggregations | Pelagic/prey aggregations | Pelagic |
| | *Scomberomorus cavalla* | King mackerel | Mackerel | Pelagic | Pelagic/ oceanic | Pelagic | Pelagic/prey aggregations | Pelagic/prey aggregations | Pelagic |
| | *Scomberomorus regalis* | Cero | Mackerel | Pelagic | Pelagic/ oceanic | Pelagic | Pelagic/prey aggregations | Pelagic/prey aggregations | Pelagic |
| | *Acanthocybium solandri* | Wahoo | Wahoo | Pelagic | Pelagic/ oceanic | Pelagic | Pelagic | Pelagic | Pelagic |
| **Class Holothuroidea --Sea Cucumbers** | Holothuroidea | Cucumbers | Cucumbers | Pelagic/ Internal | Pelagic/ brooding/ live young | | Sand, seagrass, Pelagic | Sand, seagrass, Pelagic | Sand, seagrass, Pelagic |
| **Class Echinoidea --Sea Urchins** | Echinoidea | Urchins | Urchins | Pelagic / brooding | Pelagic/ brooding | | Sand, seagrass | Sand, seagrass | Sand, seagrass, coral |
| **All Corals (soft, hard, mesophitc, deep)** | Corals | Corals | Corals | Pelagic | Pelagic | hard substrate | coral, hard substrate | sand, coral, hard substrate | sand, coral, hard substrate |

The information available include the use of habitat type by life history stages of the newly proposed species for federal management and the habitat maps with associated distribution of these habitats. Specific information on the use of habitats by life history stages is minimal or limited to the presence of the species at specific sites where surveys were conducted. Information provided by experts (SSC meetings, DAPs meetings, unpublished data, non-peer reviewed reports, and published literature) and published literature from areas other than the Puerto Rico/US Caribbean waters were also considered for the designation of EFH.

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**Table 2.6.2.** Summary of habitat types utilized by life history stage of new species proposed for federal management in Puerto Rico (E=eggs, L=Larvae, J=Juvenile, A=Adult, SPA=Spawning Adult).

| Family | Species | Common Name | Unit | Mangrove | Seagrass | Coral Reef | Hardbottom | Sand | Mud | Algal Plains | Pelagic/Water column | Sargassum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Lutjanidae - Snappers** | *Lutjanus cyanopterus* | Cubera (PR) | SU6 | **J** | | **J/A** | **A** | | | | **E/L** | |
| **Serranidae- Groupers** | *Mycteorperca interstitialis* | Yellowmouth grouper | GU4 | **J** | | **J/A/SPA** | **J/A** | | | | **E/L** | |
| **Balistidae- Triggerfishes** | *Balistes capriscus* | Gray triggerfish | Triggerfish | | | **E/J/ A** | | | | | **L/ J/A** | **J** |
| **Sphyraenidae - Barracudas** | *Sphyraena barracuda* | Great barracuda | Barracuda | **J** | **J** | **A** | **A** | | | | **E/L/ J/ A** | **E/L** |
| **Lobotidae -- Tripletail** | *Lobotes surinamensis* | Tripletail | Tripletail | | | | | | | | **E/L/ J/ A** | **E/L** |
| **Myliobatidae -- Eagle and manta rays** | *Manta birostris* | Manta | Rays Unit 1 | | | | | | | | **J/A** | |
| | *Aetobatus narinari* | Spotted eagle ray | Rays Unit 2 | | | **J/A** | **J/A** | **J/A** | | | **J/A** | |
| **Dasyatidae - Stingrays** | *Dasyatis americana* | Sting ray | Rays Unit 3 | **J/A** | **J/A** | **J/A** | | **J/A** | | | **J/A** | |
| **Carangidae--Jacks** | *Caranx hippos* | Crevalle | Jack Unit 1 | | | **J/A** | **J/A** | | **J** | | **E/L/ J/ A** | |
| | *Alectis ciliaris* | African Pompano | Jack Unit 2 | | | **J/A** | **J/A** | | | | **E/L/ J/ A** | |
| | *Elagatis bipinnulata* | Rainbow runner | Jack Unit 3 | | | **J/A** | **J/A** | | | | **E/L/ J/ A** | |
| **Coryphaenidae - Dolphin fish PR/STT/STX** | *Coryphaena hippurus* | Dolphin | Dolphinfish | | | **J/A** | **J/A** | | | | **E/L/ J/ A** | **E/L/ J/ A** |
| | *Coryphaena equiselis* | Pompano dolphin | Dolphinfish | | | **J/A** | **J/A** | | | | **E/L/ J/ A** | **E/L/ J/ A** |
| **Scombridae -- Mackerels and tunas** | *Euthynnus alletteratus* | Little tunny | Tuna | | | | | | | | **E/L/ J/ A** | **E/L** |
| | *Thunnus atlanticus* | Blackfin tuna | Tuna | | | | | | | | **E/L/ J/ A** | **E/L** |
| | *Scomberomorus cavalla* | King mackerel | Mackerel | | | | | | | | **E/L/ J/ A** | **E/L** |
| | *Scomberomorus regalis* | Cero | Mackerel | | | | | | | | **E/L/ J/ A** | **E/L** |
| | *Acanthocybium solandri* | Wahoo | Wahoo | | | **J/A** | **J/A** | | | | **E/L/ J/ A** | **E/L/ J/ A** |
| **Class Holothuroidea --Sea Cucumbers** | Holothuroidea | Cucumbers | Cucumbers | **J/A** | **J/A** | **J/A** | **J/A** | **J/A** | | **J/A** | **E/ L/J/A (deep water)** | |
| **Class Echinoidea --Sea Urchins** | Echinoidea | Urchins | Urchins | **J/A** | **J/A** | **J/A** | **J/A** | **J/A** | **J/A** | **J/A** | **E/L/ J/ A** | |
| **All Corals (soft, hard, mesophitc, deep)** | Corals | Corals | Corals | | | **J/A** | **J/A** | | | | **E/L** | |
| **E=eggs, L=Larvae, J=Juvenile, A=Adult, SPA-=Spawning Adult** | | | | | | | | | | | | |

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**Table 2.6.3.** Summary table of habitat types used by the new species proposed for management showing "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" by life history stage based on the information found in Appendix H (E=eggs, L=Larvae, J=Juvenile, A=Adult, SPA=Spawning Adult; F=feeding, G= growth, S=Spawning, B=breeding).

| Family | Species | Common Name | Unit | Mangrove | Seagrass | Coral Reef | Hardbottom | Sand | Mud | Algal Plains | Pelagic/Water column | Sargassum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Lutjanidae - Snappers** | *Lutjanus cyanopterus* | Cubera (PR) | SU6 | **J F G** | | **J/A FG S?** | **A F G** | | | | **E/L F G** | |
| **Serranidae- Groupers** | *Mycteorperca interstitialis* | Yellowmouth grouper | GU4 | **J F G** | | **J/A S** | **J/A F G** | | | | **E/L F G** | |
| **Balistidae- Triggerfishes** | *Balistes capriscus* | Gray triggerfish | Triggerfish | | | **E/J/ A F G S** | | | | | **L/ J/A F G** | **J F G** |
| **Sphyraenidae - Barracudas** | *Sphyraena barracuda* | Great barracuda | Barracuda | **J F G** | **J F G** | **A F G** | **A F G** | | | | **L/ J/A F G S** | **E/L F G** |
| **Lobotidae -- Tripletail** | *Lobotes surinamensis* | Tripletail | Tripletail | | | | | | | | **L/ J/A F G S** | **E/L F G** |
| **Myliobatidae -- Eagle and manta rays** | *Manta birostris* | Manta | Rays Unit 1 | | | | | | | | **J/A F G B** | |
| | *Aetobatus narinari* | Spotted eagle ray | Rays Unit 2 | | | **J/A F G** | **J/A F G** | **J/A F G** | | | **J/A F G B** | |
| **Dasyatidae - Stingrays** | *Dasyatis americana* | Sting ray | Rays Unit 3 | **J/A F G** | **J/A** | **J/A F G** | | **J/A F G** | | | **J/A F G B** | |
| **Carangidae--Jacks** | *Caranx hippos* | Crevalle | Jack Unit 1 | | | **J/A F G** | **J/A F G** | | **J F G** | | **L/ J/A F G S** | |
| | *Alectis ciliaris* | African Pompano | Jack Unit 2 | | | **J/A F G** | **J/A F G** | | | | **L/ J/A F G S** | |
| | *Elagatis bipinnulata* | Rainbow runner | Jack Unit 3 | | | **J/A F G** | **J/A F G** | | | | **L/ J/A F G S** | |
| **Coryphaenidae - Dolphin fish PR/STT/STX** | *Coryphaena hippurus* | Dolphin | Dolphinfish | | | **J/A F G** | **J/A F G** | | | | **L/ J/A F G S** | **L/ J/A F G** |
| | *Coryphaena equiselis* | Pompano dolphin | Dolphinfish | | | **J/A F G** | **J/A F G** | | | | **L/ J/A F G S** | **L/ J/A F G** |
| **Scombridae -- Mackerels and tunas** | *Euthynnus alletteratus* | Little tunny | Tuna | | | | | | | | **L/ J/A F G S** | **E/L F G** |
| | *Thunnus atlanticus* | Blackfin tuna | Tuna | | | | | | | | **L/ J/A F G S** | **E/L F G** |
| | *Scomberomorus cavalla* | King mackerel | Mackerel | | | | | | | | **L/ J/A F G S** | **E/L F G** |
| | *Scomberomorus regalis* | Cero | Mackerel | | | | | | | | **L/ J/A F G S** | **E/L F G** |
| | *Acanthocybium solandri* | Wahoo | Wahoo | | | **J/A F G** | **J/A F G** | | | | **L/ J/A F G S** | **L/ J/A F G** |
| **Class Holothuroidea --Sea Cucumbers** | Holothuroidea | Cucumbers | Cucumbers | **J/A F G S** | **J/A F G S** | **J/A F G S** | **J/A F G S** | **J/A F G S** | | **J/A F G S** | **E/ L/J/A (deep water) F G S** | |
| **Class Echinoidea --Sea Urchins** | Echinoidea | Urchins | Urchins | **J/A F G S** | **J/A F G S** | **J/A F G S** | **J/A F G S** | **J/A F G S** | **J/A F G** | **J/A F G S** | **E/L/ J/ A F G** | |
| **All Corals (soft, hard, mesophitc, deep)** | Corals | Corals | Corals | | | **J/A F G S** | **J/A F G S** | | | | **E/L F G** | |
| **E=eggs, L=Larvae, J=Juvenile, A=Adult, SPA-=Spawning Adult** | **F=feeding, G= growth, S=Spawning, B=breeding** | | | | | | | | | | | |

Under **Preferred Alternative 2**, based on the distribution of species and life history stages (Appendix H), the EFH is defined as follows:

<u>EFH for cubera snapper</u> in the Puerto Rico FMP consists of all waters from the mean high water to the outer boundary of the EEZ – habitats used by eggs and larvae – and all substrates from mean high water to the maximum depth at which Cubera may be found [it is not known if Cubera can be found deeper that 100 fathoms] – used by other life stages.

The specific habitats reported to be utilized juvenile cubera snapper include mangroves and reefs, and habitats used by adults include coral reefs, rocky hard bottom, and coral banks reefs to at least 50 m depth. Identification of potential spawning aggregations sites have been identified at El Seco in Vieques, Grappler Bank and others but none have been confirmed as such.

In the species-based FMPs, the Council stated that fishable habitat existed to 100-fathoms, however, this estimate is being re-evaluated as the fisheries have been expanding into deeper waters and as research and exploration continue in the deep-waters around Puerto Rico and the USVI. However, the data are not available except to continue to determine maximum depth of species seen and the habitat in which they are found. However, the majority of the exploration

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being conducted in the U.S. Caribbean is well beyond the 100-fathom depth leaving a gap in the data needed to re-evaluate the definition of fishable habitat.

EFH for yellowmouth grouper in the Puerto Rico FMP consists of all waters from the mean high water to the outer boundary of the EEZ – habitats used by eggs and larvae – and all substrates from mean high water to the maximum depth at which yellowmouth may be found [it is not known if yellowmouth groupers can be found deeper that 100 fathoms] – used by other life stages. The specific habitats reported to be utilized by yellowmouth groupers include mangroves, reefs, rocky outcrops, coral reefs, coral bank reefs to at least 50 m depth.

EFH for species in the Dolphinfish complex (dolphin and pompano dolphin) in the Puerto Rico FMP consists of all waters from the mean high water to the outer boundary of the EEZ – habitats used by eggs, larvae, juveniles, and adults. These 2 pelagic species are migratory through the US Caribbean, not having identified a local stock and furthermore EFH for these species includes Sargassum, weed lines, flotsam, and floating objects even when attached to traps for example. These habitats provide shelter and food to grow.

EFH for species in the family Scombridae (tunas, mackerels and wahoo) in the Puerto Rico FMP consists of all waters from the mean high water to the outer boundary of the EEZ – habitats used by eggs and larvae as well as juveniles and adults of all species proposed for management. All life stages are pelagic. Aggregations tend to occur around prey also found in the pelagic realm. These species area either seasonally present or seasonally targeted the distinction is not very clear. The only distinctive zonation reported is for wahoo which shows preference for the shelf edge.

EFH for the triggerfish *Balistes capriscus* within the Triggerfish stock complex in the Puerto Rico FMP consists of all waters from the mean high water to the outer boundary of the EEZ – habitats used by the larvae, a characteristic shared with the other species in the complex. However, EFH for eggs of *B. capriscus* would include not only the water column but also coral reef substrate where nests are built. It is not known if this behavior occurs in the US Caribbean. EFH for other life stages of the grey triggerfish consists of all substrates from mean high water to the maximum depth at which the grey triggerfish may be found [it is not known if grey triggerfish can be found deeper that 100 fathoms]. The specific habitats reported to be utilized by the grey triggerfish are reefs, coral reefs and the water column. Sargassum has also been reported to be utilized by grey triggerfish larvae, juveniles, and adults.

EFH for great barracuda (*Sphyraena barracuda*) in the Puerto Rico FMP consists of all waters from the mean high water to the outer boundary of the EEZ – habitats used by eggs and larvae – and all substrates from mean high water to the maximum depth at which the great barracuda may be found [it is not known if it can be found deeper that 100 fathoms, it has been reported form

the water column with depth greater than 100 fathoms] – used by other life stages. The specific habitats reported to be utilized by the great barracuda include mangroves, seagrass, reefs, rocky outcrops, coral reefs, coral banks reefs to at least 50 m depth, hardbottom, sand and the water column or pelagic environment.

EFH for tripletail (*Lobotes surinamensis*) in the Puerto Rico FMP consists of all waters from the mean high water to the outer boundary of the EEZ – habitats used by eggs and larvae, juveniles and adults. The species is pelagic and the specific habitats it uses are those waters associated to floating objects such as fish attracting devices (W. Merten, personal communication, https://dolphintagging.com/). They have been found floating near mangrove areas (G. Garcia-Moliner, CFMC, personal communication) but it appears to have a completely pelagic (neritic and oceanic) existence.

EFH for the Carangidae (Jacks) (3 separate stock complexes: crevalle or Jacks 1 (*Caranx hippos*), African pompano or Jacks 2 (*Alectis cilaris*), and rainbow runner or Jacks 3 (*Elegastis bipinnulata*) in the Puerto Rico FMP consists of all waters from the mean high water to the outer boundary of the EEZ – habitats used by eggs and larvae and juveniles and adults– and all substrates from mean high water to the maximum depth at which crevalle, African pompano and rainbow runner may be found [it is not known if these jacks can be found deeper that 100 fathoms] – used by juveniles and adults. The specific habitats reported to be utilized include brackish waters near rivers and estuaries, reefs, rocky outcrops, coral reefs, coral banks reefs, the water column from surface to deep-waters and flotsam.

EFH for Eagle and Manta Rays in the Puerto Rico FMP consists of all waters from the mean high water to the outer boundary of the EEZ – habitats used by juveniles and adults – and all substrates from mean high water to the maximum depth at which these may be found [it is possible that these species can be found deeper that 100 fathoms] – used by juveniles and adults for feeding. The specific habitats reported to be utilized by these species include reefs, rocky outcrops, coral reefs, hardbottom, and sand.

EFH for sting rays in the Puerto Rico FMP consists of all waters from the mean high water to the outer boundary of the EEZ – habitats used by juveniles and adults – and all substrates from mean high water to the maximum depth at which this species may be found [it is not known if the southern sting ray can be found deeper that 100 fathoms] – also used by juveniles and adults for feeding and growing. The specific habitats reported to be utilized by the sting ray include mangroves, seagrass, coral reefs, and sand.

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Fish spawning aggregation sites are of special concern to management because of the vulnerability of the fish to fishing pressure at the time of reproduction. Most of the new species proposed for federal management have been documented at the protected areas already in place in the federal waters of Puerto Rico: Bajo de Sico, Abrir la Sierra and Tourmaline. These species new to management also have been reported from other non-protected but known spawning aggregation sites in the state waters of Puerto Rico. The information available on potential SPAGs for the species newly proposed for federal management are represented in Table 2.6.4 below. The information is based on local knowledge of fishers interviewed and specifically asked for locations and status of fish spawning aggregations (Ojeda et al. 2007). These sites have not been confirmed to date. Numbers correspond to specific sites on each coast. None of these sites correspond to areas already under management.

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**Table 2.6.4.** Potential spawning aggregation areas for species that would be new to management under the Puerto Rico FMP.

| | | West Coast | | | South Coast | | | | | | | | North Coast | | | | | | | | | | East Coast | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Common Name** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** |
| *Lutjanus cyanopterus* | Cubera snapper | | | | X | | X | | X | | | | | | | | | | X | | X | | | X | |
| *Mycteorperca interstitialis* | Yellowmouth grouper | | | | X | | | | | | | | | | X | | | | | | | | | | |
| *Balistes capriscus* | Gray triggerfish | | | | | | | | | | | | | | | | | | | | | | | | |
| *Sphyraena barracuda* | Great barracuda | | | | | | | | | X | | | X | | | | | | | | | | | | |
| *Lobotes surinamensis* | Tripletail | | | | | | | | | | | | | | | | | | | | | | | | |
| *Manta birostris* | Manta | | | | | | | | | | | | | | | | | | | | | | | | |
| *Aetobatus narinari* | Spotted eagle ray | | | | | | | | | | | | | | | | | | | | | | | | |
| *Dasyatis americana* | Sting ray | | | | | | | | | | | | | | | | | | | | | | | | |
| *Caranx hippos* | Crevalle | | | | | | X | X | | | X | X | | | | | | | | | | | | | |
| *Alectis ciliaris* | African Pompano | | | | | | | | | | | | | | | | | | | | | | | | |
| *Elagatis bipinnulata* | Rainbow runner | | | | | | | | | | | | | | | | | | | | | | | | |
| *Coryphaena hippurus* | Dolphinfish | X? | X? | | | | | | | | | | X | | | | | | | | | | | | |
| *Coryphaena equiselis* | Pompano dolphin | | | | | | | | | | | | | | | | | | | | | | | | |
| *Euthynnus alletteratus* | Little tunny | | | | | | | | | | | | | | | | | | | | | | | | |
| *Thunnus atlanticus* | Blackfin tuna | | | | | | X | | | | | | | | | | | | | | | | | | |
| *Scomberomorus cavalla* | King mackerel | X | | | | | | | | | | | | | | | | X | | | | | | | |
| *Scomberomorus regalis* | Cero | | | X | | X | X | X | X | | X | X | X | X | | X | X | | | X | | X | X | | X |
| *Acanthocybium solandri* | Wahoo | X? | | | X | | | | | | | | | | | | | | | | | | | | |

**Preferred Alternative 2** would describe EFH for all species of sea cucumbers, sea urchins, and corals. Section 4.7.1 of the Caribbean SFA Amendment (CMFC 2005) described EFH for coral and species of sea cucumbers and sea urchins then under management as: "EFH for the coral fishery in the U.S. Caribbean consists of all waters from mean low water to the outer boundary of the EEZ – habitats used by larvae – (Figure 2.2; EFH FEIS) and coral and hard bottom substrates from mean low water to 100 fathoms depth – used by other life stages – (Figure 2.42; EFH FEIS), shown in the aggregate as Figure 2.39 (EFH FEIS)." The Puerto Rico FMP adds additional species of coral, sea urchins, and sea cucumbers to the management units, so that all species in these groups are managed. Some of the species that will be new to management include species that occur in waters deeper than 100 fathoms; the Council would have to describe and identify EFH for these species to include the depths of the mostly unexplored EEZ.

The list of new species of sea cucumbers and sea urchins under management (Appendix N) include species that have been reported from depths of over 3,000 m or Puerto Rico Trench. These organisms are found in rocky bottoms, sandy bottoms, mud-like bottoms, they are associated with both the benthos and the water column, with feeding taking place over sand-like sediment. Class Echinoidea includes not only the sea urchins but also the sand dollars, common prey items of the rays. Sea urchins feed on algae, sessile organisms and carrion while being themselves food source for fish (e.g., triggerfishes) or being used as shelter (e.g., juvenile grunts). Deep-water urchins are detritus feeders. Sea cucumbers are in the Class Holothuroidea with over 500 species. Elasipodida are the deep-water holothurids that can be pelagic and benthic. Mostly are deposit or suspension feeders.

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Under **Preferred Alternative 2**, EFH for sea urchins and cucumbers in the Puerto Rico FMP consists of all waters from the mean high water to the outer boundary of the EEZ – habitats used by eggs and larvae – and all substrates from mean high water to the maximum depth at which sea urchins and cucumbers may be found [it is known that urchins and cucumbers can be found deeper that 100 fathoms] – used by eggs (brooding behavior by adult), young born from ovary of cucumber, and other life stages. The specific habitats reported to be utilized by urchins and cucumbers include mangroves, reefs, rocky outcrops, coral reefs, coral banks reefs to at least 50 m depth, sand, mud, algal plains, water column (swimming cucumber).

Under **Preferred Alternative 2**, EFH for Corals in the Puerto Rico FMP consists of all waters from the mean high water to the outer boundary of the EEZ – habitats used by eggs and larvae – and all substrates from mean high water to the maximum depth at which corals (ahermatypic, solitary corals) may be found [it is known that corals are found deeper that 100 fathoms] – used by other life stages. The specific habitats reported to be utilized by corals include reefs, rocky outcrops, coral reefs, coral banks reefs to at least 50 m depth, other organisms that offer a hard substrate, and sand.

The methodology previously used to establish EFH, based on the best available scientific information, including expert opinion, would provide the basis for EFH determination for the new species proposed for management. Data based on abundance and densities, quantifiable predator-prey interactions, other than small samples of stomach contents, and other data considered in **Alternative 3** are lacking. The proposed methodology in **Preferred Alternative 2** fulfills the requirements of the Magnuson-Stevens Act in describing EFH with the information available. The methodology provides for describing potential EFH based on the actual habitat information available and further identifying HAPCs (e.g., spawning aggregation sites). Selecting **Preferred Alternative 2** will result in EFH designations for the species new to management. The identified EFH includes habitats used by fish for feeding, and growing to maturity such as areas of mangrove, the water column used by fish eggs and larvae and coral reefs. **Preferred Alternative 2** allows the Council to infer EFH based on the species' presence in particular habitats at various life stages and knowledge of their habitat needs. In this way, because sea urchins and sea cucumbers are found in seagrass beds and sand habitats, the Council is able to identify these areas as EFH for these species as they likely support their feeding and growing to maturity.

**Alternative 3** would allow the Council to choose between additional sources of information to describe EFH. These sources of information, and how they are used to describe and identify EFH, were discussed in the March 2004 Final Environmental Impact Statement for the Generic EFH Amendment (CFMC 2004). The Council lacks the information to specify EFH using any of the methods described in **Alternative 3** and thus this alternative would not result in the

designation of EFH for these species. For example, data based on habitat-related densities (Level 2 information), and other data considered in **Alternative 3** are lacking.

**Alternative 3** proposes the use of other information to describe and identify EFH for species not previously managed in federal waters of Puerto Rico including:

1) Designating EFH based on distribution data (distribution of habitat types, fish species and fishing effort) (*Level 1 data – surveys of presence/absence; simple habitat/species associations)*;

2) Designating EFH based on habitat-related densities of the species (EFH would be defined as the area where the density or relative abundance of a species life stage is above a threshold level) *(Level 2 – Survey/fishery related catch per unit effort as proxy for density; or spatial modeling of probability of occurrence, or other forms of habitat suitability models)*;

3) Designating EFH based on data on growth, reproduction, or survival rates within habitats (*Level 3 – obtained from tagging data (growth), fecundity data by area*);

4) Designating EFH based on production rates by habitat (*Level 4*).

5) Habitat suitability models (*uses habitat suitability modeling prepared by National Ocean Service to infer information about species distribution, and possibly relative density (i.e. assuming that habitats with a higher suitability support greater abundances of a species life stage))*;

The information that the Council could use to identify and describe EFH, described under **Alternative 3,** were fully discussed in the 2004 EFH FEIS (CFMC 2004) and the discussion is incorporated by reference herein.

The Council is engaged in endorsing projects to further data collection and analysis of the data that would result in viable EFH designations. The Caribbean Fishery Ecosystem Plan is one such collaborative effort. The Council has received NOAA Coral Reef Conservation Program grants that have resulted in the baseline characterizations of mesophotic reefs (98-164 ft [30-50 m]) and the extended description of habitat with depth for species within the fish communities at these depths. The 5-year EFH Review would include an evaluation of the data available to determine the potential to refine designations for species proposed and currently under management. The Council has also been engaged in the development of a geographic information system (GIS) database of the reported commercial landings to determine the feasibility to use spatial data in the description and identification of EFH. This project is currently underway. All these efforts would provide the basis for changes in the EFH designations. NMFS's guidelines on EFH requires using the highest level of information

(production rates) first (if available), followed by the second highest level (growth, reproduction or survival rates) and so on (50 CFR 600.815(a)(1)(iii)). The guidelines also call for applying this information in a risk-averse fashion to ensure adequate areas are protected as EFH. The most complete information available should be used to determine EFH for each species and life stage. If higher level information is available only for a portion of the species/life stage range then a decision needs to be made regarding how the information should be used – for example can the knowledge from the portion of the range covered be extrapolated to the rest of the range? Additionally, the Councils and NMFS should periodically review and revise the EFH components of FMPs based on available pertinent information.

**Comparison of Action 6 Alternatives**

Under **Alternative 1** (No Action), the Council would not be complying with the requirements of the Magnuson-Stevens Act for the new species proposed for federal management. EFH would not be described and identified for 18 species of finfish, species of cucumbers, sea urchins, and corals in the Puerto Rico FMP. Once identified, the Council must minimize effects on EFH caused by fishing, and identify other actions to encourage conservation and enhancement of this areas. The indirect effects on the species and habitat result from two different scenarios. First, after identifying EFH, the Council will determine whether they need to take action to protect these areas from the adverse effects of fishing, for example, by instituting seasonal or area closures. Second, once designated, federal agencies have to consult on actions that may affect EFH, and those consultations can result in beneficial mitigation. Under **Alternative 1** it would not be possible to determine if there is a need for specific or additional management to protect EFH for the 18 finfish species. For example, yellowmouth grouper, a species new to management for which EFH would not be identified under **Alternative 1**, aggregates for spawning as do other deeper water groupers. Protections exist for certain spawning aggregation sites, but under **Alternative 1**, the Council would not determine if these areas are EFH for the yellowmouth grouper or if additional aggregations exist that might be EFH. In addition, once identified, federal agencies must consult on actions that may adversely affect EFH, and these consultations also provide a means to protect this habitat. Not identifying EFH for the newly proposed species, assuming the EFH identified differed from the already identified EFH, would not allow the Council to realize the benefits to the biological and ecological environments from consultations or other actions to protect the habitat. Not identifying EFH for the newly proposed species would have a negative administrative impact by not complying with the provisions of the Magnuson-Stevens Act.

**Alternative 1** would not alter the current EFH descriptions for species already under management as this action does not address those species.

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Under **Preferred Alternative 2**, all new species proposed for management would have EFH described and identified in the Puerto Rico FMP, as required under the Magnuson-Stevens Act. Many, if not all, of the species proposed for federal management under the Puerto Rico FMP have been observed in protected areas such as Bajo de Sico, Abrir la Sierra and Tourmaline in western Puerto Rico. At least two of these areas have a seasonal closure in place prohibiting all fishing during the closure. These areas have been designated as HAPCs under the Caribbean SFA Amendment (CFMC 2005). HAPCs identified in Section 3.2.3.1.1 would also be HAPCs for the species new to management. There are no indirect effects on the biological, physical and ecological environment of designating these areas as EFH for these species because the Council has already identified these important areas as EFH for other species and has taken action to close these areas to fishing when those species area present. Note, however, we would need to know the area/seasonal closures exist for the same time period in which the species added to management would use the area but this is information is not available. Likewise, although there might already be EFH consultations on these areas, they don't focus on the specific ways that the new species use this area, so again, we would need to know how the species use differs, if at all however, the information is not available at this time.
**Preferred Alternative 2** would be the best approach to describe and identify EFH for the 18 finfish species proposed for management under the Puerto Rico FMP. **Preferred Alternative 2** allows the Council to use available information to describe and identify EFH for the different life stages of the species new to management under the FMP. **Alternative 1** would not comply with the requirements of the MSA, resulting in direct negative impacts on the administrative environment.

Under **Alternative 3**, the Council would require data that are not currently available to consider any of the to describe EFH for the 18 species proposed for management. For example, spatial data are not available to populate the models that would contribute to a more precise description of EFH or to more specifically identify EFH, and gathering this data is not feasible at this stage. The sources of fishery-independent data that have been identified at this late stage of the Puerto Rico FMP. The Council is proposing to specifically prepare the data for the next EFH 5-year review because the data set requires extensive quality control and assessment, very time-consuming task, before the determination that the data can be used for the purpose of describing EFH based on population densities and specific habitat associations.

**Alternative 3** includes options that would provide the most refined description of EFH for all species under management. The Council strives to obtain the data needed to improve on the identification of EFH. The use of these options in the future would likely have positive ecological, biological, and administrative benefits when the data become available. More refined description of EFH could allow the Council to take more tailored protective action if needed. More refined information also could also allow for more robust EFH consultations and potentially more tailored mitigation. Administrative benefits resulting from the application of

**Alternative 3** include allowing the Council to develop a more precise fishery ecosystem plan in its interest to continue moving forward with an ecosystem based approach to fishery management.

**Alternative 1** contrasts with **Preferred Alternative 2** and **Alternative 3** in that it would not address the legal mandate to describe and identify EFH. The new Puerto Rico FMP would not meet the required provisions of the Magnuson-Stevens Act, namely to describe and identify EFH for the 18 finfish species and additional species of coral, sea cucumbers, and sea urchins proposed for federal management under the preferred alternative in Action 2 (Preferred Alternative 2). All species new to management co-occur in the same habitats as those already managed, but there are a number of species that have a much more extensive distribution and that are only seasonally present in the Puerto Rico EEZ (e.g., dolphinfish). Other species new to management are known to be present in the EEZ but there is very limited information about the specifics of their EFH, for example the mantas and rays, tripletail and the mackerels. **Preferred Alternative 2** incorporates the best information available. **Alternative 3** provides mechanisms to improve on the description of EFH as data become available to move from basic levels of presence and absence (Level 1 in the guidelines) EFH descriptions to Level 4, the highest level of data using production rates by habitat. **Preferred Alternative 2** provides the Council with the use of the best available data and information to describe EFH for species in the fisheries that did not have EFH designation before.

Identifying EFH (**Preferred Alternative 2** and **Alternative 3**) results in benefits to the physical and biological/ecological environment. In identifying EFH for the new 18 finfish and a number of invertebrate species proposed for management, the Council could identify new areas that are EFH or, where the same areas are found to be EFH as are presently identified, new threats to this EFH.

The indirect effects of identifying EFH on the biological or ecological environment depend on which habitat is identified and whether the Council is already taking action to protect these areas. The Council must take action to minimize, to the extent practicable, the effects on EFH caused by fishing, and NMFS conducts consultations on actions that may affect EFH, with a goal of minimizing effects to EFH. Unless management measures are proposed to decrease fishing impact to habitats, bycatch or other aspects that impact EFH, or consultations on effects to EFH result in positive mitigation measures, **Preferred Alternative 2** and **Alternative 3** -description of EFH- would not have any effects on the physical, biological, ecological, social and economic environments, but may have effects on the administrative environments. **Alternative 1** however, in not complying with the requirements of the Magnuson-Stevens Act, would have an impact on the administrative environment.

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To summarize, identification and designation of EFH would not have a direct effect on the biological or physical environment but is could present indirect effects to those environments from EFH consultations, which may provide recommendations to minimize effects to EFH, or via actions the Council may take to reduce effects to EFH from fishing. The extent of these effects depends on whether the Council designates new areas as EFH, or whether the EFH for the species new to management is the same as the existing EFH designations. In addition, identification and designation of EFH would have indirect effects to the administrative environment due to consultation requirements, again to the extent that new areas are designated, and result in controversy within the social environment due to differences in desired methodologies for designating EFH.

## 2.7 Action 7: Framework Procedures for the Puerto Rico FMP

Through Action 7, the Caribbean Fishery Management Council (Council) would establish the framework procedure to be included under the new Puerto Rico Fishery Management Plan (FMP). As with the previous actions, this action follows from selecting Alternative 2 in Action 1 and proceeding with establishing a Puerto Rico FMP comprised of measures pertinent to Puerto Rico. The purpose of the framework is to allow the Council to more expeditiously adjust reference points and management measures in response to changing fishery conditions. Amendments done through frameworks (Framework Amendments) typically take less time to develop than a traditional plan amendment, while continuing to ensure a thorough evaluation of the effects of alternative approaches to achieving management goals.

### 2.7.1 Proposed Alternatives for Action 7

In Action 7, **Alternative 1** is the no action alternative and would result in retaining, in the Puerto Rico FMP, the framework procedures included in the Reef Fish FMP, Spiny Lobster FMP, Queen Conch FMP, and Coral FMP. Per Action 1, Alternative 2, the Council would create a Puerto Rico FMP that would retain management measures pertinent to Puerto Rico, including framework procedures. Therefore, no new or modified framework procedures would be added to the Puerto Rico FMP. **Preferred Alternative 2** proposes a framework procedure that includes both closed and open framework procedures (*see discussion of alternatives below)* and, within the open framework, the additional option of using an abbreviated framework. **Alternative 3** and **Alternative 4** both include open and closed framework procedures; however, **Alternative 3** proposes a broader framework procedure while **Alternative 4** proposes a narrower framework procedure than that included in **Preferred Alternative 2**.

**Alternative 1.** No action. In the Puerto Rico FMP, created in Action 1, retain the framework procedures presently included under the Reef Fish, Spiny Lobster, Queen Conch, and Corals and Reef Associated Plants and Invertebrates FMPs (Table 2.7.1).

**Preferred Alternative 2.** Adopt the Framework Procedure listed in Table 2.7.2.

**Alternative 3.** Adopt the broader Framework Procedure listed in Table 2.7.3.

**Alternative 4.** Adopt the narrower Framework Procedure listed in Table 2.7.4.

**Table 2.7.1.** Framework measures in the Reef Fish, Spiny Lobster, Coral, and Queen Conch FMPs under Alternative 1, Action 7.

| **Framework Measures in the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs** |
|---|
| a) Quota Requirements<br>b) Seasonal Closures<br>c) Area Closures<br>d) Fishing Year<br>e) Trip/Bag Limit<br>f) Size Limits<br>g) Gear Restrictions or Prohibitions<br>h) Fishery Management Unit (FMU)<br>i) Total Allowable Catch (TAC)<br>j) Annual Catch Limits (ACLs)<br>k) Accountability Measures (AMs)<br>l) Annual Catch Targets (ACTs)<br>m) Maximum Sustainable Yield (MSY)<br>n) Optimum Yield (OY)<br>o) Minimum Stock Size Threshold (MSST)<br>p) Maximum Fishing Mortality Threshold (MFMT)<br>q) Overfishing Limit (OFL)<br>r) Acceptable Biological Catch (ABC) control rules<br>s) Actions to Minimize the Interaction of Fishing Gear with Endangered Species or Marine Mammals |
| **Establish an assessment group and adjustments:**<br>The following discussion outlines the procedure by which the Council may make management changes through regulatory amendment. As previously discussed, the purpose of frameworks and regulatory amendments is to provide the most responsive and efficient modifications to management measures. If an additional review process was included, there could be substantial delays, thus resulting in a longer lag time between identification of a problem and implementation of a response.<br><br>1. When the Council determines that management measures require modification, the Council will appoint an advisory panel (Group) that will assess the condition of species in the management units (including periodic economic and sociological assessments as needed). The Group will present a report of its recommendations to the Council.<br><br>2. The Council will consider the report and recommendations of the Group and may hold public hearings at a time and place of the Council's choosing to discuss the Group's report. The Council may convene its |

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Scientific and Statistical Committee to provide advice prior to taking final action. After receiving public input, the Council will make decisions on the need for change.

3. If changes to management regulations are needed, the Council will advise the Regional Administrator (RA) in writing of its recommendations accompanied by the Group's report (where appropriate), relevant background material, draft regulations, Regulatory Impact Review, and public comments.

4. The RA will review the Council's recommendations, supporting rationale, public comments, and other relevant information. If the RA concurs that the Council's recommendations are consistent with the goals and objectives of the fishery management plan, the national standards, and other applicable laws, the RA will recommend that the Secretary take appropriate regulatory action for the fisheries on such date as may be agreed upon with the Council.

5. Should the RA reject the recommendations, the RA will provide written reasons to the Council for the rejection, and existing measures will remain in effect until the issue is resolved.

6. Appropriate adjustments that may be implemented by the Secretary include:

a. Specification of MSY or MSY proxy and subsequent adjustment where this information is available;

b. Specification of an ABC control rule and subsequent adjustment where this information is available;

c. Specification of TAC and subsequent adjustment where this information is available;

d. Specification of ACLs and Annual Catch Targets (ACTs), and subsequent adjustment;

e. Specification of AMs and subsequent adjustment;

f. Specification of OY and subsequent adjustment where this information is available;

g. Specification of Minimum Stock Size Threshold (MSST) and subsequent adjustment;

h. Specification of Maximum Fishing Mortality Threshold (MFMT) or OFL and subsequent adjustment;

i. Specification (or modification) of quotas (including zero quotas), trip limits, bag limits (including zero bag limits), size limits, gear restrictions (ranging from modifying current regulations to a complete prohibition, including to respond to interactions with listed species), season/area closures (including spawning closures), and fishing year;

j. Initial specification and subsequent adjustment of biomass levels and age structured analyses;

k. Adjustments to the composition of Fishery Management Units (FMUs).

Authority is granted to the RA to close any fishery (i.e. revert any bag limit to zero and close any commercial fishery), once a quota has been established through the procedure described above, and such quota has been filled.

If NMFS decides not to publish the proposed rule of the recommended management measures, or to otherwise hold the measures in abeyance, then the RA must notify the Council of its intended action and the reasons for NMFS' concern, along with suggested changes to the proposed management measures that would alleviate the concerns. Such notice shall specify: 1) The applicable law with which the amendment is inconsistent; 2) the nature of such inconsistencies; and 3) recommendations concerning the action that could be taken by the Council to conform the amendment to the requirements of applicable law.

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**Table 2.7.2.** Base framework procedure under Preferred Alternative 2 in Action 7.

| OPEN FRAMEWORK | |
|---|---|
| **1. Situations under which this open framework procedure can be used:**<br>**A. A new stock assessment or other information indicates changes should be made to: MSY, OFL, ABC, or other related management reference points and status determination criteria (SDC).** | |
| **B. New information or circumstances indicates management measures should be changed.**<br>- The Council will, as part of a proposed framework action, identify the new information and provide rationale as to why this new information indicates that management measures should be changed. | |
| **C. Changes are required to comply with applicable laws such as MSA, ESA, MMPA, or are required as a result of a court order.**<br>- In such instances, the RA will notify the Council in writing of the issue and the action that is required. If there is a legal deadline for taking action, the deadline will be included in the notification. | |
| **2. Types of Open Frameworks:** | |
| **Abbreviated Framework** | **Standard Framework** |
| Can be used for routine or insignificant changes | Changes that do not qualify as routine or insignificant. |
| Request is made with letter or memo from the Council to the RA with supporting analyses (biological, social, economic).<br>If RA concurs and approves action, it will be implemented through publication of FR Notice. | Requires a completed framework document with supporting analyses. |
| **Actions that can be taken under each Framework** | |
| **Abbreviated Framework** | **Standard Framework** |
| i. Gear marking requirements<br>ii. Vessel marking requirements<br>iii. Restrictions related to maintaining fish in a specific condition (whole condition, filleting, use as bait, etc.)<br>iv. Recreational bag and possession limit changes of not more than 1 fish per boat<br>v. Size limit changes of not more than one inch of the prior size limit for reef fish.<br>vi. Commercial vessel trip limit changes of not more than 10% of the prior trip limit<br>vii. Changes to the length of an established closed season by no more than 1 day of the existing season.<br>viii. Minor changes to gear modifications to address conservation issues including to respond to interactions with listed species. | In addition to making changes specified under Abbreviated Framework (left column) that exceed the established thresholds, the following actions can be completed via a standard framework:<br>i. Re-specify ABC<br>ii. Re-specify MSY and OY, and SDC<br>iii. Re-specify SYL<br>iv. Re-specify ACLs<br>v. Re-specify ACTs<br>vi. Rebuilding plans and revisions to approved rebuilding plans<br>vii. Revise accountability measures (e.g., change AM triggers and AM timing)<br>viii. Modify reporting and monitoring requirements<br>ix. Modify seasonal or year-round closures and closure procedures<br>x. Modify area closures and closure procedures |

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|---|---|
| **3.** | The Council will initiate the open framework process to inform the public of the issues and develop potential alternatives to address the issues. The framework process will include the development of documentation and public discussion during at least one council meeting. |
| **4.** | Prior to taking final action on the proposed framework action, the Council may convene its Scientific and Statistical Committee (SSC) or applicable Advisory Panel (AP), as appropriate, to provide recommendations on the proposed actions. |
| **5.** | For all framework actions, the Council will provide the letter, memo, or the completed framework document along with proposed regulations to the Regional Administrator in a timely manner following final action by the Council. |
| **6.** | For all framework action requests, the Regional Administrator will review the Council's recommendations and supporting information and notify the Council of the determinations, in accordance with the MSA and other applicable law. |
| **CLOSED FRAMEWORK** | |
| Consistent with existing requirements in the FMP and implementing regulations, the RA is authorized to conduct the following closed framework actions through appropriate notification in the Federal Register:<br>a. Reopen any sector of the fishery that had been prematurely closed.<br>b. Implement AMs, either in-season or post-season. Implement an in-season AM for a sector that has reached or is projected to reach, or is approaching or is projected to approach its ACL according to the process established in the FMP, or implement a post-season AM for a sector that exceeded its ACL according to the process established in the FMP, or any other established AM. | |

**Table 2.7.3.** Broad framework procedure under Alternative 3 in Action 7.

| **OPEN FRAMEWORK** |
|---|
| **1.** The Council may utilize this open framework procedure to implement management changes in response to any additional information or changed circumstances.<br>**a.** The Council will, as part of a proposed open framework action, identify any new information and provide rationale as to why this new information requires that management measures be adjusted.<br>**2.** Open framework actions may be implemented at any time based on information supporting the need for adjustment of management measures or management parameters:<br>**Actions that can be taken under this Open Framework**<br>i. Re-specify ABC<br>ii. Re-specify MSY and OY, and SDC<br>iii. Re-specify SYL<br>iv. Re-specify ACLs<br>v. Re-specify ACTs<br>vi. Rebuilding plans and revisions to approved rebuilding plans<br>vii. Revise accountability measures (e.g., change AM triggers and AM timing)<br>viii. Modify reporting and monitoring requirements<br>ix. Modify seasonal or year-round closures and closure procedures |

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| x. Modify area closures and closure procedures<br>xi. Modify recreational bag and possession limits<br>xii. Modify commercial trip limits<br>xiii. Modify size limits<br>xiv. Modify gear restrictions and marking requirements (ranging from altering current regulations to a complete prohibition, including to respond to interactions with listed species)<br>xv. Other adjustment to management measures within the scope and criteria established by the FMP and implementing regulations deemed appropriate by the Council |
| **3.** The Council will initiate the open framework process to inform the public of the issues and develop potential alternatives to address the issue. The framework process will include the development of documentation and public discussion during one council meeting. |
| **4.** For all framework actions, the Council will provide the letter, memo, or the completed framework document along with proposed regulations to the Regional Administrator in a timely manner following final action by the Council. |
| **5.** For all framework action requests, the Regional Administrator will review the Council's recommendations and supporting information and notify the Council of the determinations, in accordance with the Magnuson-Stevens Act and other applicable law. |
| **CLOSED FRAMEWORK** |
| Consistent with existing requirements in the FMP and implementing regulations, the RA is authorized to conduct the following closed framework actions through appropriate notification in the Federal Register:<br>a. Reopen any sector of the fishery that had been prematurely closed.<br>b. Implement AMs, either in-season or post-season. Implement an in-season AM for a sector that has reached or is projected to reach, or is approaching or is projected to approach its ACL, according to the process established in the FMP, or implement a post-season AM for a sector that exceeded its ACL according to the process established in the FMP, or any other established AM.<br>c. Take any other immediate action specified in the FMP and implementing regulations. |

**Table 2.7.4.** Narrow framework procedure under Alternative 4 in Action 7.

| |
|---|
| **OPEN FRAMEWORK** |
| **A. A new stock assessment or other information indicates changes should be made to: MSY, OFL, ABC, or other related management reference points and status determination criteria (SDC).**<br><br>B. **New information or circumstances indicates management measures below should be changed.** |
| **Open Framework actions may be implemented only in response to the above conditions. Actions that may be implemented via the framework include only the following:** |

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|---|
| i. Specify or re-specify ABC<br>ii. Re-specify MSY and OY, and SDC<br>iii. Re-specify SYL<br>iv. Re-specify ACLs<br>v. Re-specify ACTs<br>vi. Modify recreational bag and possession limits<br>vii. Modify size limits<br>viii. Modify seasonal or year-round closures and closure procedures<br>ix. Modify reporting and monitoring requirements |
| The Council will initiate the open framework process to inform the public of the issues and develop potential alternatives to address the issue. The framework process will include the development of documentation and public discussion during at least three council meetings, and shall be discussed at separate public hearings within the areas most affected by the proposed measures. |
| Prior to taking final action on the proposed framework action, the Council shall convene its SSC and AP to provide recommendations on the proposed actions. |
| For all framework actions, the Council will provide the letter, memo, or the completed framework document and all supporting analyses, along with proposed regulations to the Regional Administrator in a timely manner following final action by the Council. |
| For all framework action requests, the Regional Administrator will review the Council's recommendations and supporting information and notify the Council of the determinations, in accordance with the MSA and other applicable law. The RA will provide the Council weekly updates on the status of the proposed measures. |
| **CLOSED FRAMEWORK** |
| Consistent with existing requirements in the FMP and implementing regulations, the RA is authorized to conduct the following closed framework actions through appropriate notification in the Federal Register:<br>a. Reopen any sector of the fishery that had been prematurely closed.<br>c. Implement AMs, either in-season or post-season. Implement an in-season AM for a sector that has reached or is projected to reach, or is approaching or is projected to approach its ACL according to the process established in the FMP, or implement a post-season AM for a sector that exceeded its ACL according to the process established in the FMP, or any other established AM. |

### 2.7.2 Discussion of Action 7 Alternatives

A framework procedure is a mechanism that can be included in an FMP to allow the Council to address recurrent, routine, or foreseeable actions in an expedited manner. Under the framework procedures, certain management actions can be adjusted via an expedited process. This differs from revising the management program via an FMP amendment, which contains additional procedural steps. The alternatives in Action 6 describe the management measures that would be appropriate to revise via the framework procedures. If the action cannot be completed via framework, then the FMP must be amended. The purpose of establishing framework procedures

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is to make it possible to manage fisheries more responsively under conditions requiring "real time" management (EPA 2005).

The use of framework procedures is not intended to circumvent standard FMP/amendment and rulemaking procedures under the Magnuson-Stevens Act, and must be done in a manner that is consistent with requirements of the Magnuson-Stevens Act, as well as other applicable law such as the Administrative Procedure Act, the Endangered Species Act, the National Environmental Policy Act, among others. To the extent that statutory requirements can be addressed up front when establishing the framework mechanism, this may result in less analysis and process being needed when individual actions are executed under that mechanism. The analyses and processes required for each individual action will depend on the specific facts and circumstances of that action (NMFS 2015). Every measure adjusted via framework must be analyzed under applicable law and be available to the public for comment at some time prior to implementation, either when the measure to be adjusted via framework was established or when the adjustment occurs, or both. The analysis may be provided at the same time the measure is added to the FMP, or it may be provided subsequently when the action is taken under the framework procedures in the FMP and/or its implementing regulations. The timing and extent of analysis and notification and comment required will depend on the specificity and analysis when the framework was established (NMFS 1997).

Types of Framework Procedures

Framework procedures can be of one of two forms: *Open* or *Closed*.

*Open framework procedures* allow the Council to apply discretion to adjust certain management measures. Under an open framework procedure, the Council can select among various management options to address an identified management issue, such as changing a size limit to reduce discards. An example of a past Caribbean action done through an open framework procedure was Regulatory Amendment 3 to the Reef Fish FMP, completed in 2010, which modified management in the Bajo de Sico seasonal area closures in western Puerto Rico by increasing the closure from a 3-month closure to a 6-month closure, prohibited fishing for and possession of Caribbean reef fish in or from the EEZ portion of Bajo de Sico during the closure, and prohibited anchoring in the EEZ portion of Bajo de Sico year-round (CFMC 2010).

An open framework may be used to clarify Council intent or to interpret broad terms contained in approved FMPs; it also may be used to implement a portion of an approved FMP/amendment that was reserved and the Council now desires NMFS to implement. Open frameworks can be used when a Council believes a specific problem may occur in the fishery that would require addition to or amendment of the original regulations, but the exact nature of the event or the remedial action cannot be foreseen at the time the FMP is being prepared. There are different types of open frameworks, namely abbreviated and standard frameworks. **Preferred**

**Alternative 2** proposes the use of both types of open frameworks, while **Alternatives 1**, **3**, and **4** would only allow the use of the standard open framework. The two types of open frameworks are discussed below when discussing **Preferred Alternative 2**.

Closed Framework procedures allow for adjustment of management measures in specific factual circumstances. In this case, the FMP and implementing regulations identify a specific action to be taken in the event of specific facts occurring, such as closing a sector of a fishery after their ACL has been harvested. Closed frameworks are appropriate when the action occurs without application of discretion. The action's ecological, economic, and social impacts have already been described in the analyses prepared when the framework measure was adopted. Examples of actions that can be taken through closed frameworks are in-season adjustments such as the closure of a fishery based on a projection of attainment of a an ACL, adjustment of trip limits or hours of fishing, based on actual effort, or adjustment of quotas, based on computational errors or late reporting (NMFS 1997).

All alternatives in Action 7 propose a framework procedure that includes both open and closed frameworks. However, the actions that can be taken under each of the open and closed frameworks vary among the alternatives. These are listed for **Alternatives 1**, **2 (Preferred)**, **3**, and **4** in Tables 2.7...1, 2.7.2, 2.7.3, and 2.7.4, respectively.

**Alternative 1** is the no action alternative and would retain without modification the existing framework procedure for implementing management measures in the Puerto Rico FMP. The existing framework measures were those included in the Council's Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs. These framework procedures were developed in the 2005 Caribbean Sustainable Fisheries Amendment (CFMC 2005) for stocks in the Reef Fish, Queen Conch, and Coral FMPs and further modified in the 2010 and 2011 Caribbean ACL Amendments (CFMC 2011a, b). Framework measures for the Spiny Lobster FMP were established in the 2011 Caribbean ACL Amendment. Table 8.2.1 lists the framework measures under these FMPs. **Alternative 1** would not allow for the inclusion of new and more specific framework measures that could be taken in a relatively shorter time, such as those that can be taken through an abbreviated framework proposed in **Preferred Alternative 2**. In **Alternative 1**, some of the framework measures listed need to be updated to comport with how management is been structured under the Puerto Rico FMP under development. For example, a framework measure in **Alternative 1** allows for the adjustment of total allowable catch, which will not be used under the Puerto Rico FMP.

**Preferred Alternative 2** proposes a framework procedure that includes open and closed frameworks. Under **Preferred Alternative 2**, instances under which the open framework procedure may be used to implement management changes include: (A.) A new stock assessment

or other information indicates changes should be made to the MSY, OFL, ABC, or other related management reference points and status determination criteria (SDC); (B.) New information or circumstances exist. In that instance, the Council will, as part of a proposed framework action, identify the new information and provide rationale as to why this new information indicates that management measures should be changed; (C.) Changes are required to comply with applicable laws such as the Magnuson-Stevens Act, ESA, Marine Mammal Protection Act (MMPA), or are required as a result of a court order. In such instances, the Regional Administrator (RA) will notify the Council in writing of the issue and that action is required. If there is a legal deadline for taking action, the deadline will be included in the notification.

In contrast to **Alternatives 1**, **3**, and **4**, actions under an open framework in **Preferred Alternative 2** can be implemented either by an abbreviated framework or by a standard framework. An abbreviated open framework can be used for routine or for insignificant changes. An abbreviated framework combines the attributes of closed frameworks (prior notice of the action, short timetable, and additional analysis likely unnecessary) and those of open frameworks (flexibility and Council input), allowing the action to be implemented quicker than a regular FMP amendment or than under a standard open framework. Examples of the type of actions that are routine or that constitute insignificant changes under **Preferred Alternative 2** are listed in Table 8.2.2, and include recreational bag and possession limit changes of no more than one fish per boat and size limit changes of no more than an inch, among others. In an abbreviated framework, a request is made with letter or memo from the Council to the RA containing the proposed action with supporting analyses (biological, social, economic). If multiple actions are proposed, a finding that the actions are also routine or insignificant must also be included. If the RA concurs and approves action, the action will be implemented through publication of notice in the Federal Register.

Changes that do not qualify as routine or insignificant would be addressed under a standard open framework. The process for standard open frameworks is similar to that described for **Alternative 1** above. A standard open framework under **Preferred Alternative 2** requires a completed framework document with supporting analyses. Actions that can be taken through a standard open framework are listed in Table 8.2.2, and include, among others, making changes specified under the abbreviated framework that exceed the established thresholds; specification or re-specification of ABC and ABC control rule (CR); re-specification of MSY and OY, and SDC; re-specification of SYL. **Preferred Alternative 2** requires opportunity for public comment in at least one Council meeting, and specifies that the Council may convene the SSC or an AP as appropriate.

The actions that can be taken through a closed framework under **Preferred Alternative 2** include: reopening any sector of the fishery that had been prematurely closed and implementing accountability measures, either in-season or post-season (implement an in-season AM for a

sector that has reached or is projected to reach, or is approaching or is projected to approach its ACL according to the procedures established in the FMP, or implement a post-season AM for a sector that exceeded its ACL according to the procedures established in the FMP, or any other established AM).

**Alternative 3** also proposes a framework procedure that includes the option for using open or closed frameworks. **Alternative 3** proposes a procedure that is broader than those included in **Alternatives 2 (Preferred)** and **4**. Under **Alternative 3**, the Council may utilize this framework procedure to implement management changes in response to any additional information or changed circumstances. Under **Alternative 3**, the Council will, as part of a proposed framework action, identify any new information and provide rationale as to why this new information requires that management measures be adjusted. Open framework actions may be implemented at any time based on information supporting the need for adjustment of management measures or management parameters. These conditions make **Alternative 3** different than **Preferred Alternative 2** and **4**, as **Alternatives 2 (Preferred)** and **4** list specific conditions for when the open framework can be used. Actions that can be taken under **Alternative 3** are listed in Table 8.2.3.

Actions that can be taken under a standard open framework in **Alternative 3** are similar to those proposed in **Alternative 2**, with the difference that **Alternative 3** also allows to use the procedure for any other measures deemed appropriate by the Council. **Alternative 3** requires public discussion in one Council meeting and similar to **Alternative 2**, does not require convening the SSC or APs to prior to final action. **Alternative 2** expressly notes that the Council may convene its SSC or APs prior to taking action, but **Alternative 3** is silent as to this point, however, the Council may always exercise its discretion to convene its auxiliary bodies before taking action.

Actions that can be taken through a closed framework under **Alternative 3** are similar to those proposed under **Preferred Alternative 2** with the difference that **Alternative 3** also allows to take any other immediate action specified in the regulations and **Preferred Alternative 2** does not provide for that.

**Alternative 4** also proposes a framework procedure that includes open and closed frameworks, but, when compared to **Alternatives 1**, **2 (Preferred)**, and **3**, would not allow as many management measures to be implemented through a framework procedure (Table 2.7.4). An open standard framework in **Alternative 4** can only be used when a new stock assessment or other information indicates changes should be made to the MSY, OFL, ABC, or other related management reference points or when new information or circumstances indicates management measures listed in Table 8.2.4 should be changed. In combination, having such a narrow list of measures that can be adjusted with limited conditions for use makes **Alternative 4** less efficient

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than the other alternatives proposed as it will not allow for a rapid adjustment of additional management measures that otherwise could be streamlined through the framework procedure.

Different than **Alternatives 2 (Preferred)** and **3**, **Alternative 4** requires public discussion in at least three Council meetings and discussion at separate public hearings. Also, the Council shall convene its SSC and/or APs to provide recommendations on the proposed actions. These requirements may make the framework process for some actions longer than they could be under **Alternatives 1**, **2 (Preferred),** and **3**.

Actions that can be taken through a closed framework in **Alternative 4** are similar to those proposed in **Alternatives 2 (Preferred)** but differ than **Alternative 3** in that **Alternative 3** also allows the Council to take any other immediate action specified in the FMP and implementing regulations. **Alternative 4** also does not allow management measures to be adjusted via an abbreviated standard framework, as under **Preferred Alternative 2**.

Table 2.7.5 highlights the major differences among the action alternatives proposed (**Alternatives 2-4**).

**Table 2.7.5.** Differences among the action alternatives in Action 7.

| | Preferred Alternative 2 (base) | Alternative 3 (broad) | Alternative 4 (narrow) |
|---|---|---|---|
| When can open framework be used | - New stock assessment or other information indicates changes should be made to MSY, OFL, ABC or other related management reference points and SDC<br>- New information or circumstances<br>- When changes are required to comply with applicable law or court order.<br>*Abbreviated Open Framework can be used for minor or insignificant changes.<br>*Standard Open Framework for all other allowed changes. | In response to any additional information or changed circumstances. | - New stock assessment or other information indicates changes should be made to MSY, OFL, ABC or other related management reference points and SDC<br>- New information or circumstances indicates management measures listed should be changed |
| Actions that can be taken | - Abbreviated Open FMW can be used for actions that are considered minor and insignificant<br>- Standard Open FMW. List of actions that can be taken under Abbv and Standard Open FMW are given.<br>- Closed FMW can be used for a specific list of actions. | - Open FMW can be used for a representative list of actions, plus other measures deemed appropriate by the Council.<br>- Closed FMW can be used for a specific list of actions, plus any other immediate actions specified in the FMP and implementing regulations. | - Open FMW can only be used for specific listed actions.<br>- Closed FMW can be used for a specific list of actions. |

| | | | |
|---|---|---|---|
| Public Input | Requires public discussion in at least one Council meeting. | Requires public discussion at one Council meeting | Requires public discussion during at least three Council meetings, and discussion at separate public hearings within the areas most affected by the proposed measures. |
| APs/SSC participation | The Council may convene its SSC or an AP(s), as appropriate | Silent as to convening SSC or AP, but Council may take such action at its discretion | The Council shall convene its SSC and an AP(s). |

**Comparison of Action 7 Alternatives**

A comparison of the alternatives can be found in the discussion above. Modifying the framework procedure in Action 7 is not expected to have direct effects on the physical or biological/ecological environments. However, if the level of fishing effort or the use of certain gears is affected by the management strategies modified by the framework, the physical environment could be affected by changing the interactions between gear types and the habitat. The biological/ecological environment could also be indirectly affected by those framework actions that modify fishing effort to protect the biological integrity of the managed resources and decrease the risk of overfishing those resources.

Indirect effects to the physical and biological/ecological environments would be expected from those framework measures that result in a faster protection of the habitat from gear/habitat interactions (physical effects) or a faster protection to the biology of the stocks (biological effects) than if the measure was changed through a regular FMP amendment. For example, these effects could be expected from the specification or modification of gear restrictions, including those that minimize the interaction of fishing gear with endangered species such as listed habitat-forming corals (e.g., *Orbicella annularis*, *Orbicella franski*) found in **Alternatives 1**, **2 (Preferred)**, and **3**, and those actions that close/open areas to fishing, adjust harvest, and regulate fishing effort (e.g., adjustment of trip limits, bag limits, size limits, ABCs, ACLs), among others, which are included in all alternatives proposed but with varied limitations.

The potential indirect physical and biological benefits from **Alternative 3** are expected to be slightly larger than those from **Alternatives 1**, **2 (Preferred)**, and **4**, given that **Alternative 3** allows for a broader spectrum of measures that can be rapidly implemented through framework. **Alternative 4** would be the least beneficial to the physical and biological/ecological environments because the range of actions that could be taken more expeditiously through framework is more limited than the other alternatives. Administratively, by allowing the use of both abbreviated and standard frameworks and the inclusion of a comprehensive list of actions, **Preferred Alternative 2** would provide the best balance between the actions allowed to be implemented under the framework and the procedure required to take these actions. Also when compared to **Alternatives 1**, **3**, and **4**, **Preferred Alternative 2** provides the opportunity for

sufficient public review and involvement in the process, while still accommodating the ability for more streamlined implementation.

From an economic perspective, the alternatives listed in Action 7 represent administrative actions. Hence, none of the alternatives will have a direct economic impact on the economic environment. Framework procedures that reduce the amount of time needed to change a management measure, however, could provide benefits in the nature of stock/stock complex protection or rebuilding. In addition, regulations that may be forthcoming in response to a change in framework procedures could indirectly result in a change in the economic environment via a change in effort and/or fishing techniques.

In terms of social effects, timing and public input become the parameters that are most constrained or alleviated by the various alternatives for a framework procedure. **Alternative 1** does not allow new framework procedures that may be tailored specifically to Puerto Rico which may incur some indirect negative social effects. The framework procedure in **Preferred Alternative 2** provides the most flexibility compared to **Alternatives**, **1**, **3**, and **4** and would likely have the most beneficial social effects. The proposed framework actions in **Alternative 3** are likely to have slightly fewer beneficial social effects as it does not require as much public input under certain procedures, whereas **Alternative 4** requires the most extensive input from the public, AP and SSC with three Council meetings which could extend the process unnecessarily when expedited action is needed.

DRAFT

# Chapter 3. Affected Environment – Description of the Puerto Rico Management Area

## 3.1 Introduction

Chapter 3 describes the environment and resources included within the Puerto Rico Fishery Management Plan (FMP). Additional information on the physical, biological/ecological, economic, social, and administrative environments of Puerto Rico have been described in detail in the 2010 and 2011 Caribbean Annual Catch Limit (ACL) Amendments (CFMC 2011a, b) and associated environmental impact statements (EIS), and in the most recent Caribbean actions affecting Caribbean Fishery Management Council (Council)-managed resources including the Timing of Accountability Measures Amendment (CFMC 2016) and Regulatory Amendment 6 (CFMC 2017) and in the 2014 Environmental Assessment (EA): Transitioning from a species-based management to an island-based management (NMFS 2014). Information from these documents is incorporated herein by reference and is summarized below along with information from additional sources. The documents can be found on the National Marine Fisheries Service (NMFS) Sustainable Fisheries, Caribbean Branch website. Information about the marine resources that span Puerto Rico's territorial waters is also included, although the FMP will only apply to the exclusive economic zone (EEZ) off Puerto Rico.

The actions considered in this FMP and associated EA would affect the U.S. Caribbean EEZ off Puerto Rico (Figure 3.1.1).

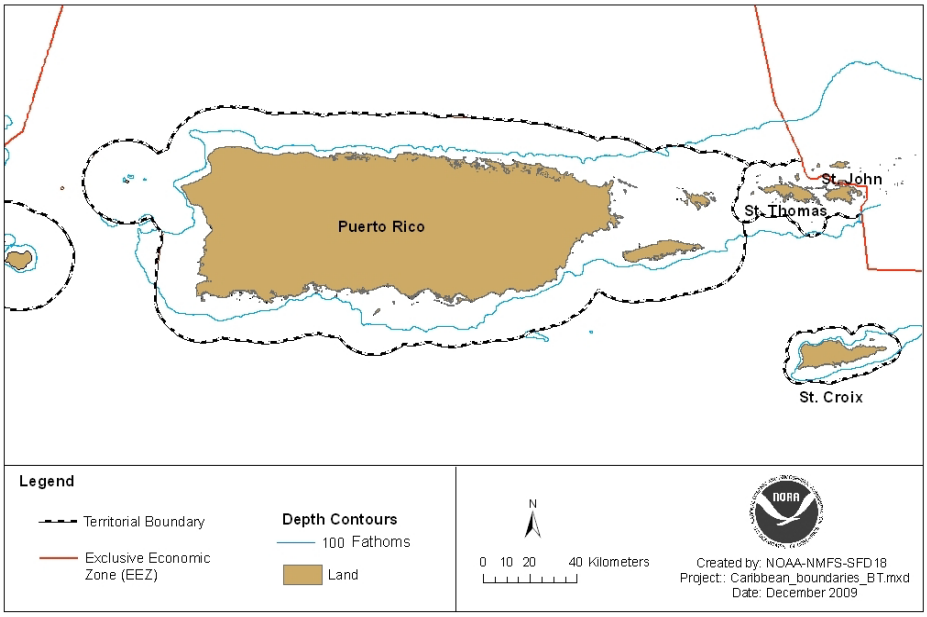


**Figure 3.1.1.** Location of Puerto Rico and the U.S. Virgin Islands.
(Source: CFMC 2011a, b).

## 3.2 Physical/Habitat Environment

### 3.2.1 Geography and Geology

The U.S. Caribbean is located in the eastern portion of the Caribbean archipelago, about 1,100 miles (mi) (1,770 kilometers [km]) east-southeast of Miami, Florida (Olcott 1999). The region is composed of the Commonwealth of Puerto Rico in the Greater Antilles and the Territory of the USVI in the Lesser Antilles island chains (Figure 2.2), both of which separate the Caribbean Sea from the western central Atlantic Ocean. The U.S. Caribbean exclusive economic zone (EEZ) covers an area of approximately 75,687 square miles ($mi^2$) (196,029 square kilometers [$km^2$]). Puerto Rico EEZ waters are located 9 - 200 nautical miles (17 - 370 km) from the coast of the island and covers approximately 65,368 $mi^2$ (169,303 $km^2$).

The island of Puerto Rico is almost rectangular in shape, approximately 110 by 35 mi (177 by 56 km), and is the smallest and the most eastern island of the Greater Antilles (CFMC 1998, Morelock et al. 2000). Its coast measures approximately 700 mi (1,227 km) in linear extent, including the adjacent inhabited islands of Vieques and Culebra as well as various other isolated islands without permanent populations including Mona, Monito, and Desecheo. Puerto Rico is surrounded on three sides by deep ocean waters. The Mona Passage separates Puerto Rico from Hispaniola to the west and is about 75 mi (120 km) wide and more than 3,300 ft (1,000 m) deep. The Puerto Rico Trench borders the northern coast and is 28,000 ft (8,500 m) deep, and to the south the sea bottom descends to the 16,400 ft (5,000 m) deep Venezuelan Basin of the Caribbean Sea. To the east, Puerto Rico shares the shallow-water shelf platform with St. Thomas and St. John, which extends east towards the British Virgin Islands.

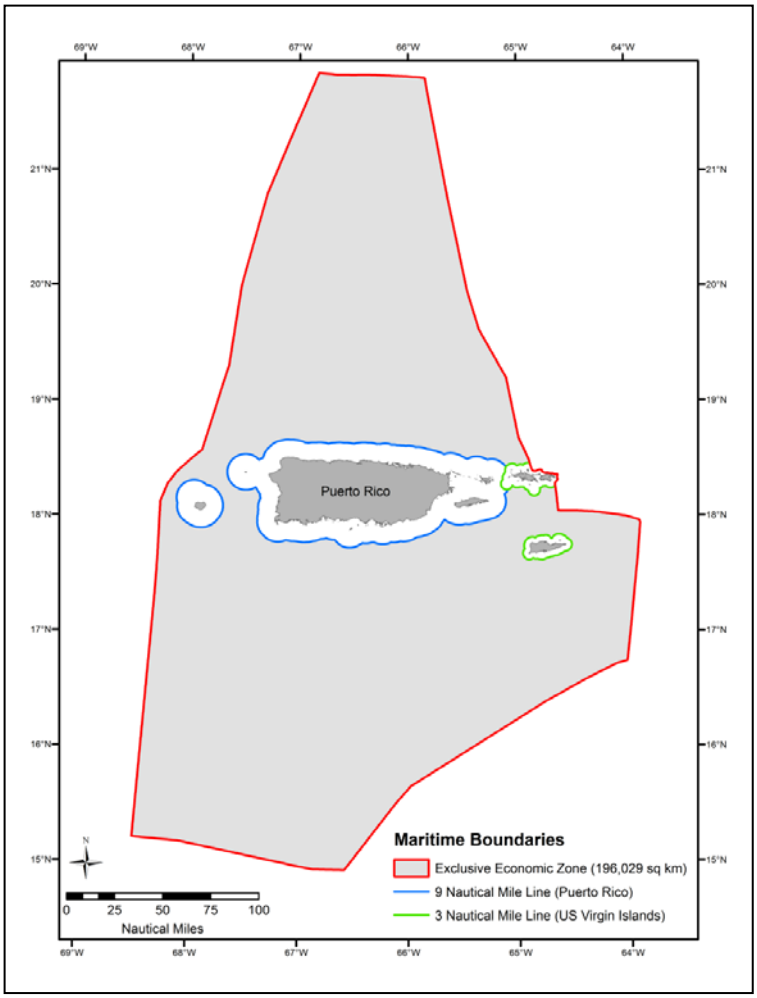



**Figure 3.2.1.** Boundaries of the U.S. Caribbean EEZ, Puerto Rico waters, and USVI waters. (Source: NMFS 2014)

The physical (including geology and climate) and habitat environments of the U.S. Caribbean and Puerto Rico were described in detail in the Generic Essential Fish Habitat (EFH) Amendment to FMPs of the U.S. Caribbean, the EFH Final Environmental Impact Statement (EFH-FEIS) (CFMC 1998, 2004), the Five -Year review of EFH in the U.S. Caribbean, Vols.1 and 2 (CFMC 2011c), and Regulatory Amendment 2 to the Queen Conch FMP (CFMC 2013a). These documents are incorporated herein by reference and are summarized below.

Puerto Rico shares the same shelf platform as St. Thomas and St. John, and that shelf also extends east to include the British Virgin Islands. The St. Croix platform connects through a deep submerged mountain range (including Grappler Bank and Investigador, among other banks in the EEZ) to the southeast platform of Puerto Rico (Figure 3.2.2).

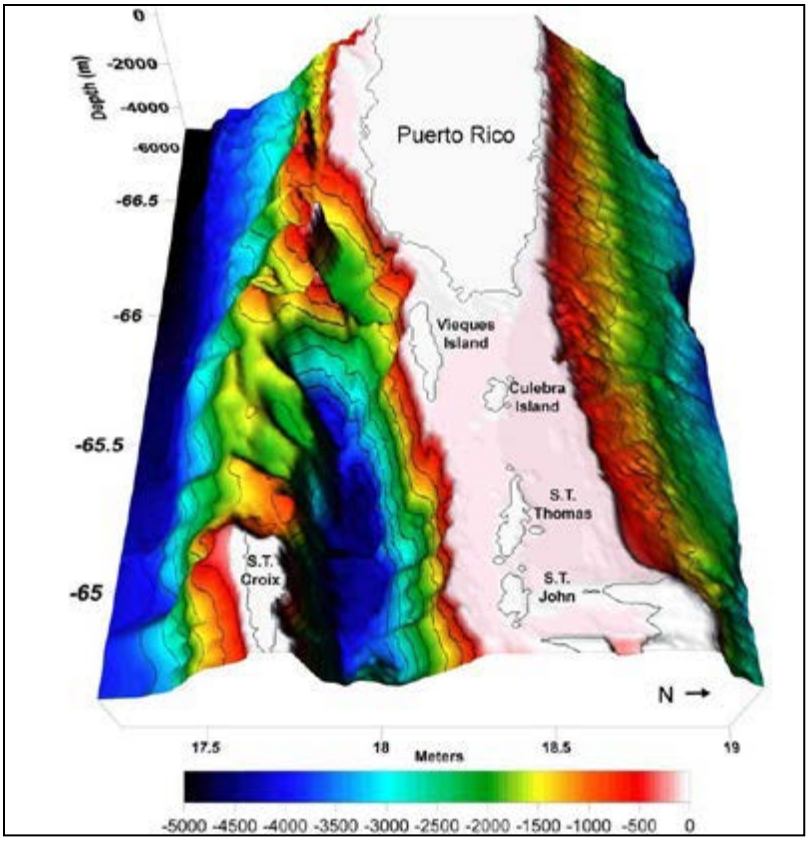



**Figure 3.2.2.** Shared platform between the east coast of Puerto Rico and St. Thomas/St. John.
The deep trough between the Puerto Rico/St. Thomas/St. John platform and St. Croix is clearly seen in this graphic representation of depth.
(Source: García-Sais et al. 2005)

## 3.2.2 Oceanography and Climatology

The North Equatorial Current is the predominant hydrological driving force in the Caribbean region. It flows from east to west along the northern boundary of the Caribbean plateau and splits at the Lesser Antilles. To the north, the current flows westward along the north coasts of the U.S. Caribbean islands, splitting north of the Mona Channel. The north branch flows north of Silver and Navidad Banks, past the Turks and Caicos, to form the Bahama Current. The south branch parallels the north coast of Hispaniola about 16 nm (30 km) offshore. A small gyre has been documented off the northwest corner of Puerto Rico resulting in an easterly flow nearshore in this area (CFMC 2004). To the south, the current enters the Caribbean Sea through the passages between the Lesser Antilles (Chakalall et al. 1998). The water then continues northwestward as the Caribbean Current, the main surface circulation in the Caribbean Sea.

The Caribbean Current flows about 62 mi (100 km) south of the U.S. Caribbean islands at an average speed of 0.5 to 1 knots (CFMC 2004). The current is characterized by large cyclonic and anticyclonic gyres. Its strength is influenced by changes in the position of the inter-tropical convergence zone (ITCZ). The zonal shift of the ITCZ is also responsible for the seasonal change in precipitation in the Caribbean. The dry season occurs when the ITCZ is near the equator, generally in the late winter to spring. The wet season occurs when the ITCZ is at its most northerly position in the Caribbean, generally in the late summer into late fall (CFMC 2011a and references therein).

Surface water salinity changes along with the seasonal change in precipitation and the position of the ITCZ. Discharge from the Amazon, Orinoco, and Magdalena rivers is the main contributor to buoyancy in the Caribbean Sea, increasing silica concentrations, decreasing salinity (Yoshioka et al. 1985) and increasing chlorophyll and pigments, as well as increasing the input of terrestrial materials (Kjerfve 1981). These parameters vary with changes in the outflow from these South American rivers, dependent on rainfall in the areas supplying water to these rivers and the ITCZ-driven currents transporting those discharges.

Sea surface temperature ranges from a minimum of 25 degrees Celsius (ºC) in February-March to a maximum of about 28.5ºC in August-September. Tidal regimes differ between the north and south coasts. The fluctuations range from a diurnal tide of about 3.9 in (10 cm) on the south coast to a semi-diurnal regime of between 24-39 in (60 to 100 cm) along the north coast, where waves are larger (CFMC 2004). But the astronomical tidal range is slight (8 to 12 in [20 to 30 cm]) (Kjerfve 1981).

Hurricane and storms can have a dramatic effect on the environment, especially in coastal habitats, causing a cascade of direct and indirect ecological responses[24]. These environmental effects can also affect the socio-economics of an area. More information about the impact of recent hurricanes to Puerto Rico and its fisheries can be found in sections 2.5 and 3.12 of this document.

Detailed information about the oceanography and climate of Puerto Rico can be found in Section 5.1.2 of the 2010 Caribbean ACL Amendment and is incorporated herein by reference. More information on the effects of climate change is included in the Cumulative Effects Analysis in Section 4.8 of this document.

### 3.2.3 Coastal and Marine Habitats

The fisheries of the U.S. Caribbean rely on healthy coastal and marine environments and habitats. While the islands of the U.S. Caribbean share physical and biological similarities, they

[24] http://www.hurricanescience.org/society/impacts/environmentalimpacts/

exhibit unique differences. For instance, mangroves, seagrasses, coral reefs, and estuaries are found throughout the islands of the U.S. Caribbean. Yet, the distribution and magnitude of these environments vary, and those variations are reflected in the distribution and abundance of fish species that support the fisheries pursued on each island. For example, the narrow continental shelf off the west coast of Puerto Rico, which drops to 3,000 feet depth within x miles of shore in as part of the Mona Passage, fosters a productive environment for snapper and grouper fishing by commercial, recreational, and charter boat fishermen.

The fisheries of the islands and island groups constitute an important part of the ecosystems in the U.S. Caribbean. The NMFS defines ecosystem as a geographically specified system of organisms, involving complex connections between fishery resources, humans, their environments, and the processes that control their dynamics.

A description of the major habitat types in the U.S. Caribbean EEZ, along with information on their ecological functions and condition, can be obtained in Section 3.2 of the EFH-FEIS (CFMC 2004) and in Section 5.1.3 of the Caribbean SFA Amendment (CFMC 2005), which are incorporated herein by reference, and is summarized below. A description of the major habitat types of Puerto Rico may be found in García-Sais et al. (2008).

The coastal marine environments of Puerto Rico are characterized by a wide variety of habitat types. Kendall et al. (2001) delineated 21 distinct benthic habitats types. The EFH-FEIS (CFMC 2004) summarized the percent distribution for all habitats in the U.S. Caribbean from the 5,494 $km^2$ (2,121 $mi^2$) of total bottom area mapped from aerial photographs. This total included both Puerto Rico (5,009 $km^2$ [1,934 $mi^2$]) and the USVI (485 $km^2$ [187 $mi^2$]), and covered from the shore line to about 20 m (66 ft) depth.

In Puerto Rico, 49 $km^2$ (19 $mi^2$) of unconsolidated sediment, 721 $km^2$ (278 $mi^2$) of submerged aquatic vegetation, 73 $km^2$ (28 $mi^2$) of mangroves, and 756 $km^2$ (292 $mi^2$) of coral reef and colonized hard bottom were mapped (CFMC 2013).

#### 3.2.3.1 Essential Fish Habitat

Essential fish habitat (EFH) is defined in the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) as “those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 U.S. C. 1802(10)). Specific categories of EFH identified in Puerto Rico and the USVI, which are utilized by federally managed fish and invertebrate species, include both estuarine/inshore and marine/offshore areas. Specifically, estuarine/inshore EFH includes estuarine emergent and mangrove wetlands, submerged aquatic vegetation, intertidal flats, palustrine emergent and forested systems, and the estuarine water column. Additionally, marine/offshore EFH includes live/hard bottom habitats, coral and coral reefs, seagrass and algal plains, sand and shell substrate, and the marine water column. Essential

fish habitat includes the spawning area in the water column above the adult habitat. EFH utilized by fish and invertebrate species in this region includes coral reefs, live/hard bottom, and submerged aquatic vegetation.

#### 3.2.3.1.1 Habitat Areas of Particular Concern (HAPC)

Process and Designation of HAPC

*Designated Areas*

The 2005 Comprehensive Sustainable Fisheries Amendment designated HAPCs in the Reef Fish and Coral FMPs based on confirmed spawning locations and on areas or sites identified as having particular ecological importance to managed species.

Areas of Puerto Rico designated as HAPCs based on the occurrence of confirmed spawning locations

a. Tourmaline Bank/Buoy 8;
b. Abrir La Sierra Bank/Buoy 6;
c. Bajo de Sico; and
d. El Seco, Vieques.

Areas of Puerto Rico designated as HAPC based on EFH or sites identified as having particular ecological importance to Caribbean reef fish species:

a. Hacienda la Esperanza, Manatí;
b. Bajuras and Tiburones, Isabela;
c. Cabezas de San Juan, Fajardo;
d. JOBANNERR, Jobos Bay;
e. Bioluminescent Bays, Vieques;
f. Boquerón State Forest, Cabo Rojo;
g. Pantano Cibuco, Vega Baja;
h. Piñones State Forest, Loiza;
i. Río Espiritu Santo, Río Grande;
j. Seagrass beds of Culebra Island (nine sites designated as Resource Category 1 and two additional sites), Culebra; and
k. Northwest Vieques seagrass west of Mosquito Pier, Vieques.

Areas of Puerto Rico designated as HAPC based on EFH or sites identified as having particular ecological importance to Caribbean coral species:

a. Luis Peña Channel, Culebra;
b. Mona/Monito;
c. La Parguera, Lajas;
d. Caja de Muertos, Ponce;

e. Tourmaline Reef;
f. Guánica State Forest, Guánica;
g. Punta Petrona, Santa Isabel;
h. Ceiba State Forest, Ceiba;
i. La Cordillera, Fajardo;
j. Guayama Reefs, Guayama;
k. Steps and Tres Palmas, Rincón;
l. Los Corchos Reef, Culebra; and
m. Desecheo Reefs, Desecheo.

#### 3.2.3.1.2 Effects of Fishing on Essential Fish Habitat

The effects of fishing on EFH were thoroughly described in the 2004 EFH-EIS. Specifically, 'Section 3.5.1.2 Determination of identifiable adverse fishing effects' describes the impacts by gears including all gears currently in use for harvesting the new species proposed for management (e.g., hook and line; spear). All prohibited gear such as trawls and explosives are also discussed. The following is a summary of the information contained in the 2004 EFH-EIS. The impacts of fishing gears on fish habitat in the southeastern US and the US Caribbean have been described in Hamilton (2000) and Barnette (2001). In most cases, limited data preclude definitive conclusions on the impacts of fishing gears on specific habitats in the Caribbean. However, these papers indicate the types of habitat most likely to suffer damage from each gear. Based on the analysis of the effects of fishing on EFH described in Section 2.1.5 of the 2004 EFH-EIS, the actions taken to limit the impact of fishing on EFH included modifications to anchoring techniques; modifications to construction specifications for pots/traps; and close areas to certain recreational and commercial fishing gears (i.e., pots/traps, gill/trammel nets, and bottom longlines) to prevent, mitigate, or minimize adverse fishing impacts in the EEZ:
As part of an effort to identify fishing impacts on fish habitat from the gears used in the Gulf of Mexico, South Atlantic, and Caribbean Regions, Rester (2000a, b) completed an annotated bibliography that compiled a listing of papers and reports that addressed fishery-related habitat impacts. The bibliography included scientific literature, technical reports, state and federal agency reports, college theses, conference and meeting proceedings, popular articles, memoranda, and other forms of nonscientific literature, but did not include studies that pertained to the ecosystem effects of fishing (e.g. changes in the biological community structure). While recognizing that fishing may have many varying impacts on EFH, the bibliography focused on the physical impacts of fishing activities on habitat.

Hamilton (2000) summarized a December 1999 workshop concerning gear impacts on EFH attended by NOAA Fisheries scientists and managers. The workshop participants examined existing studies on gear impacts, and examined which factors made gear impact studies relevant to the Southeast region. The criteria included whether the specified gear was utilized in the Southeast Region, whether it was utilized in the same manner (similar fisheries), and whether the

habitat was similar. This review recognized that in many instances numerous epifaunal and infaunal species are an integral part of benthic habitat. Such species act as ecosystem engineers and modify the habitats they occupy through burrowing activities (Coleman and Williams 2002). Therefore, studies that document impacts (i.e., reduction in biomass or species diversity) to benthic communities have been included in this section. Recommendations were made concerning future research needs, and a table of the relative impacts of various fishing gears on different habitats was developed.

Barnette (2001) used the over 600 papers compiled by Rester (2000a, 2000b, 2001) to examine fishing impacts in the Southeast Region. The following section is largely excerpted from Barnette (2001). Barnette found a paucity of readily available information on the numerous types of gear utilized within the Caribbean, South Atlantic, and Gulf of Mexico. While there have been hundreds of studies published on gear impacts worldwide, the majority of these focus on mobile gear such as dredges and trawls. Furthermore, in addition to the approved gears within the various FMPs, there are other gears utilized within state and territorial waters that also needed to be evaluated because EFH may extend into coastal and estuarine waters. However, there are few, if any, habitat impact studies that have been conducted on many of these gear types.

Johnson (2002) also reviewed literature (through May 2002) dealing with the effects of fishing gears on benthic habitats. The document focused on mobile gears, such as trawls and dredges, which are not typically used in Caribbean fisheries, but also contained some information on traps, pots, longlines, and gill nets.

Morgan and Chuenpagdee (2003) reviewed literature on gear impacts, summarized these findings, and presented them to an expert panel of fishers, scientists, and managers who then ranked habitat impacts for 10 fishing gears commonly used in U.S. fisheries. In this instance, gear impacts considered physical habitat damage, bycatch, and potential ghost fishing together. Based on the results of the panel workshop, a questionnaire was developed to assess fishing impacts, which was circulated among a broad range of marine fisheries experts. Results from the questionnaires were analyzed to rank fishing gear impacts and categorize gears as having high, medium, or low impacts. The report states that bottom trawls, bottom gillnets, dredges, and midwater gillnets have relatively high impacts; pots/traps, pelagic longlines, and bottom longlines have medium impacts; while midwater trawls, purse seines, and hook and line have relatively low impacts. On the Morgan and Chuenpagdee (2003) report, the gear impacts for gears used in Caribbean fisheries from high to low would be: bottom gillnets (high); pots/traps, bottom longlines, pelagic longlines (medium); hook and line (low).

The Council prohibited explosives and poisons due to the documented habitat damage associated with those methods, but the methods are briefly reviewed because of their historical use. While trawls are not used within the region, they are allowed for non-FMP fisheries (50 CFR 600.725). The nature and magnitude of the effects of fishing activities depend heavily upon the physical and biological characteristics of a specific area in question. There are strict limitations on the degree to which probable local effects can be inferred from the studies of fishing practices conducted elsewhere (North Carolina Division of Marine Fisheries 1999). The extreme variability that occurs within marine habitats confounds the ability to easily evaluate habitat impacts on a regional basis. Obviously, observed impacts at coastal or nearshore sites should not be extrapolated to offshore fishing areas because of the major differences in water depth, sediment type, energy levels, and biological communities (Prena et al. 1999).

Of the gears used in the US Caribbean (state and federal waters) pots and traps, longline, vertical gear, and gillnets and trammel nets have the highest individual impact and the greatest potential for adverse damage to fish habitat. Hand harvest of coral and live/hard bottom, if it were allowed, could also cause substantial habitat damage. Of the habitat types considered in the US Caribbean, coral has the greatest vulnerability to fishing impacts, followed by hard bottom and SAV. Barnette (2001) noted that several gears have negligible or minimal impacts on fish habitat, but that this conclusion was based on limited information. For the Caribbean region, specifically, less information is available than in other regions. Reduction of coral and reef heterogeneity due to damage or removal of physical structure can seriously impact available shelter for juvenile fishes and post-settlement larvae, and there is likely a correlation between topographic relief and fish abundance (Luckhurst and Luckhurst 1978). However, conclusions drawn on impacts, or lack of impacts, should be made cautiously.
A “Symposium on Impacts from Fishery Activities to Benthic Habitats” was held in Tampa, Florida on November 11-15, 2002. The following is a summary of the meeting prepared by SSC member R. Boulon for the Council.

The driving force for this symposium was the question of the relationship of EFH and impacts to benthic habitats by fishing activities. This requirement was instrumental in the development of three questions that were defined as the goals for this symposium: 1. What have we learned about fishery impacts? 2. What more do we need to know? 3. What do we know enough about to act on right now?

However, the greatest need (and where very little information exists beyond nearshore, shallow water areas) is accurate mapping of benthic habitats. Without knowing what exists and where it is, management measures to protect or conserve benthic habitat cannot be developed. The next step is identifying the level and distribution of fishing activities relative to our benthic habitats. Once mapped, habitats can be classified based on their availability (how much there is), their

vulnerability (which is based on frequency of natural disturbance) and their risk (measured by frequency of disturbance from fishing activities).

NOAA's R/V Nancy Foster, Okeanos Explorer and others have contributed to the efforts of mapping the marine habitats by producing high resolution bathymetry, side scan sonar imagery and documenting the species and associated habitat at depth. However, to date we are still lacking a comprehensive map of the habitats in the area.

DeAlteris et al. (1999) stated that fishery-related impacts to fish habitat need to be compared to natural causes, both in magnitude and frequency of disturbance. Fishing can be adjusted or eliminated to complement particular habitats, whereas natural conditions continue unabated.

#### 3.2.3.1.3 Non-Fishing Impacts Threats to the coastal and marine environments and essential fish habitat

Hurricanes Irma and Maria clearly demonstrated the extent to which coastal and marine environments and essential fish habitat can be altered by non-fishing impacts, the hurricanes themselves. Assessment of the impact to coral reefs, many monitored over the past 20 years by PRDNER/NOAA, is currently under way. These coral reef areas are found in shallower depths to about 30 m. Mesophotic reefs are also currently being assessed to determine impacts to habitats at depths between 30 and 50 m (CRCP FY 18) caused by the hurricanes.
The passage of storms and hurricanes through mangroves and seagrasses can cause uprooting, mechanical defoliation, and deposition of sediment and other materials. This stress can eliminate vegetation from some areas. For mangroves, following the acute stress, there is a rapid reestablishment of new seedlings on suitable habitats, and the system restores itself. Seagrasses also may recover quickly, if damage is slight and the substrate has not been severely altered. Some storms may have beneficial effects on mangroves such as removing accumulations of materials choking drainage ways, and reopening salt ponds to the sea. Such tropical disturbances are important agents that redistribute materials along the coast. Storms passing within +/- 2° of Puerto Rico have increased in number and intensity since 1990.

Damage to coral reefs in Puerto Rico and the USVI due to natural phenomena has been well documented. A large portion of the Caribbean lies within the hurricane belt and therefore reefs are frequently exposed to severe hurricane related impacts. Hurricanes can modify substantial portions of shallow reefs. Two tropical storms in 1979 (David and Frederic) caused extensive damage on the outer east coast and southern coastal reefs, especially in the shallow *Acropora palmata* zone, off the eastern point of Vieques and off St. Croix (Goenaga and Cintrón 1979, Rogers 1982). Changes to the shape of emergent reefs, and to the flora in these reefs, were documented in La Parguera after these hurricanes (Armstrong 1980, Matta 1982). Hurricane Hugo caused a significant reduction in total living scleractinian cover on reefs on the south side of St. John (Rogers et al 1991). It devastated portions of coral reefs and seagrass beds off St.

Croix (Rogers et al 1991). Rogers et al (1991) were able to study the effect of Hurricane Hugo that hit the USVI in 1989 Analysis of quantitative data collected before and after the storm allowed documentation of the effects of this powerful storm on coral community structure. The total living cover by scleractinians, including the dominant species, *Montastrea annularis*, decreased significantly. The amount of substrate available for colonization increased. Cover by macroscopic algae increased dramatically after the storm, later decreased, and then rose again one year later. It appears that the level of herbivory by urchins and fishes is too low to keep the macroalgae in check, and algae are inhibiting coral settlement and growth (Rogers et al. 1997). In spite of the reduction in live coral cover by the dominant coral species, neither diversity nor evenness increased. Hurricane Georges in 1998 was the worst hurricane since San Ciprián in 1932, with sustained winds of 185 km/hour. Hurricane Maria might be significantly more devastating than any previous storm that had impacted Puerto Rico. Testimony from fishers at the Council meeting immediately after Maria provided evidence of the changes to the seascape. The non-fishing impacts to EFH were also thoroughly discussed in Section 3.5.2 of the 2004 EFH-EIS, the EFH 5-year Review (2011) and are incorporated herein by reference. Currently there are two on-going efforts to expand on the information on non-fishing impacts, the second 5-year EFH Review and the development of a Fishery Ecosystem Plan.

#### 3.2.3.2 Fishable Habitat

In the Caribbean SFA Amendment (CFMC 2005), fishable habitat was defined as those waters less than or equal to 100 fathoms (fms) (600 ft; 183 m). The majority of fishing activity for Council-managed species occurs in that area, except for fishing for deep-water snappers, which occurs primarily in the EEZ at depths greater than 100 fms (600 ft; 183 m) (CFMC 2005). The total area of fishable habitat (less or equal to 100 fms) in the U.S. Caribbean is estimated to be approximately 2,214.1 square nautical miles ($nm^2$) (7,594 $km^2$). The fishable habitat within the EEZ is 304.7 $nm^2$ (1,045 $km^2$) or 13.7% of the U.S. Caribbean total, with 119.5 $nm^2$ (410 $km^2$) occurring in the EEZ off Puerto Rico and 185 $nm^2$ (635 $km^2$) occurring in the EEZ off the USVI (Table 3.6.1). The vast majority of the fishable habitat in federal waters off Puerto Rico is located off the west coast.

**Table 3.2.1.** Estimates of fishable habitat areas in the U.S. Caribbean.

| **Region** | **Total Fishable Habitat Area** | | **EEZ Waters** | | **Territorial Waters** | | **Percent of the total fishable area in EEZ waters** | **Percent of the total fishable area in territorial waters** |
|---|---|---|---|---|---|---|---|---|
| U.S. Caribbean (EEZ and Territorial | $Km^2$ | $Nm^2$ | $Km^2$ | $Nm^2$ | $Km^2$ | $Nm^2$ | 13.7 | 86 |
| | 7594 | 2214.1 | 1045 | 304.7 | 6549 | 1909.4 | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Waters combined) | | | | | | | | |
| Puerto Rico | 5823 | 1697.7 | 410 | 119.5 | 5413 | 1578.2 | 5.4 | 71 |
| St. Croix | 375 | 109.3 | 68 | 19.8 | 307 | 89.5 | | |
| St. Thomas/St. John | 1396 | 407 | 567 | 165 | 829 | 241.7 | | |
| USVI (total) | 1771 | 516 | 635 | 185 | 1136 | 331 | 8.4 | 14.9 |

(Source: NMFS-SERO 2015)

## 3.3 Biological and Ecological Characteristics

The biological and ecological environment of the U.S. Caribbean, including that which supports or influences the majority of the species included in the Puerto Rico FMP, is described in detail in the Caribbean SFA Amendment (CFMC 2005), and the 2010 and 2011 Caribbean ACL Amendments (CFMC 2011a, b). Stocks affected by this action include those in the Puerto Rico Management Area described in this section.

Puerto Rico waters support hundreds of marine fish species and invertebrates including corals and organisms associated to coral reefs. Of those, the 68 stocks and stock complexes identified for inclusion in the management unit of the Puerto Rico FMP, represent those that the Council believes requires conservation and management. Many of these stocks are taken primarily in commercial, subsistence, and/or recreational fisheries; the remainder are stocks that require protection from fisheries effects, such as coral species in shallow and deep-water habitats, species of rays and mantas, and species with an important ecological function.

Together, the Island-Based FMPs conserve and manage the fisheries of the islands and islands groups in the U.S. Caribbean. The Puerto Rico FMP focuses specifically on the fisheries resources in the waters of the Puerto Rico EEZ management area of the U.S. Caribbean EEZ (Figure 1.5.1).

### 3.3.1 Stock Management

Section 302(h)(1) of the Magnuson-Stevens Act requires a Council to prepare an FMP for each fishery under its authority that is in need of conservation and management (16 U.S.C. 1852(h)(1)). Any stocks that are predominately caught in Federal waters and are overfished or subject to overfishing, or likely to become overfished or subject to overfishing, are considered to require conservation and management. Beyond such stocks, Councils may determine that additional stocks require conservation and management.

The following list of factors should be considered by a Council when deciding whether additional stocks require conservation and management:

(i) The stock is an important component of the marine environment;

(ii) The stock is caught by the fishery;

(iii) Whether an FMP can improve or maintain the condition of the stock;

(iv) The stock is a target of a fishery;

(v) The stock is important to commercial, recreational, or subsistence users;

(vi) The fishery is important to the Nation or to the regional economy;

(vii) The need to resolve competing interests and conflicts among user groups and whether an FMP can further that resolution;

(viii) The economic condition of a fishery and whether an FMP can produce more efficient utilization;

(ix) The needs of a developing fishery, and whether an FMP can foster orderly growth;

(x) The extent to which the fishery is already adequately managed by states, by state/Federal programs, or by federal regulations pursuant to other FMPs or international commissions, or by industry self-regulation, consistent with the requirements of the Magnuson-Stevens Act and other applicable law.

A Council should consider the specific circumstances of a fishery, based on the best scientific information available to determine whether there are biological, economic, social, and/or operational concerns that can and should be addressed by federal management. When considering adding a stock to an FMP, no single factor is dispositive or required. One or more of the above factors, and any additional considerations that may be relevant to the particular stock, may provide the basis for determining that a stock requires conservation and management.

In addition, a Council may choose to identify stocks within their FMPs as EC species (see 50 CFR §§ 600.305(d)(13) and 600.310(d)(1)) if the Council determines that the stocks do not require conservation and management based on the considerations and factors described above. EC species may be identified at the species or stock level, and may be grouped into complexes. There are no species identified as EC in the Puerto Rico FMP.

Councils should periodically review their FMPs and the best scientific information available and determine if the stocks are appropriately identified. As appropriate, stocks should be reclassified within an FMP, added to or removed from an existing FMP, or added to a new FMP, through an FMP amendment that documents the rationale for the decision.

*Stocks in an FMP*

Stocks in the fishery can be grouped into stock complexes as appropriate. Target stocks are stocks or stock complexes that fishermen seek to catch for sale or personal use, including such fish that are discarded for economic or regulatory reasons as defined under the Magnuson-Stevens Act. The non-target species and non-target stocks are fish caught incidentally during the pursuit of target stocks in a fishery. Non-target stocks may require conservation and management and, if so, must be included in a FMP and be identified at the stock or stock complex level. If non-target species are not in need of conservation and management, they may be identified in an FMP as EC species.

The Caribbean Council, with input from the Council's Scientific and Statistical Committee (SSC) and District Advisory Panels (DAP), established a process for determining which species would be included in the new Puerto Rico FMP. For those species for which landings data are available, the Council followed a stepwise application of a set of criteria to determine if a species should be managed under the Puerto Rico FMP. Sections 5.1-5.5 in Chapter 5 of this document contain a description of each criterion and its analysis.

Based on the selection criteria in Action 2 of this FMP/EA, several species previously managed under the Council's Reef Fish, Spiny Lobster, Corals, and Queen Conch FMPs would continue to be managed under the Puerto Rico FMP, while several other species would be removed from federal management. Eighteen new finfish species and several genera of corals and other invertebrates would be added to the Puerto Rico FMP. The Puerto Rico FMP would be composed of one species of queen conch, one species of spiny lobster, all species of sea cucumbers and sea urchins, all species of corals, and 63 finfish species (See Table 3.3.1 below).

Stock Complexes

Once species are assigned as targeted or non-targeted stocks, the Council has the option to group stocks into "stock complexes". A stock complex is a tool to manage a group of stocks within an FMP. Where practicable, the group of stocks should have a similar geographic distribution, life history characteristics, and vulnerabilities to fishing pressures such that the impact of management actions to the stocks is similar. National Standard (NS) 3 of the Magnuson-Stevens Act requires that, to the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination (16 U.S.C. 1851(3); 50 CFR 600.320).

Stocks may be grouped into complexes for various reasons, for example, where stocks in a multispecies fishery cannot be targeted independent of one another; where there are insufficient data to measure a stock's status relative to established status determination criteria (SDC); or when it is not feasible for fishermen to distinguish individual stocks among their catch.

The vulnerability of individual stocks should be considered when determining if a particular stock complex should be established or reorganized, or if a particular stock should be included in a complex.

The FMP should provide, to the extent practicable, a full and explicit description of the proportional composition of each stock in the stock complex, to the extent possible at the time the stock complex is established.

Definitions

**Productivity** – the capacity of the stock to produce maximum sustainable yield and to recover if the population is depleted.

**Susceptibility** – the potential for the stock to be impacted by the fishery, which includes direct captures, as well as indirect impacts to the fishery (e.g., loss of habitat quality).

**Vulnerability** – the combination of a stock's productivity, which depends upon its life history characteristics, and its susceptibility to the fishery.

The species resulting from the selection process in Action 2 of the DEIS for the Puerto Rico FMP described above, were either grouped as stock complexes or managed as individual stocks based on scientific analysis, including one or more of the following: cluster analysis based on landings patterns; outcomes from the SEDAR Caribbean Data Evaluation Workshop (2009) (only for species previously managed that would remain in the FMP); biological/life history similarities and vulnerability (for all species); or, expert opinion from the scientific and fishing communities (for all species). Please see the Sections 5.7 and 5.8 in Chapter 5 of this document for a description of this process. Table 2.3.1 below shows the final organization for the stocks and stock complexes included in the Puerto Rico FMP.

Indicator Stocks

The Magnuson-Stevens Act NS1 Guidelines define an indicator stock as a stock with measurable and objective SDCs that can be used to help manage and evaluate the more poorly known stocks that are in a stock complex[25]. Where practicable, stock complexes should include one or more indicator stocks (each of which has SDC and ACLs). Otherwise, stock complexes may be comprised of several stocks without an indicator stock, with SDC and an ACL for the complex as a whole; or one of more indicator stocks, each of which has SDC and management objectives, with an ACL for the complex as a whole. Councils should review the available quantitative or qualitative information (e.g. catch trends, changes in vulnerability, fish health indices, etc.) of stocks within a complex on a regular basis to determine if they are being sustainably managed.

[25] https://www.govinfo.gov/content/pkg/FR-2016-10-18/pdf/2016-24500.pdf

If an indicator stock is used to evaluate the status of a complex, it should be representative of the typical vulnerability of stocks with the complex (see box above). If the stocks within a stock complex have a wide range of vulnerabilities, they should be reorganized into different stock complexes according to similar vulnerabilities; otherwise the indicator stock should be chosen to represent the more vulnerable stocks within the complex. In instances where an indicator stock is less vulnerable than other members of the complex, management measures should be more conservative so the more vulnerable members of the complex are not at risk from the fishery.

More than one indicator stock can be selected to provide a broader base of information about the status of the complex. When indicator stocks are used, the stock complex's MSY could be listed as "unknown," while noting that the complex is managed on the basis of one or more indicator stocks that do have known stock-specific MSYs, or suitable proxies.

For the Puerto Rico FMP, an indicator stock is one where the stock status of the indicator is extrapolated to represent that of other species in a multi-species management units.
The Council's SSC identified indicator stocks based on a set of criteria (See Section 5.8). These were assigned to a complex based on the following criteria: percent of the catch, targeted, habitat co-occurrence, life history/vulnerability, catch co-occurrence, data availability, and market value. Stocks in the stock complex would be subject to AMs as a group based on the indicator stock ACL. Annual catch limits and AMs are discussed in Chapters 6 and 10.

In the Puerto Rico FMP, seven indicator stocks were selected (Table 3.3.1). If no indicator stocks were identified, for stock complexes for which harvest is allowed, species in the complex would be subject to AMs as a group based on the aggregate ACL. This is discussed in detail in Chapter 4.

**Table 3.3.1.** List of stocks and stock complexes included in the Puerto Rico FMP.
Where applicable, indicator stocks are in bold text. Species new to management are marked with a plus sign+.

| Family or Class | Stock/Stock Complex | Species Name | Common Name/Nombre común |
|---|---|---|---|
| **Strombidae -- True conchs** | Queen conch | *Lobatus (Strombus) gigas* | Queen conch; carrucho |
| **Palinuridae -- Spiny lobster** | Spiny Lobster | *Panulirus argus* | Caribbean spiny lobster; langosta espinosa |
| **Lutjanidae -- Snappers** | SU1 | *Apsilus dentatus* | Black snapper; pargo prieto |
| | | *Lutjanus buccanella* | Blackfin snapper; alinegra |
| | | ***Lutjanus vivanus*** | **Silk snapper; chillo ojo amarillo** |
| | | *Rhomboplites aurorubens* | Vermilion snapper; chilla rubia, besugo |

| | | | |
|---|---|---|---|
| | | *Pristipomoides aquilonaris* | Wenchman; limosnera, muniama de adentro |
| | SU2 | *Pristipomoides macrophthalmus* | Cardinal snapper; muniama de afuera |
| | | ***Etelis oculatus*** | **Queen snapper; cartucho** |
| | SU3 | *Lutjanus synagris* | Lane snapper; arrayao |
| | SU4 | ***Lutjanus analis*** | **Mutton snapper; sama** |
| | | *Lutjanus jocu* | Dog snapper; pargo colorado |
| | | *Lutjanus apodus* | Schoolmaster; pargo amarillo |
| | SU5 | *Ocyurus chrysurus* | Yellowtail snapper; colirrubia |
| | SU6 | *Lutjanus cyanopterus*[+] | Cubera snapper[+]; pargo mulato |
| **Serranidae -- Groupers** | GU1 | *Epinephelus striatus* | Nassau Grouper; mero cherna |
| | GU2 | *Epinephelus itajara* | Goliath grouper; mero batata |
| | GU3 | *Cephalopholis cruentata* | Graysby |
| | | ***Cephalopholis fulva*** | **Coney; mantequilla** |
| | GU4 | *Mycteroperca bonaci* | Black grouper; mero prieto |
| | | *Epinephelus morio* | Red grouper; mero rojo |
| | | *Mycteroperca tigris* | Tiger grouper; tigre |
| | | *Mycteroperca venenosa* | Yellowfin grouper; guajil |
| | | *Mycteroperca interstitialis*[+] | Yellowmouth grouper[+]; guajil boquiamarillo |
| | GU5 | *Hyporthodus flavolimbatus* | Yellowedge grouper; guajil amarillo |
| | | *Hyporthodus mystacinus* | Misty grouper; guasa |
| | GU6 | ***Epinephelus guttatus*** | **Red hind; cabrilla** |
| | | *Epinephelus adscensionis* | Rock hind; cabra mora |
| **Scaridae -- Parrotfishes** | Parrotfish 1 | *Scarus coeruleus* | Blue parrotfish; brindao |
| | | *Scarus coelestinus* | Midnight parrotfish; judío |
| | | *Scarus guacamaia* | Rainbow parrotfish; guacamayo |
| | Parrotfish 2 | *Scarus vetula* | Queen parrotfish; loro reina |
| | | *Scarus taeniopterus* | Princess parrotfish; princesa |
| | | *Sparisoma chrysopterum* | Redtail parrotfish; loro colirrojo |
| | | *Sparisoma viride* | Stoplight parrotfish; loro verde; chaporra |
| | | *Sparisoma aurofrenatum* | Redband parrotfish; loro banda colorada |
| | | *Scarus iseri* | Striped parrotfish; loro rayado |
| **Acanthuridae -- Surgeonfishes** | Surgeonfish | *Acanthurus coeruleus* | Blue tang; barbero |
| | | *Acanthurus tractus* | Ocean surgeonfish; médico |
| | | *Acanthurus chirurgus* | Doctorfish; cirujano |
| **Balistidae -- Triggerfishes** | Triggerfish | *Canthidermis sufflamen* | Ocean triggerfish; turco |
| | | ***Balistes vetula*** | **Queen triggerfish; peje puerco** |

| | | | |
|---|---|---|---|
| | | *Balistes capriscus*[+] | Gray triggerfish[+]; peje puerco blanco |
| **Labridae -- Wrasses** | Wrasse 1 | *Lachnolaimus maximus* | Hogfish; capitán |
| | Wrasse 2 | *Halichoeres radiatus*<br>*Bodianus rufus* | Puddingwife; capitán de piedra<br>Spanish hogfish; loro capitán |
| **Pomacanthidae -- Angelfishes** | Angelfish | *Holacanthus ciliaris*<br>*Pomacanthus arcuatus*<br>*Pomacanthus paru* | Queen angelfish; isabelita<br>Gray angelfish; isabelita gris<br>French angelfish; isabelita negra |
| **Sphyraenidae -- Barracudas** | Barracuda | *Sphyraena barracuda*[+] | Great barracuda[+]; picúa |
| **Lobotidae -- Tripletail** | Tripletail | *Lobotes surinamensis*[+] | Tripletail[+]; viajacas del mar |
| **Myliobatidae – Eagle and Manta** | Manta | *Manta birostris*[+] | Manta[+]; manta |
| | Spot Eagle | *Aetobatus narinari*[+] | Spotted eagle ray[+]; chucho |
| | Sting ray | *Dasyatis americana*[+] | Sting ray[+]; raya |
| **Haemulidae -- Grunts** | Grunts | *Haemulon plumieri* | White grunt; cachicata, boquicolorao |
| **Carangidae -- Jacks** | Jack Unit 1 | *Caranx hipos*[+] | Crevalle Jack; jurel amarillo[+] |
| | Jack Unit 2 | *Alectis ciliaris*[+] | African pompano[+]; pámpano |
| | Jack Unit 3 | *Elagatis bipinnulata*[+] | Rainbow runner[+]; salmón |
| **Coryphaenidae – Dolphin fish** | Dorado | ***Coryphaena hippurus*** [+]<br>*Coryphaena equiselis*[+] | **Dolphinfish; dorado**[+]<br>Pompano dolphin[+]; doradito |
| **Scombridae – Mackerels and tunas** | Tuna | *Euthynnus alletteratus*[+] | Little tunny[+]; bonito |
| | | *Thunnus atlanticus*[+] | Blackfin tuna[+]; albacora |
| | Mackerel | *Scomberomorus cavalla*[+] | King mackerel; sierra carite[+] |
| | | *Scomberomorus regalis*[+] | Cero; sierra alasana[+] |
| | Wahoo | *Acanthocybium solandri*[+] | Wahoo; peto[+] |
| **Classs Holothuroidea – Sea Cucumbers** | Cucumbers | All (several families and sps) | Sea cucumbers; pepinos de mar |
| **Class Echinoidea -- Sea Urchins** | Urchins | All (several families and sps) | Sea urchins; erizos |
| **All Corals** | Corals | Several families and species | Corals; corales |

*Description of the Stocks Managed under the Puerto Rico FMP*

Appendix C contains specific information about the distribution and habitat, life history, diet, reproduction and spawning characteristics for all species in the Puerto Rico FMP.

### 3.3.2 Protected Species and Critical Habitat

Within the U.S. Caribbean, some species and their habitats are protected under the Marine Mammal Protection Act (MMPA), the Endangered Species Act (ESA), or both. At least 17 species of whales and dolphins have been reported in or near U.S. waters in the northeastern Caribbean (Mignucci-Giannoni 1998). All 17 species are protected under the MMPA. Three of these species (*i.e.*, sperm, sei, and fin whales) are also listed as endangered under the ESA.[26] In addition to these three marine mammals, 16 other species that are known to occur in the U.S. Caribbean are also protected under the ESA (Table 3.3.2), and include sea turtles, corals, and fish species. ESA designated critical habitat for the green sea turtle (Figure 3.3.1), hawksbill sea turtle (Figure 3.3.2), and *Acropora* corals (Figure 2.3.3) also occur within the Puerto Rico management area.

**Table 3.3.2.** ESA-listed species that occur in U.S. Caribbean federal waters.

| Common Name | Scientific Name | Status |
|---|---|---|
| Sei whale | *Balaenoptera borealis* | Endangered |
| Sperm whale | *Physeter macrocephalus* | Endangered |
| Fin whale | *Balaenoptera physalus* | Endangered |
| Green turtle (North Atlantic Distinct Population Segment [DPS]) | *Chelonia mydas* | Threatened |
| Green turtle (South Atlantic DPS) | *Chelonia mydas* | Threatened |
| Hawksbill sea turtle | *Eretmochelys imbricata* | Endangered |
| Leatherback sea turtle | *Dermochelys coriacea* | Endangered |
| Loggerhead sea turtle (Northwest Atlantic DPS) | *Caretta caretta* | Threatened |
| Elkhorn coral | *Acropora palmata* | Threatened |
| Staghorn coral | *Acropora cervicornis* | Threatened |
| Rough cactus coral | *Mycetophyllia ferox* | Threatened |
| Pillar coral | *Dendrogyra cylindrus* | Threatened |
| Lobed star coral | *Orbicella annularis* | Threatened |
| Mountainous star coral | *Orbicella faveolata* | Threatened |
| Boulder star coral | *Orbicella franksi* | Threatened |
| Scalloped hammerhead shark (Central and Southwest Atlantic DPS) | *Sphyrna lewini* | Threatened |
| Nassau grouper | *Epinephelus striatus* | Threatened |
| Oceanic whitetip shark | *Carcharhinus longimanus* | Threatened |
| Giant Manta Ray | *Manta birostris* | Threatened |

[26] Five DPSs of humpback whales are listed under the ESA; however, the West Indies DPS, which is the only DPS present in the U.S. Caribbean, is not listed as endangered or threatened (81 FR 62259).

Background information on the life history, habitat, diet, growth patterns, or other species-specific information for each of the ESA-listed species occurring in that action area are described below for reference.

Marine Mammals

The sei whale occurs in all ocean basins of the world, primarily in temperate to subpolar latitudes. Sei whales in the North Atlantic reportedly feed primarily on calanoid copepods, with a secondary preference for euphausiids (Hjort and Ruud 1929; Mitchell 1975a; Mitchell et al. 1986; Christensen et al. 1992). Throughout their range, sei whales occur predominantly in deep water. They are most common over the continental slope (Mitchell 1975b; Cetacean and Turtle Assessment Program 1982; Martin 1983; Olsen et al. 2009), shelf breaks (Committee on the Status of Endangered Wildlife in Canada 2003), and deep ocean basins situated between banks (Sutcliffe and Brodie 1977). Studies in various ocean basins indicate that sei whales are associated with ocean fronts and eddies (Nasu 1966; Nemoto and Kawamura 1977; Skov et al. 2008; Bost et al. 2009). Direct hunting was the main cause of initial depletion of sei whales. Loss of prey base due to climate and ecosystem change presents an unknown, but potentially high impact to recovery.

The sperm whale occurs in all oceans of the world. Sperm whales are distributed throughout most oceanic areas, but are found in deeper waters seaward of the continental shelf. The primary cause of the population decline that precipitated ESA listing was commercial whaling for ambergris and spermaceti in the eighteenth, nineteenth, and twentieth centuries. Cephalopods (*i.e.*, squid, octopi, cuttlefishes, and nautili) are the main component of sperm whale diets. Current threats to sperm whales include ship strikes and entanglements in fishing gear. Other threats to sperm whales include disturbance by man-made noise, for example from seismic surveys, and this threat is heightened in areas of oil and gas activities or where shipping activity is high. NMFS' Recovery Plan for Sperm Whales (NMFS 2010) identified 4 main categories of threats to the recovery of sperm whales in the Atlantic Ocean: (1) vessel interactions, (2) incidental capture in fishing gear, (3) habitat degradation, and (4) military operations.

The fin whale is found throughout the world in deep, offshore waters of all major oceans, primarily in temperate to polar latitudes. They are less common in the tropics. They occur year-round in a wide range of locations, but the density of individuals in any one area changes seasonally. Fin whales feed on krill, small schooling fish (including herring, capelin, and sand lance), and squid. Fin whales can become entangled in fishing gear, either swimming off with the gear attached or becoming anchored. They can become entangled in many different gear types, including traps, pots, or gillnets. Underwater noise also threatens whale populations, interrupting their normal behavior and driving them away from areas important to their survival. Increasing evidence suggests that exposure to intense underwater sound in some settings may cause some whales to strand and ultimately die.

Sea Turtles

After emerging from the nest, green sea turtle hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. This early oceanic phase remains one of the most poorly understood aspects of green sea turtle life history (NMFS and USFWS 2007). At approximately 8-10 inches (20-25 cm) carapace length, juveniles leave the pelagic environment and enter nearshore developmental habitats such as protected lagoons and open coastal areas rich in sea grass and marine algae. Within the developmental habitats, juveniles begin the switch to a more herbivorous diet, and by adulthood feed almost exclusively on seagrasses and algae (Rebel 1974), although some populations are known to also feed heavily on invertebrates (Carballo et al. 2002). The diving abilities of all sea turtles species vary by their life stages. The maximum diving range of green sea turtles is estimated at 360 ft (110 m) (Frick 1976), but they most frequently make dives of less than 65 ft (20 m) (Walker 1994). The time of these dives also varies by life stage. The maximum dive length is estimated at 66 minutes with most dives lasting from 9 to 23 minutes (Walker 1994). Green sea turtles face threats including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (e.g., plastics, petroleum products, petrochemicals), ecosystem alterations (e.g., nesting beach development, beach nourishment and shoreline stabilization, vegetation changes), poaching, global climate change, fisheries interactions, natural predation, and disease.

Hawksbill sea turtles nest on sandy beaches throughout the tropics and subtropics. The most significant nesting within the United States occurs in Puerto Rico and the U.S. Virgin Islands, specifically on Mona Island and Buck Island Reef National Monument, respectively. Post-hatchlings (oceanic stage juveniles) are believed to live in the open ocean, taking shelter in floating algal mats and drift lines of flotsam and jetsam in the Atlantic ocean (Musick and Limpus 1997) before returning to more coastal foraging grounds. In the Caribbean, hawksbill sea turtles are known to almost exclusively feed on sponges (Meylan 1988; Van Dam and Diez 1997), although at times they have been seen foraging on other food items, notably corallimorphs and zooanthids (León and Diez 2000; Mayor et al. 1998; Van Dam and Diez 1997). Adult foraging typically occurs over coral reefs, although other hard-bottom communities and mangrove-fringed areas are occupied occasionally. NMFS believes it is probable that much of the Caribbean, down to 328 ft (100 m) or more, provides a foraging habitat for the adult turtles, particularly since sponges grow to this depth. Hawksbill sea turtles are currently subjected to the same suite of threats on both nesting beaches and in the marine environment that affect other sea turtles (e.g., interaction with federal and state fisheries, coastal construction, oil spills, climate change affecting sex ratios). Due to their preference to feed on sponges associated with coral reefs, hawksbill sea turtles are particularly sensitive to losses of coral reef communities. Because

continued loss of coral reef communities (especially in the greater Caribbean region) is expected to impact hawksbill foraging, it represents a major threat to the recovery of the species.

Leatherback sea turtles are the most pelagic of all ESA-listed sea turtles and spend most of their time in the open ocean. However, they will enter coastal waters and are seen over the continental shelf on a seasonal basis to feed in areas where jellyfish are concentrated. Leatherback sea turtles feed primarily on cnidarians (medusae, siphonophores) and tunicates. Unlike other sea turtles, leatherbacks' diets do not shift during their life cycles. Leatherback sea turtles are the deepest diving of all sea turtles, with recorded depths in excess of a half-mile (Eckert et al. 1989), but they may also come into shallow waters to locate prey items. Dive times range from a maximum of 37 minutes to more routines dives of 4 to 14.5 minutes (Standora et al. 1984; Eckert et al. 1986; Eckert et al. 1989; Keinath and Musick 1993). Leatherback sea turtles may spend 74% to 91% of their time submerged (Standora et al. 1984). Leatherback sea turtles face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (plastics, petroleum products, petrochemicals, etc.), ecosystem alterations (nesting beach development, beach nourishment and shoreline stabilization, vegetation changes, etc.), poaching, global climate change, fisheries interactions, natural predation, and disease. Of all sea turtle species, leatherbacks seem to be the most vulnerable to entanglement in fishing gear, especially gillnet and pot/trap lines.

Critical habitat for listed green turtles includes waters extending seaward 3 nm (5.6 km) from the mean high water line of Culebra Island, Puerto Rico (Figure 2.3.1). These waters include Culebra's outlying Keys, including Cayo Norte, Cayo Ballena, Cayos Geniquı´, Isla Culebrita, Arrecife Culebrita, Cayo de Luis Peña, Las Hermanas, El Mono, Cayo Lobo, Cayo Lobito, Cayo Botijuela, Alcarraza, Los Gemelos, and Piedra Steven.

Critical habitat for listed hawksbill turtles includes waters extending seaward 3 nm (5.6 km) from the mean high water line of Mona and Monito Islands, Puerto Rico (Figure 2.3.2).

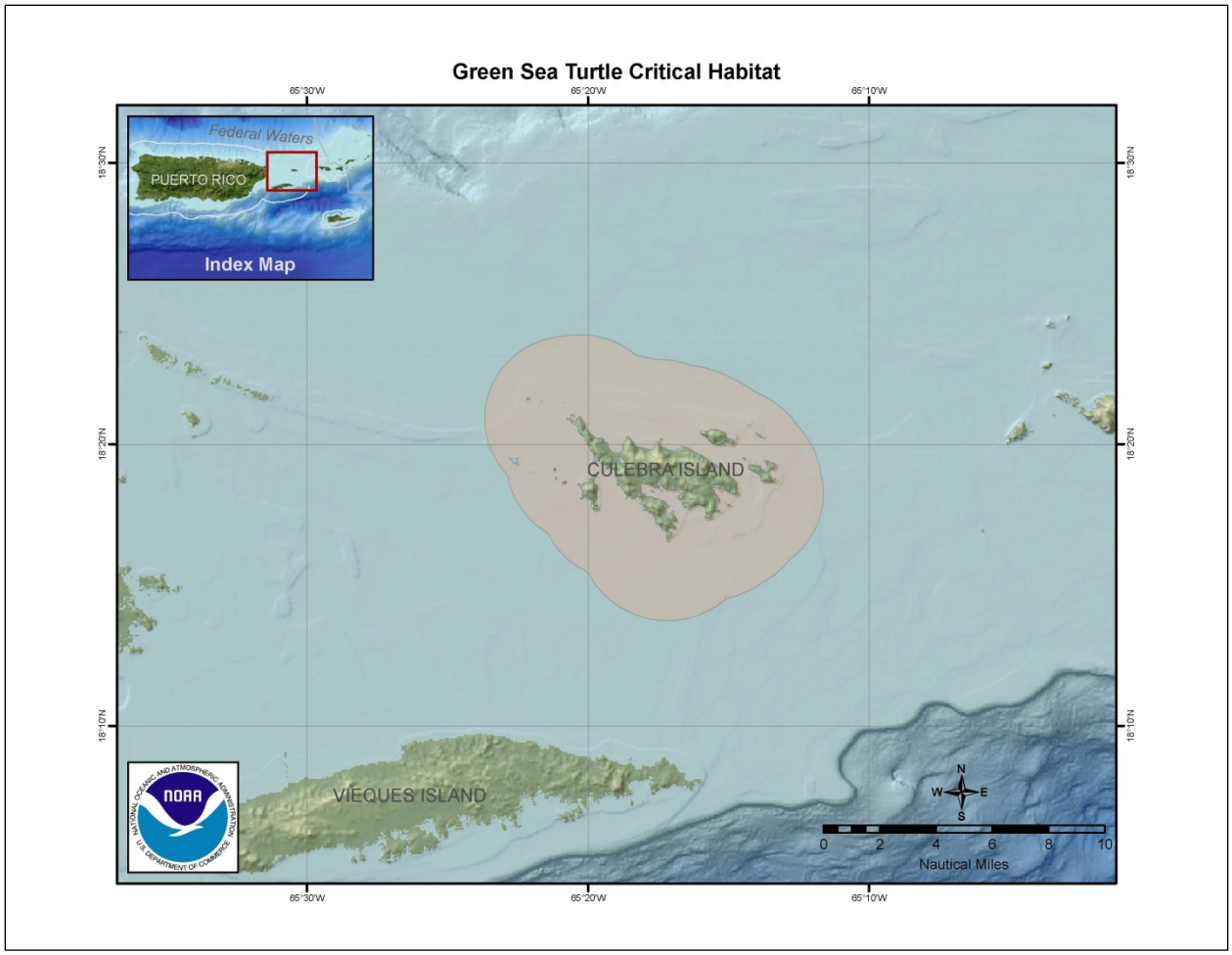



**Figure 3.3.1.** Area in Puerto Rico designated as green sea turtle critical habitat.

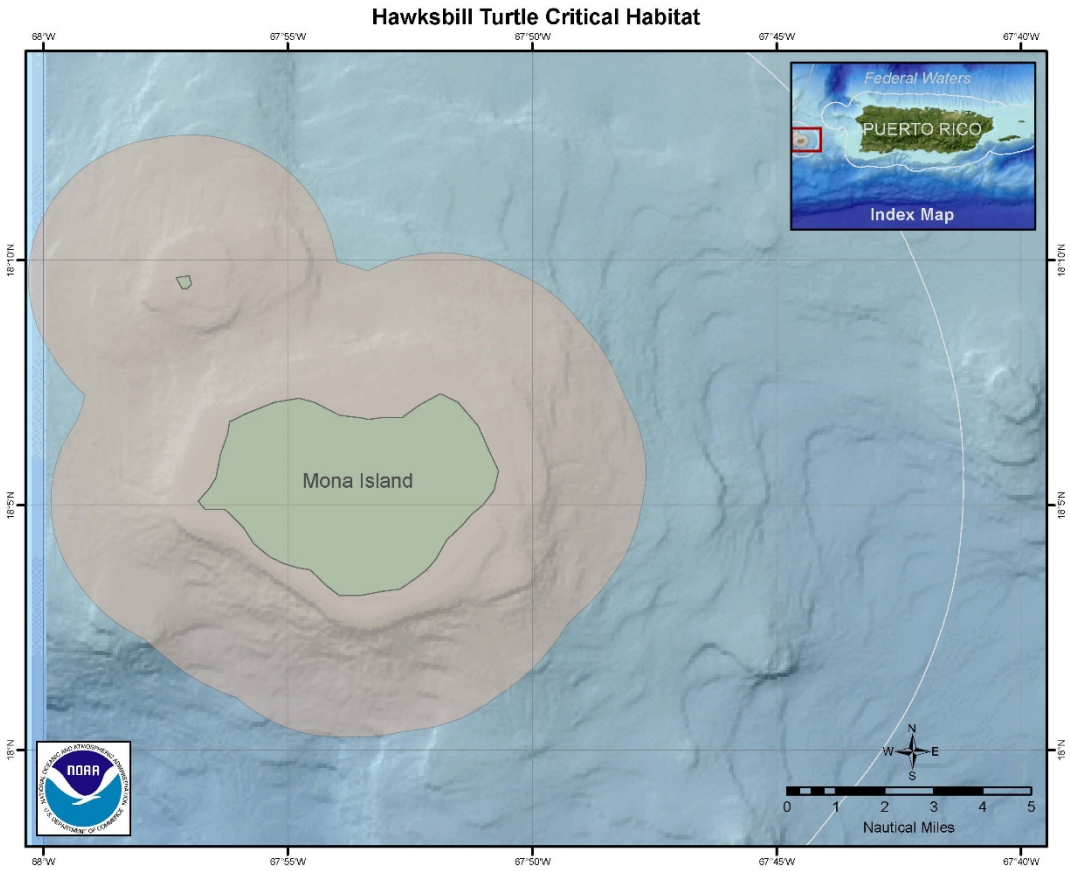



**Figure 3.3.2.** Area in Puerto Rico designated as hawksbill sea turtle critical habitat.

Corals

*Acropora cervicornis* and *Acropora palmata*, the only two species of acroporids in the Caribbean, are two of the major reef-building corals in the wider Caribbean. Elkhorn colonies form flattened to near-round branches that typically radiate outward from a central trunk that is firmly attached to the sea floor. Staghorn colonies are stag antler-like, with cylindrical, straight, or slightly curved branches. The branching morphology of these species provides important habitat for other reef organisms. Historically, both acroporid species formed dense thickets at shallow (16 ft [<5 m]) and intermediate (33 to 49 ft [10 to 15 m]) depths in many reef systems, including locations in the Florida Keys, western Caribbean (e.g., Jamaica, Cayman Islands, Caribbean Mexico, Belize), and eastern Caribbean. In the 1960s and 1970s in the USVI, elkhorn coral was the main reef-building coral at depths less than 33 ft (10 m) (Rogers et al. 2002). Elkhorn coral grew in nearly monospecific stands on the reef crest and in the upper and lower forereef zones of well-developed fringing and bank barrier reefs, as well as on isolated patch reefs (Rogers et al. 2002). Elkhorn coral commonly grows in turbulent water on the fore-reef, reef crest, and shallow spur-and-groove zone (Cairns 1982; Miller et al. 2008; Rogers et al. 1982;

Shinn 1963) in water ranging from approximately 3-15 ft (1-5 m) depth, and up to 40 ft (12 m). The preferred habitat of elkhorn coral is the seaward face of a reef (turbulent shallow water), including the reef crest, and shallow spur-and-groove zone (Shinn 1963; Cairns 1982; Rogers et al. 1982). Historically, staghorn coral was reported from depths ranging from <3.28 to 197 ft (<1 to 60 m) (Goreau and Goreau 1973). It is suspected that 197 ft (60 m) is an extreme situation and that the coral is relatively rare below 66 ft (20 m) depth. The common depth range at which staghorn coral is currently observed is 16 to 56 ft (5 to 17 m). In the USVI, this species was abundant, but not often found in dense thickets or well-defined zones (Rogers et al. 2002); unlike in areas in the western Caribbean where this species was historically the primary constructor of mid-depth (33 to 49 ft [10 to 15 m]) reef terraces (Adey 1978).

Pillar coral (*Dendrogyra cylindrus*) forms cylindrical columns on top of encrusting bases. Colonies are generally grey-brown in color and may reach circa 10 ft (3 m) in height. Polyp tentacles remain extended during the day, giving columns a furry appearance. Pillar coral inhabits most reef environments in water depths ranging from ~3-75 ft (1-25 m), but it is most common between ~15-45 ft (5-15 m) depths (Acosta and Acevedo 2006; Cairns 1982; Goreau and Wells 1967). Pillar coral is a gonochoric (separate sexes) broadcast spawning species with relatively low annual egg production for its size. Sexual recruitment of this species is low, and reported juvenile colonies in the Caribbean are lacking. Pillar coral can reproduce by fragmentation following storms or other physical disturbance. Average growth rates of 0.7-0.8 inches (in) (1.8-2.0 centimeters [cm]) per year in linear extension have been reported in the Florida Keys compared to 0.31 in (0.8 cm) per year in Colombia and Curaçao. Feeding rates (removal of suspended particles in seawater) are low relative to most other Caribbean corals, indicating it is primarily a tentacle feeder rather than a suspension feeder. However, pillar coral has a relatively high photosynthetic rate, and it receives substantial amounts of energy from its symbiotic algae. Pillar coral is uncommon but conspicuous with scattered, isolated colonies. In monitoring studies, cover is generally less than 1%. At permanent monitoring stations in the USVI, pillar coral has been observed in low abundance at 10 of 33 sites and, where present, ranged in cover from less than 0.05-0.22% (Smith 2013). It is rarely found in aggregations.

Rough cactus coral (*Mycetophyllia ferox*) forms a thin, encrusting plate that is weakly attached. Maximum colony size is ~20 in (50 cm) in diameter. It has been reported in reef environments in water depths of ~15 to 300 ft (5 to 90 m), including shallow and mesophotic habitats. Rough cactus coral is a hermaphroditic (simultaneously both sexes) brooding (fertilization occurs within the parent colony and grows for a period of time before release) species. Colony size at first reproduction is greater than 15 $in^2$ (100 $cm^2$). Recruitment of rough cactus coral appears to be very low, even in studies from the 1970s. Rough cactus coral has a lower fecundity compared to other species in its genus (Morales Tirado 2006). Over a 10 year period, no colonies of rough cactus coral were observed to recruit to an anchor-damaged site in the USVI although adults were observed on the adjacent reef (Rogers and Garrison 2001). Rough cactus coral is usually

uncommon or rare, constituting less than 0.1% of all coral species at generally less than 1% of the benthic cover. Benthic cover of rough cactus coral in the Red Hind Marine Conservation District off St. Thomas, USVI, which includes mesophotic coral reefs, was 0.003 ± 0.004% in 2007, accounting for 0.02% of coral cover, and ranking 20$^{th}$ highest in cover out of 21 coral species (Nemeth et al. 2008; Smith et al. 2010). In the USVI between 2001 and 2012, cover of rough cactus coral appeared in 12 of 33 survey sites and accounted for 0.01% of the bottom, and 0.07% of the coral cover, ranking as 13$^{th}$ most common (Smith 2013).

Boulder star coral (*Orbicella franksi*) is one of the three species in the *Orbicella annularis* complex (mountainous star coral [*Orbicella faveolata*] and lobed star coral [*Orbicella annularis*] are the other two). These three species were formerly in the genus *Montastraea*; however, recent work has reclassified the three species in the *annularis* complex to the genus *Orbicella* (Budd et al. 2012). Boulder star coral is distinguished by large, unevenly arrayed polyps that give the colony its characteristic irregular surface. Colony form is variable, and the skeleton is dense with poorly developed annual bands. Colony diameter can reach up to 16 ft (5 m) with a height of up to 6.5 ft (2 m). Boulder star coral tends to have a deeper distribution than the other two species in the *Orbicella* species complex. It occupies most reef environments and has been reported from water depths ranging from ~16-165 ft (5 to 50 m), with the species complex reported to 250 ft (90 m). *Orbicella* species are a common, often dominant, component of Caribbean mesophotic reefs, suggesting the potential for deep refugia for boulder star coral. Boulder star coral is hermaphroditic (simultaneously having both sexes) broadcast spawners, with spawning concentrated on 6 to 8 nights following the full moon in late August, September, or early October. Boulder star coral spawning is reported to be about one to two hours earlier than lobed star coral and mountainous star coral. Fertilization success measured in the field was generally below 15% for all three species being closely linked to the number of colonies concurrently spawning. In Puerto Rico, minimum size at reproduction for the star coral species complex was 13 in$^2$ (83 cm$^2$). Boulder star coral is reported as common. In the USVI, boulder star coral is the second most abundant species by percent cover at permanent monitoring stations. However, because the species complex, which is the most abundant by cover, was included as a category when individual *Orbicella* species could not be identified with certainty, it is likely that boulder star coral is the most abundant. Population estimates of boulder star coral in the ~19 square mile (49 km$^2$) Red Hind Marine Conservation District are at least 34 million colonies (Smith 2013). Abundance was stable between 1998-2008 at nine sites off Mona and Desecheo Islands, Puerto Rico. In 1998, 4% of all corals at six sites surveyed off Mona Island were boulder star coral colonies in 1998 and approximately 5% in 2008; at Desecheo Island, about 2% of all coral colonies were boulder star coral in both 2000 and 2008 (Bruckner and Hill 2009).

Lobed star coral (*Orbicella annularis*) colonies grow in columns that exhibit rapid and regular upward growth. Unlike the other two star coral species, margins on the sides of columns are typically dead. Live colony surfaces usually lack ridges or bumps. Lobed star coral is reported

from most reef environments in depths of ~1.5-66 ft (0.5-20 m). The star coral species complex is a common, often dominant component of Caribbean mesophotic (deeper than ~100 ft) reefs, suggesting the potential for deep refuge across a broader depth range, but lobed star coral is generally described with a shallower distribution. Asexual fission and partial mortality can lead to multiple clones of the same colony. The percentage of unique genotypes is variable by location and is reported to range between 18% and 86% (14-82% are clones). Colonies in areas with higher disturbance from hurricanes tend to have more clonality. Although lobed star coral is still abundant, it may exhibit high clonality in some locations. Like the other species in the complex, lobed star coral is a hermaphroditic broadcast spawners, with spawning concentrated on 6-8 nights following the full moon in late August, September, or early October. Lobed star coral is reported to have slightly smaller egg size and potentially smaller size/age at first reproduction that the other two species of the *Orbicella* genus. In Puerto Rico, minimum size at reproduction for the star coral species complex was 12 $in^2$ (83 $cm^2$). Lobed star coral has been described as common overall. Demographic data collected in Puerto Rico over nine years straddling the 2005 bleaching event showed that population growth rates were stable in the pre-bleaching period (2001–2005) but declined one year after the bleaching event. Population growth rates declined even further two years after the bleaching event, but they returned to stasis the following year. Lobed star coral is the third most abundant coral by percent cover in permanent monitoring stations in the USVI. A decline of 60% was observed between 2001 and 2012 primarily due to bleaching in 2005. However, most of the mortality was partial mortality, and colony density in monitoring stations did not change (Smith 2013). At nine sites off Mona and Desecheo Islands, Puerto Rico, no species extirpations were noted at any site over 10 years of monitoring between 1995 and 2008. In 1998, 8% of all corals at six sites surveyed off Mona Island were lobed star coral colonies, dipping to approximately 6% in 2008. At Desecheo Island, 14% of all coral colonies were lobed star coral in 2000 while 13% were in 2008 (Bruckner and Hill 2009).

Mountainous star coral (*Orbicella faveolata*) grows in heads or sheets, the surface of which may be smooth or have keels or bumps. The skeleton is much less dense than in the other two star coral species. Colony diameter can reach up to 33 ft (10 m) with heights of 13-16 ft (4-5 m). Mountainous star coral has been reported in most reef habitats and is often the most abundant coral between 33-66 ft (10-20 m) in fore-reef environments. The depth range of mountainous star coral has been reported as ~1.5-132 ft (0.5-40 m), though the species complex has been reported to depths of 295 ft (90 m), indicating mountainous star coral's depth distribution is likely deeper than 132 ft (40 m). Like the other species in the complex mountainous star coral is a hermaphroditic broadcast spawner with spawning concentrated on 6 to 8 nights following the full moon in late August, September, or early October. Fertilization success measured in the field was generally below 15% for all three species being closely linked to the number of colonies concurrently spawning. In Puerto Rico, minimum size at reproduction for the star coral species complex was 12 $in^2$ (83 $cm^2$). In many life history characteristics, including growth

rates, tissue regeneration, and egg size, mountainous star coral is considered intermediate between lobed star coral and boulder star coral. Reported growth rates of mountainous star coral range between 0.12 and 0.64 in (0.3-1.6 cm) per year (Cruz-Piñón et al. 2003; Tomascik 1990; Villinski 2003; Waddell 2005). Szmant and Miller (2005) reported low post-settlement survivorship for mountainous star coral transplanted to the field with only 3-15% remaining alive after 30 days. Mountainous star coral is the sixth most abundant species by percent cover in permanent monitoring stations in the USVI. Population estimates in the 19-square-mile (49 kilometers squared) Red Hind Marine Conservation District are at least 16 million colonies (Smith 2013). At nine sites off Mona and Desecheo Islands, Puerto Rico, no species extirpations were noted at any site over 10 years of monitoring between 1998 and 2008 (Bruckner and Hill 2009). Both mountainous star coral and lobed star coral sustained large losses during the period. The number of colonies of mountainous star coral decreased by 36% and 48% at Mona and Desecheo Islands, respectively (Bruckner and Hill 2009). In 1998, 27% of all corals at six sites surveyed off Mona Island were mountainous star coral colonies, but decreased to approximately 11% in 2008 (Bruckner and Hill 2009). At Desecheo Island, 12% of all coral colonies were mountainous star coral in 2000 compared to 7% in 2008.

On November 26, 2008, a final rule designating *Acropora* critical habitat was published in the *Federal Register* and defined the physical or biological features essential to the conservation of the species (also known as essential feature). The essential features to the conservation of *Acropora* species is substrate of suitable quality and availability, in water depths from the mean high water line to 98 ft (30 m), to support successful larval settlement, recruitment, and reattachment of fragments. Substrate of suitable quality and availability means consolidated hardbottom or dead coral skeletons free from fleshy macroalgae or turf algae and sediment cover. Areas containing these features have been identified in Puerto Rico (Figure 3.3.3).

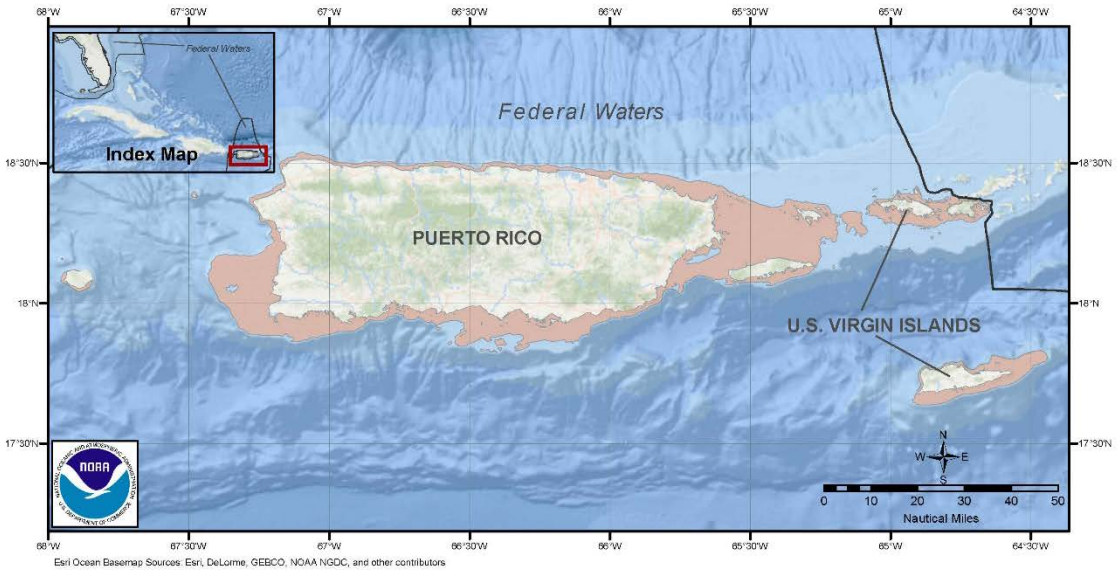



**Figure 3.3.3.** Area of *Acropora* critical habitat in U.S. Caribbean federal waters, including Puerto Rico.

Fish

The Nassau grouper is primarily a shallow-water, insular species that has long been valued as a major fishery resource throughout the wider Caribbean, South Florida, Bermuda and the Bahamas (Carter et al. 1994). Nassau grouper are slow-growing and long-lived, with estimates that the species can live up to 29 years (Bush et al. 1996). The Nassau grouper is considered a reef fish, but it transitions through a series of ontogenetic shifts of both habitat and diet. As larvae they are planktonic. As juveniles, they are found in nearshore shallow waters in macroalgal and seagrass habitats. They shift progressively deeper with increasing size and maturation into predominantly reef habitat (e.g., forereef and reef crest). Adult Nassau grouper tend to be relatively sedentary and are found most abundantly on high relief coral reefs or rocky substrate in clear waters (Sadovy and Eklund 1999), although they can be found from the shoreline to about 328-427 ft (100-130 m). Larger adults tend to occupy deeper, more rugose, reef areas (Semmens et al. 2007). Both adults and juveniles will use either natural or artificial reefs (Smith 1971, Beets and Hixon 1994, Colin et al.1997). As a top predator in reef ecosystems, the Nassau grouper serves ecological functions that are still being clarified (Mumby et al. 2006). Its presence maintains grazers and grazing pressure on reef alga providing an important benefit to stony corals (Mumby et al. 2006). As with most large marine reef fish, Nassau grouper demonstrate a bi-partite life cycle with demersal juveniles and adults but pelagic eggs and larvae. Reproduction is only known to occur during annual aggregations, in which large numbers of Nassau grouper, ranging from dozens to tens of thousands, collectively spawn (Smith 1972, Olsen and LaPlace 1979, Colin et al. 1987, Fine 1990, Fine 1992, Colin 1992).

The scalloped hammerhead shark is a circumglobal species that lives in coastal warm temperate and tropical seas. It occurs over continental and insular shelves, as well as adjacent deep waters, but is seldom found in waters cooler than 22° C (Compagno 1984, Schulze-Haugen et al. 2003). It ranges from the intertidal and surface to depths of up to 1479-1680 ft (450-512 m) (Sanches 1991, Klimley 1993), with occasional dives to even deeper waters (Jorgensen et al. 2009), and has been documented entering enclosed bays and estuaries (Compagno 1984). Both juveniles and adult scalloped hammerhead sharks occur as solitary individuals, pairs, or in schools. The scalloped hammerhead shark is viviparous (*i.e.*, give birth to live young), with a gestation period of 9-12 months (Branstetter 1987, Stevens and Lyle 1989), which may be followed by a one-year resting period (Liu and Chen 1999). Females attain maturity around 6.5-8.2 ft (200-250 cm) total length (TL) while males reach maturity at smaller sizes (range 4.2-6.6 ft [128 – 200 cm] TL); however, the age at maturity differs by region. Data from the northwest Atlantic and Gulf of Mexico indicate the von Bertalanffy growth parameters are: $L\infty$= 9.2 ft (279 cm) TL, k = 0.13 year−1, t0 = -1.62 years for males and $L\infty$=9.9 ft (303 cm) TL, k=0.09 year−1, t0=−2.22 years for females (Piercy et al. 2007). Maximum size observed was 10.3 ft (313 cm) TL for a female and 10.0 ft (304 cm) TL for a male, corresponding to an age of 30.5 years.

The oceanic whitetip is considered the only truly oceanic (*i.e.*, pelagic) shark of its genus (Bonfil et al. 2008). They are distributed worldwide in epipelagic tropical and subtropical waters, usually found far offshore between 30° North latitude and 35° South latitude (Baum et al. 2006). It has a clear preference for open ocean waters and is most abundant between 10° South latitude and 10° North latitude (Backus et al. 1956; Strasburg 1958; Compagno 1984; Bonfil et al. 2008). In the western Atlantic, oceanic whitetips occur from Maine to Argentina, including the Caribbean and Gulf of Mexico. The oceanic whitetip shark is a highly migratory species that is usually found offshore in the open ocean, on the outer continental shelf, or around oceanic islands in deep water, occurring from the surface to at least 499 ft (152 m) depth. The species can be found in water temperatures between 15°C and 28°C, but it exhibits a strong preference for the surface mixed layer in water with temperatures above 20°C, and is considered a surface-dwelling shark. Little is known about the movement or possible migration paths of the oceanic whitetip shark. Although the species is considered highly migratory and capable of making long distance movements, tagging data provides evidence that this species also exhibits a high degree of philopatry (*i.e.*, site fidelity) in some locations. The oceanic whitetip has an estimated maximum age of 17 years, with confirmed maximum ages of 12 and 13 years in the North Pacific and South Atlantic, respectively (Seki et al. 1998; Lessa et al. 1999). Other information from the South Atlantic suggests the species likely lives up to 20 years based on observed vertebral ring counts (Rodrigues et al. 2015). Sexual maturity is estimated to occur at an age of 6-7 years and the gestation period is 10-12 months. The number of pups in a litter ranges from 1-14 (mean=6) (Compagno 1984; Seki et al. 1998; Bonfil et al. 2008). When compared to other shark species, the oceanic whitetip is relatively productive, with an intrinsic rate of population increase (r) of 0.121 per year (Cortés et al. 2012). Oceanic whitetips are ranked among the

highest in productivity when compared with other pelagic sharks in terms of pup production, rebound potential, potential for population increase, and growth rate (Chapple and Botsford 2013). However, although the oceanic whitetip shark has a relatively high productivity rate relative to other sharks, it is still considered low for a fish species (r <0.14), making them generally vulnerable to depletion and potentially slow to recover from overexploitation (Young et al. 2016).

The giant manta ray can be found in all ocean basins, but within this broad distribution, individual populations are scattered and highly fragmented (CITES 2013). In terms of range, the species has been documented as far north as New Jersey on the United States east coast (Gudger 1922; Kashiwagi et al. 2010; Moore 2012; CITES 2013). Clark (2010) suggests that giant manta rays may forage in less productive pelagic waters and conduct seasonal migrations following their prey. Despite this large range, sightings are often sporadic. The timing of these sightings also varies by region and seems to correspond with the movement of zooplankton, circulation and tidal patterns, seawater temperature, and possibly mating behavior (Couturier et al. 2012; De Boer et al. 2015; Armstrong et al. 2016). Within its range, the giant manta ray inhabits tropical, subtropical, and temperate bodies of water and is commonly found offshore, in oceanic waters, and near productive coastlines (Marshall et al. 2009; Kashiwagi et al. 2011). As such, giant manta rays can be found in cooler water, as low as 19°C, although temperature preference appears to vary by region (Duffy and Abbott 2003; Marshall et al. 2009; Freedman and Roy 2012; Graham et al. 2012). Additionally, giant manta rays exhibit a high degree of plasticity in terms of their use of depths within their habitat. Tagging studies show the species conducting nightly descents from the surface to 656-1,476 ft (200-450 m) (Rubin et al. 2008; Stewart et al. 2016), and that they are capable of diving to depths exceeding 3,281 ft (1,000 m) (A. Marshall et al. unpubl. data cited in Marshall et al. 2011). The giant manta ray gives birth to live young (*i.e.*, "viviparous"). They are slow to mature and have very low fecundity and typically give birth to only one pup every two to three years. Gestation lasts approximately 10-14 months. Females are only able to produce between 5 and 15 pups in a lifetime (CITES 2013; Miller and Klimovich 2017). Although giant manta rays have been reported to live at least 40 years, not much is known about their growth and development. Maturity is thought to occur between 8-10 years of age (Miller and Klimovich 2017). In the Atlantic, very little information on *M. birostris* populations is available, but there is a known, protected population within the Flower Garden Banks National Marine Sanctuary in the Gulf of Mexico. However, researchers are still trying to determine whether the manta rays in this area are only giant manta ray individuals or potentially also comprise individuals of a new, undescribed species (Marshall et al. 2009; Hinojosa-Alvarez et al. 2016). With populations potentially ranging from around 100 to 1,500 individuals (see Table 4 in Miller and Klimovich 2016), coupled with their life history traits and productivity estimates and particularly their low reproductive output and sensitivity to changes in adult survival rates, giant manta ray populations are inherently vulnerable to depletions, with low likelihood of recovery.

## 3.4 Description of the Socio-Economic Characteristics of the Puerto Rico Management Area

**Introduction**

The 2017 hurricane season was disastrous for Puerto Rico's economy and supporting infrastructures. In a span of a few weeks in September, two hurricanes, Hurricanes Irma and Maria, affected the island.

Irma was a category 5 hurricane and the most powerful Atlantic hurricane on record. Its eye passed north of the island on Wednesday Sept 6th, and it left more than one million people, about two-thirds of Puerto Rico Electrical Power Authority's (PREPA's) electric customers, without power. Puerto Rico Aqueducts and Sewers Authority's (PRASA's) water users were without a reliable source of clean water. More than 56,000 people (approximately 34% of the population) were without potable water (NBC News September 7, 2017). Irma was estimated to have caused $1 billion in damages (Sullivan and Fieser 2017).

Hurricane Maria was the strongest hurricane (category 4) to hit the island in nearly 90 years; it made landfall in Yabucoa at 6:15 a.m. on September 20, and brought maximum sustained winds of 155 mph (NOAA National Weather Service (NWS), National Hurricane Center, September 20, 2017). As shown in Figure 3.4.1, Maria's northwest track brought its eye inland from Yabucoa, northwest to Caguas and then to the northwestern coast near Arecibo where it exited the island by 2 p.m.

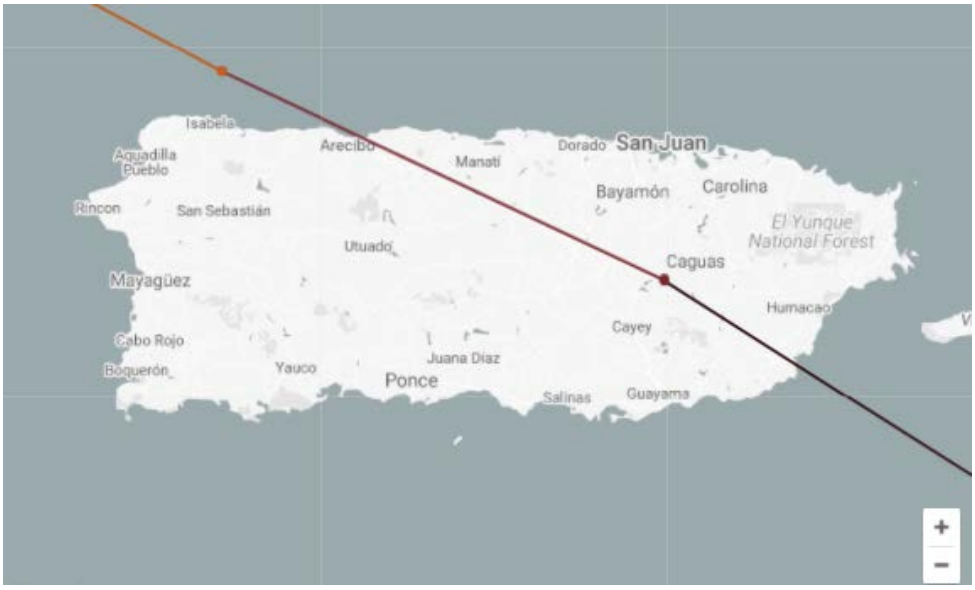



**Figure 3.4.1.** Path of Hurricane Maria over Puerto Rico.
(Source: NOAA NWS National Hurricane Center September 21, 2017)

Parts of Puerto Rico saw 30 inches of rain in one day, equal to the amount that Houston received over three days during Hurricane Harvey (Meyer 2017). Caguas had 37.9 inches in 48 hours (Figure 3.4.2), Villalba had 27.82 inches, and Canóvanas 23.89 inches of rain. Wind gusts as high as 118 and 113 were recorded in Salinas and Culebra, respectively (NOAA NWS September 21, 2017). Six months' worth of rainfall fell in less than four days.

The huge rainfalls created massive flash flooding and landslides, which took human lives and wiped out power lines, roads, bridges, homes, commercial and other structures, crops, livestock, and habitat. In the Utuado area, there were more than 25 landslides per square kilometer as shown in Figure 3.4.3.

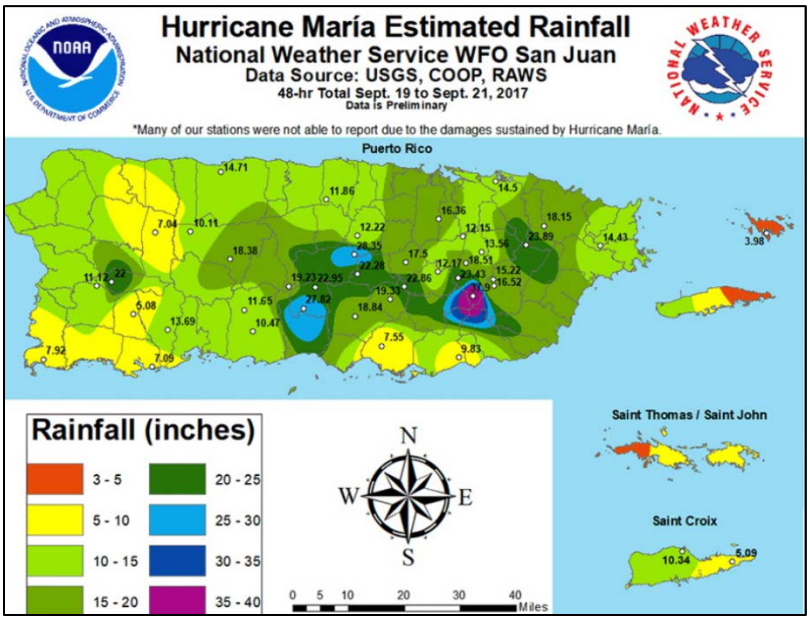



**Figure 3.4.2.** Map of Hurricane Maria rainfall.
(Source: NOAA NWS, September 21, 2017)

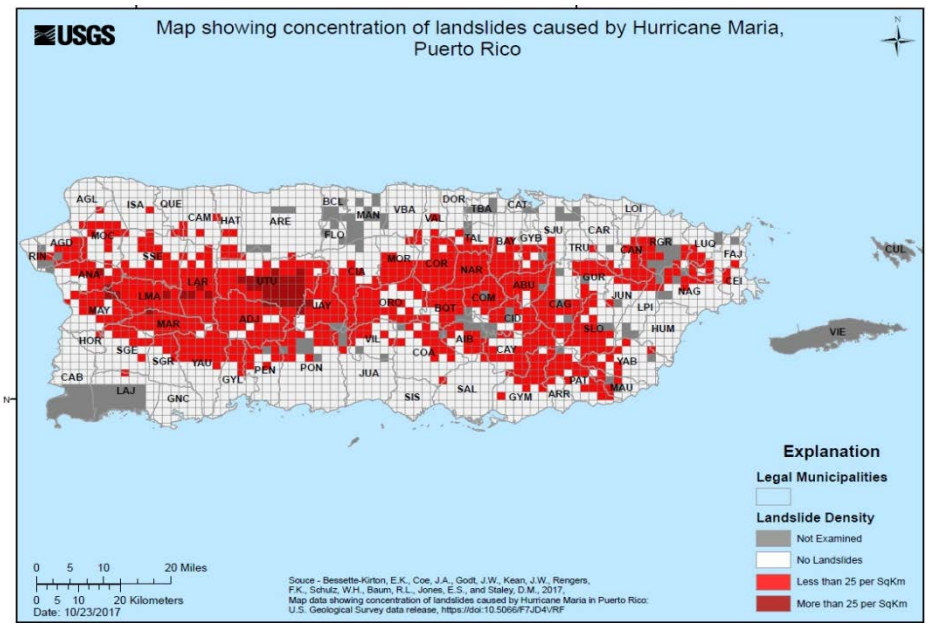



**Figure 3.4.3.** Map showing concentration of landslides caused by Hurricane Maria.
(Source: U.S. Geological Service (USGS) October 23, 2107).

The official death toll from Hurricane Maria was 64 as of December 9, 2017, but various news sources estimated losses of lives far greater. The Center for Investigative Journalism, for example, estimated over 1,065 deaths from Hurricanes Irma and Maria (Varela 2017). In response to potential undercounting, such as not counting indirect deaths caused by the power outages, Governor Ricardo Rosselló Nevares ordered that every death on the island since Hurricane Maria to be reviewed (Coto 2017).

Various news sources reported that almost the entire communications infrastructure was knocked out by Hurricane Maria. Eighty-five percent of the island's 1,600 cell towers did not work and the majority of internet and telephone lines were inoperable. Most of the island's residents were without electricity, but its electrical infrastructure needed maintainance before Maria struck. A $72 billion municipal bond debt crisis has left agencies like PREPA in difficult financial circumstances, and PREPA had abandoned most basic maintenance in recent years, leaving the island subject to regular blackouts prior to Hurricanes Irma and Maria (Gillette 2017). Three months after Maria, approximately 45% of the island's households were still without electricity (USA Today 2017).

The U.S. Coast Guard, Environmental Protection Agency, NOAA, and Puerto Rico Department of Natural and Environmental Resources established a unified command to organize salvage and removal operations for displaced, sunken and wrecked vessels throughout the island (Steenson 2017). Vessel identification teams located more than 351 vessels needing removal or salvage,

and many of the vessels were lodged in environmentally sensitive areas, presenting a unique challenge for removal operations (Coastguardnews.com 2017). A major barrier to removal has been getting in contact with vessel owners to let them know their vessels had been located and to give each one of them the option of the Coast Guard removing it at no cost, taking care of it themselves, or working through their insurance company.

Because of the devastating impacts of Hurricane Maria to Puerto Rico's economy, the remainder of this section is divided into descriptions of the pre- versus post-Hurricane Maria economy.

**Pre-Hurricane Maria Economy**

Puerto Rico's Gross Domestic Product (GDP) tracks what is produced on the island, regardless of where the workers in Puerto Rico may be from, and Puerto Rico's real GDP has continued to decline since 2006. Its decline is often used to illustrate that the island has been in a recession since 2006 (Figure 3.4.4).[27]

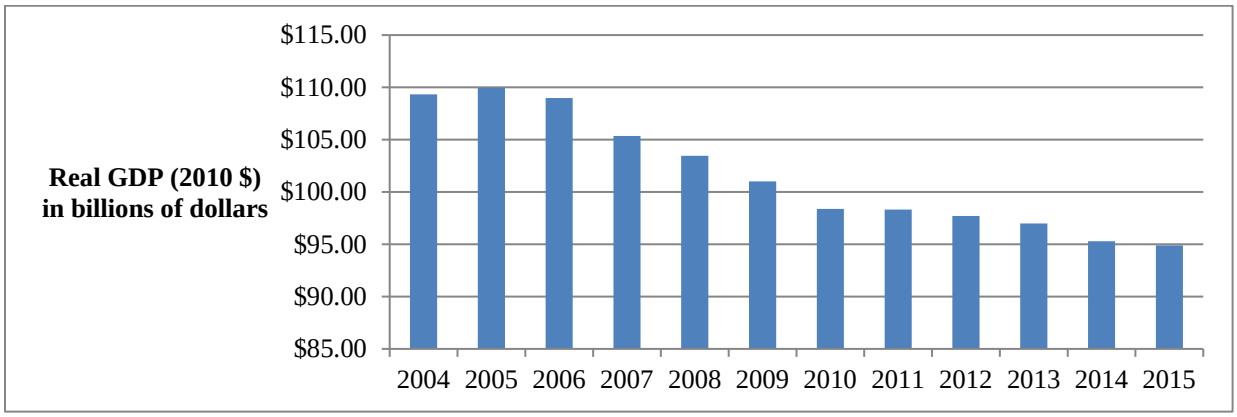



**Figure 3.4.4.** Puerto Rico's real GDP in 2010 dollars, fiscal year 2004-2015.
(Source: Government Development Bank of Puerto Rico Economic Report for the Governor and U.S. Department of Commerce Bureau of Economic Analysis (BEA) for implicit price deflator)

The island's Gross National Product (GNP) measures the market value of what Puerto Ricans produce no matter where they live, so it includes the market products made by Puerto Ricans on the mainland, such as houses constructed and restaurant meals prepared in New York or Florida. Some argue GDP is a better measure than GNP when evaluating Puerto Rico's economy because it focuses on what is produced on the island; however, GNP is a much better measure of the island's economic activity and the condition of its people and businesses because it filters out the large outflows of profits from U.S. companies operating on the island. This is especially the case because much of the earnings of the corporations based outside of Puerto Rico have been a result

[27] A recession is a period of significant declining economic activity spread across the whole economy, lasting more than a few months, and it is evidenced by declining real GDP.

of the ownership of their patents being located in Puerto Rico and of transfer pricing, both designed to locate profits, but not real activity, in Puerto Rico (MacEwan and Hexner 2016). The Economist Intelligence Unit (2015) estimates approximately 45% of Puerto Rico's GDP flows out of the island to the mainland.

Puerto Rico's GNP per capita is its GNP divided by its population, and it reflects what part of its GNP each person would have if Puerto Rico's GNP were divided equally. Generally people living in countries with higher GNP per capita tend to have longer life expectancies, higher literacy rates, better access to safe water, and lower infant mortality rates. The World Bank has converted GNP per capita to gross national income (GNI) per capita so that every country's GNI per capita (in US dollars) can be compared.

Figure 3.4.5 shows Puerto Rico's GNI per capita (constant 2010 U.S. dollars) from 1972 through 2013. GNI per capita rises and falls as Puerto Rico's economy expands and contracts, and it tends to reflect the expansion and contractions of the U.S. economy. However, when the U.S. goes into a recession, Puerto Rico goes into one that is worse and longer. The first trough (lowest GNI per capita) in 1976 coincides with the recession, experienced both on the mainland and Puerto Rico that began with the 1973 oil embargo, which caused fuel prices on both the mainland and island to rise to very high levels. The second trough in 1983 coincides with another recession that was created in part by the Federal Reserve Bank's contractionary monetary policy, which sought to limit high inflation caused in wake of the 1973 oil crisis and 1979 energy crisis. The most recent decline that started in 2008 and bottomed out in 2011 reflects the recession caused by the subprime mortgage crisis between 2007 through 2010, which contributed to the U.S. recession of December 2007 through June 2009, and had more adverse effects on the island.[28] Puerto Rico's economy improved in 2012.

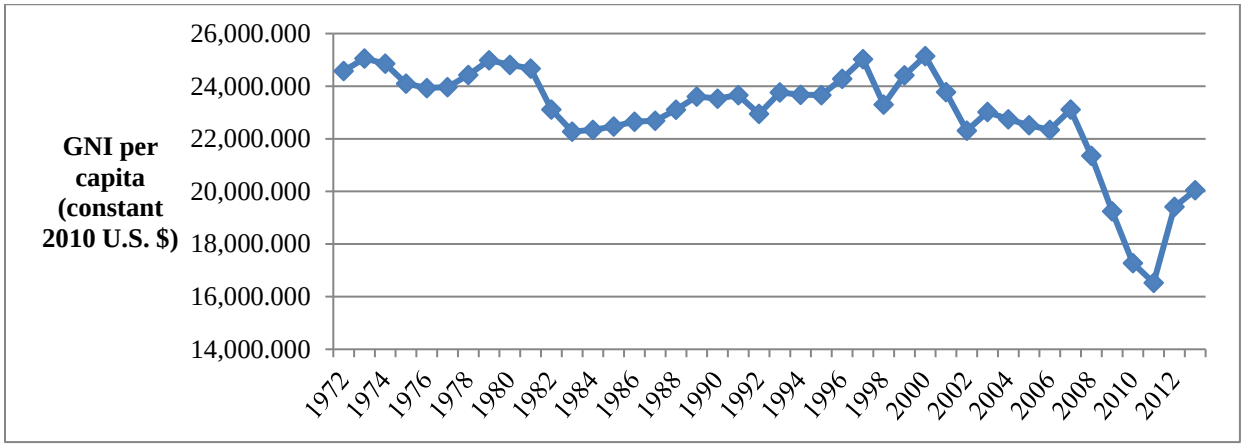



**Figure 3.4.5.** Puerto Rico's GNI per capita (constant 2010 U.S. dollars), 1972 – 2018.
(Source: World Bank https://data.worldbank.org/indicator/NY.GNP.PCAP.KD?locations=PR.)

[28] More information on the subprime mortage crisis can be found at https://en.wikipedia.org/wiki/Subprime_mortgage_crisis.

Up until 2006, Section 936 of the Internal Revenue Code gave approximately 411 mainland U.S. companies an exemption from federal taxes on income earned in Puerto Rico, whether it came from operations or interest on local bank deposits (Joint Committee on Finance 2006, GAO 1993). The tax exemption was for corporations only. Individuals on the United States mainland, for example, could not use Section 936 to shelter money by placing it in Puerto Rican banks. Despite the significant flaws in evaluating Puerto Rico's economy by GDP, advocates for recreating the Section 936 tax breaks use real GDP (Figure 3.4.4) to claim the most recent recession on the island began in 2006 when the Section 936 tax breaks ended. That is in contradiction with GNI per capita, which increased in 2007 and declined from 2008 through 2011 during the period of the subprime mortgage crisis.

According to a 1993 GAO report to the Senate Committee on Finance, Section 936 provided significant benefits to U.S. subsidiaries that located in Puerto Rico. In 1989, for example, those benefits totaled approximately $2.6 billion. Section 936 manufacturing corporations' benefits slightly exceeded the average compensation those corporations paid to their employees. In 1989, for example, average tax benefits per employee were $24,300, while average wages paid, including estimated fringe benefits, per employee were $22,800. For some industries, in particular the capital-intensive chemical industry and its pharmaceutical component, average tax benefits considerably exceeded wages paid. The average tax benefits per chemical industry employee were $69,800 in 1989, but average compensation to the employee was $32,900 that year. The labor-intensive apparel industry paid average compensation per employee of $12,600 in 1989 but received only $2,100 of tax benefit per employee (GAO 1993).

Under the Small Business Job Protection Act of 1996, mainland corporations could no longer establish new facilities on the island to get the Section 936 tax breaks and all of their existing facilities operating under Section 936 had their tax breaks disappear by 2006. Mainland corporations, such as chemical manufacturers, had been drawn to Puerto Rico by the tax break, the island's relatively low wages, and duty-free entry to the mainland markets, but especially the tax break. Congress expressed its concern that the tax benefits provided by Section 936 were enjoyed by only the relatively small number of large U.S. corporations that operated in Puerto Rico and that the tax cost of the benefits provided to these corporations by Section 936 was borne by all U.S. taxpayers (Joint Committee on Taxation 2006). Because the Section 936 credit applied to the income generated in Puerto Rico, not to jobs or investments in plant or equipment, U.S. parent firms especially found it advantageous to shift income-producing intangible assets, such as patents and trademarks, to their section 936 Puerto Rican subsidiaries. Over the 30-year lifespan of Section 936, companies shifted billions of corporate income to their Puerto Rican subsidiaries to receive partial or full exemption from federal taxes.

Between 1971 and 1991, Puerto Rico's GNP increased at an average annual rate of 2.2 percent and its GDP increased at an annual average rate of 3.5 percent (Joint Committee on Taxation; July 23, 2006). However, the faster growth rate for Puerto Rico's GDP compared to its GNP means that an increasing portion of total income produced in Puerto Rico went to U.S. and foreign corporations than to Puerto Rican residents.[29] Section 936's significant tax advantage benefited mainland corporations at the expense of developing economic activities in which Puerto Rico had a comparative advantage[30] (Marxuach and Muñoz Marín 2007).

Section 936 did not protect Puerto Rico from recessions. In 1982, for example, as the U.S. economy moved into a sharp recession so too did the island. The unemployment rate in Puerto Rico rose to 23% in 1982 and then went as high as 24% in February 1983 (U.S. Department of Labor Bureau of Labor Statistics (BLS) Local Area Unemployment Statistics). By 1986, up to 282 of the plants that benefited from Section 936 had closed with a loss of over 13,000 jobs (Rivera-Batiz and Santiago 1996). Although Section 936 was supposed to increase employment, especially in the manufacturing sector; there was a general decline in employment in that sector before the tax benefits ended (Figure 3.4.6).

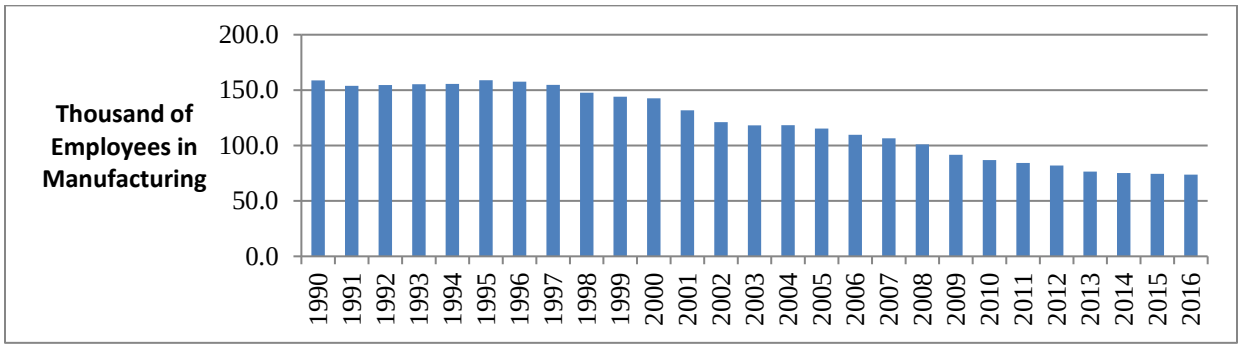



**Figure 3.4.6.** Average annual employment in Puerto Rico's manufacturing sector, 1990-2016. (Source: U.S. Department of Labor BLS)

The island's annual unemployment rate generally is in step with the rise and fall of Puerto Rico's economy. The unemployment rate rose with the recession of the early 1980s, and by January 1983, the official unemployment rate was 25.3%, the highest figure on the island since the Great Depression (Santana 1996). The unemployment rate declined as the island's economy recovered

[29] GNP equals GDP plus income paid to Puerto Rican residents and companies for their contribution to production that takes place on the mainland or in other countries minus the income paid to mainland and foreign residents and companies for their contribution to production that takes place within Puerto Rico.

[30] Puerto Rico's comparative advantage refers to the ability of Puerto Rico to produce something at a lower (opportunity) cost than the U.S. mainland or another country. Puerto Rico's relatively low wages are typically identified as Puerto Rico's primary or only comparative advantage; however, Puerto Rico could have created comparative advantage, especially relative to the mainland, with increased public investment in bilingual or multilingual education, for example.

after that recession, but then rose again during the recession created by the subprime mortgage crisis of the late 2000s.

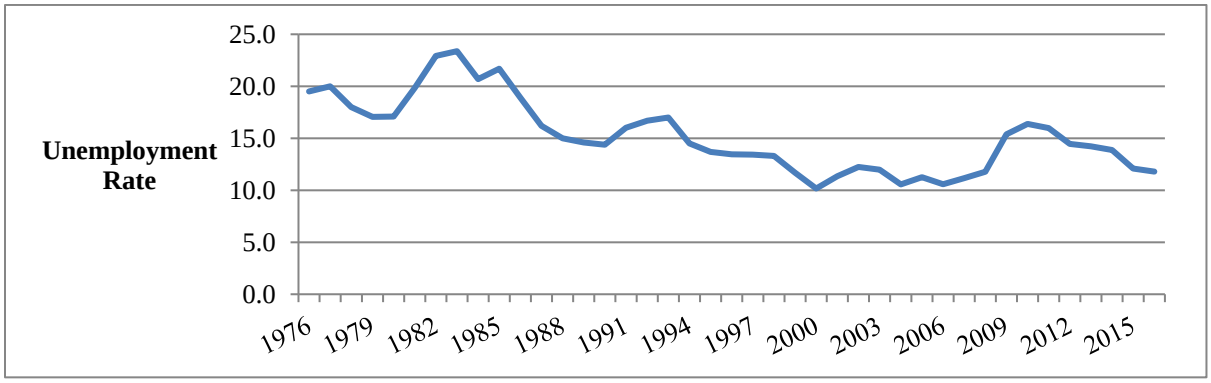



**Figure 3.4.7.** Annual unemployment rate, 1976-2016.
(Source: U.S. Department of Labor BLS)

Year after year, the percentage of Puerto Rico's population with incomes below the poverty threshold has been substantially higher than that in the U.S. or Mississippi, the latter which tends to have the highest poverty rate of states on the mainland (Table 3.4.1). The poverty rates for children under 18 years of age in Puerto Rico are higher than that for all individuals on the island. In 2015, for example, the island's poverty rate was 46.1% for all individuals and 58.3% for children under 18 years of age.

**Table 3.4.1.** Percentage of population living below poverty threshold, 2005 – 2016.

| Year | Percentage of Population Below Poverty Threshold | | |
|---|---|---|---|
| | Puerto Rico | U.S. | Mississippi |
| **1969** | 65.2% | 13.7% | 35.4% |
| **1979** | 62.4% | 12.4% | 23.9% |
| **1989** | 58.9% | 13.1% | 25.2% |
| **1999** | 48.2% | 12.4% | 19.9% |
| **2000** | 44.6% | 12.2% | 18.2% |
| | | | |
| **2005** | 44.9% | 13.3% | 21.3% |
| **2006** | 45.4% | 13.3% | 21.1% |
| **2007** | 45.5% | 13.0% | 20.6% |
| **2008** | 44.8% | 13.2% | 21.2% |
| **2009** | 45.0% | 14.3% | 21.9% |
| **2010** | 45.0% | 15.3% | 22.4% |
| **2011** | 45.6% | 15.9% | 22.6% |
| **2012** | 44.9% | 15.9% | 24.2% |
| **2013** | 45.4% | 15.8% | 24.0% |
| **2014** | 46.2% | 15.5% | 21.5% |
| **2015** | 46.1% | 14.7% | 22.0% |
| **2016** | 43.5% | 14.0% | 20.8% |

(Source: U.S. Census Bureau (Census) American Community Survey, 1-year estimates, 2005 – 2016; Census Statistical Brief for 1969, 1979, 1989, 1999)

The population of Puerto Rico grew from approximately 2.36 million in1960 to 3.83 in 2004 and has been declining since peaking in 2004 (Figure 3.4.8). Puerto Rican residents had been leaving for the mainland in response to historical differences in economic opportunities and more recently the economic turndown for the past decade. By 2016, the population declined to approximately 3.41 million. In 2014 alone, approximately 84,000 people left the island for the mainland (Census 2014 American Community Survey and Puerto Rico Community Survey).

The Census Bureau estimated net emigration rates of 64,073 in 2014 and 64,238 in 2015 (Velázquez-Estrada 2017). According to Meléndez and Hinojosa (2017) of Hunter College's Center for Puerto Rican Studies, 61% of Puerto Ricans lived on the mainland in 2014 (http://centroweb.hunter.cuny.edu/pr_summit/press).

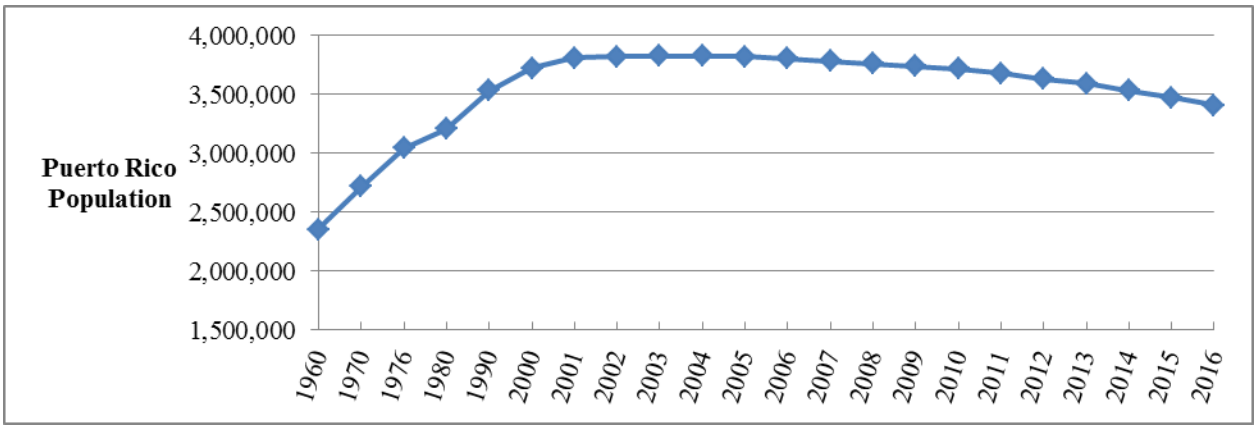



**Figure 3.4.8.** Population of Puerto Rico, 1960, 1970, 1076, 1980, 1990, 2000– 2016.
(Source: World Bank 2017)

The net emigration to the mainland has reduced the island's labor force. From August 2008 through August 2017, Puerto Rico's labor force shrank by 18.7%, from approximately 1.35 million to 1.09 million. The labor force peaked at approximately 1.42 million in 2006 during the 41-year time period from 1976 through 2016 (Figure 3.4.9). In 2017, there was a monthly average of 1.12 million individuals in the labor force from January through August.

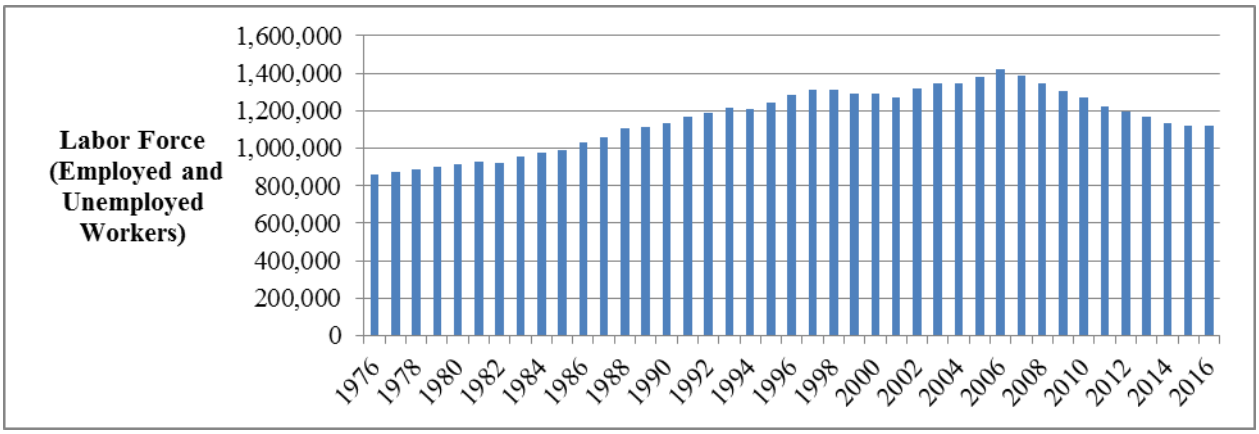



**Figure 3.4.9.** Annual labor force, 1976-2016. (Source: U.S. Department of Labor BLS).

Puerto Ricans leave the island for higher wages on the mainland. For example, the mean and median nominal hourly wages in Puerto Rico for all occupations were substantially below those in the U.S. in both 2014 and 2016 (Figure 2.4.10). Not only are wages lower on the island, but the cost of living is higher in Puerto Rico. In 2014, for example, the cost of living on the island was approximately 13% higher than in the U.S. as a whole. Grocery prices and utility prices tend to be substantially higher on the island, although housing is substantially lower. But when wages are adjusted for the differences in the cost of living, Puerto Rico's real hourly wage is even lower relative to the U.S. real hourly wage.

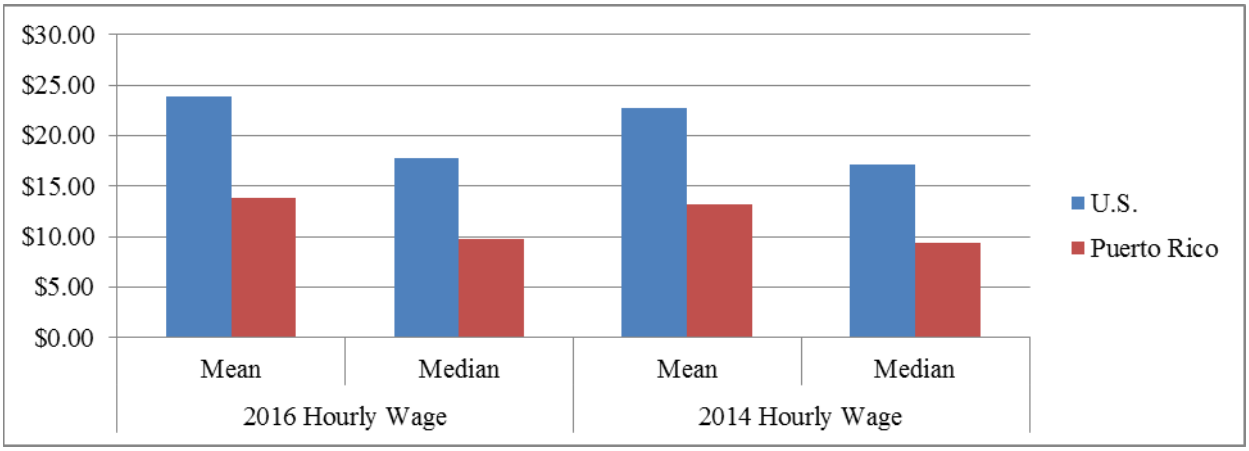



**Figure 3.4.10.** Nominal mean and median hourly wages in Puerto Rico and U.S, 2014 & 2016. (Source: U.S. Department of Labor BLS 2014 and 2016 National and State Occupational Employment and Wage Estimates)

Median household income is also higher on the mainland. The median household income for a householder 25 to 44 years old was $62,815 in the U.S. (as a whole) in 2016, but only $21,877 in Puerto Rico that year (Census 2016 American Community Survey 1-Year Estimates). The

median household income for a Hispanic or Latino householder was $46,882 in the U.S. versus $19,977 for the same householder in Puerto Rico (Census 2016 American Community Survey 1-Year Estimates). That is a substantial difference.

The Gini index is a measure of income inequality that varies from 0 to 1. A zero results from perfect income equality among households (no income inequality), whereas a 1 results with perfect income inequality (one household has it all). Puerto Rico's Gini index in 2015 and 2016 was 0.559 and 0.542, respectively. Puerto Rico ranked worst in 2015 among U.S. states and territories (and Washington DC) with the highest level of income inequality, and tied for worst in 2016 with Washington, DC (Guzman 2017). Typically, income inequality is associated with barriers to upward economic mobility, especially for those at and towards the bottom of the income pyramid. Income inequality and barriers to upward economic mobility have also motivated Puerto Ricans to move to the mainland.

The number of nonfarm jobs on the island has been declining. From August 2008 to August 2017, Puerto Rico lost approximately 133,600 nonfarm jobs, and most of those losses were in the government sector (Table 2.4.2). Only three of the ten non-farming sectors had job growth. The Education and Health Services sector had the largest growth in jobs during that period (16,100), followed by Leisure & Hospitality (10,500 jobs) and Professional & Business Services (6,900 jobs). In 2015, seven of the island's top 10 employers were health service providers (Table 3.4.3).

**Table 3.4.2.** Number of non-farm jobs, August 2008 – August 2017.

| August Year | Thousands of Nonfarm Jobs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Government | Trade, Transportation & Utilities | Professional & Business Services | Education & Health Services | Manufactur-ing | Leisure & Hospitality | Financial Activities | Mining, Logging & Con-struction | Information | Other Services | Total |
| **2008** | 299.3 | 179.3 | 105.8 | 108.8 | 100.4 | 72 | 49.5 | 54.6 | 20.6 | 20.8 | 1011.1 |
| **2009** | 277.8 | 173.3 | 102.4 | 110.1 | 90.1 | 70.6 | 46.3 | 39.4 | 19.2 | 19.1 | 948.3 |
| **2010** | 263.7 | 174.3 | 104.3 | 113.8 | 86.2 | 70.8 | 43.5 | 32.2 | 20.2 | 18.2 | 927.2 |
| **2011** | 256.1 | 174.4 | 105.9 | 116.3 | 84 | 71.7 | 44 | 32.9 | 18.5 | 17.6 | 921.4 |
| **2012** | 256.9 | 176.3 | 112.4 | 120.7 | 81.5 | 75.3 | 44.5 | 36.8 | 20 | 17.8 | 942.2 |
| **2013** | 243.3 | 176.3 | 115.3 | 123.4 | 75.2 | 78.8 | 43.8 | 29.3 | 19.3 | 17.9 | 922.6 |
| **2014** | 234.4 | 175.5 | 111.9 | 121.9 | 75 | 80 | 42.7 | 27.3 | 19.8 | 18 | 906.5 |
| **2015** | 231.8 | 173.5 | 113.3 | 122.7 | 74.3 | 81.3 | 42.1 | 24.6 | 19.4 | 17.4 | 900.4 |
| **2016** | 226.9 | 174.3 | 114.1 | 122.7 | 73.8 | 81 | 42.7 | 23.6 | 17.6 | 17.5 | 894.2 |
| **2017** | 217.5 | 170.7 | 112.7 | 124.9 | 70.9 | 82.5 | 42.3 | 20.4 | 17.8 | 17.8 | 877.5 |
| **Change** | -81.8 | -8.6 | 6.9 | 16.1 | -29.5 | 10.5 | -7.2 | -34.2 | -2.8 | -3 | -133.6 |
| **Average** | **250.77** | **174.79** | **109.81** | **118.53** | **81.14** | **76.4** | **44.14** | **32.11** | **19.24** | **18.21** | **925.14** |
| **Median** | 249.7 | 174.35 | 112.15 | 121.3 | 78.35 | 77.05 | 43.65 | 30.75 | 19.35 | 17.85 | 922 |

(Source: U.S. Department of Labor BLS Nonfarm jobs)

**Table 3.4.3.** Puerto Rico's 10 largest employers, 2015.

| Rank | Employer | Municipality | Number of Employees |
|---|---|---|---|
| **1** | Hospital Hima San Pablo | Bayamón | 1,668 |
| **2** | Evertec Inc | San Juan | 1,600 |
| **3** | St Luke's Episcopal Hospital | Ponce | 1,146 |
| **4** | Alco High Tech Plastic Inc | Corozal | 1,010 |
| **5** | Manati Medical Center | Manati | 900 |
| **6** | Hospital Ryder Memorial | Humacoa | 873 |
| **7** | Hospital Pavia-Santurce | San Juan | 861 |
| **8** | Mennonite Memorial Hospital | Albonito | 860 |
| **9** | San Juan Marriott Resort | San Juan | 800 |
| **10** | Ashford Presbyterian Community Hospital | San Juan | 771 |

(Source: Infogroup)

The government sector had the largest number of nonfarm employees from 2011 through 2015. In 2015, approximately 25% of nonfarm employees were in the government sector, although it was down from approximately 28% in 2011 (Table 2.4.4). Employees in the education and health services sector rose from approximately 117,000 in 2011 to 129,300 in 2015. Although the manufacturing sector ranks first by share of GDP, it ranks lower by number of employees. For example, the manufacturing sector ranked fifth by number of employees in the nonfarm sector in 2011 and sixth in 2015.

**Table 3.4.4.** Number of November employees by sector, 2011 – 2016; percentage, 2011, 2015.

| Sectors | November Employees by Sector (In Thousands) | | | | | Percent of Total | |
|---|---|---|---|---|---|---|---|
| | **2011** | **2012** | **2013** | **2015** | **2015** | **2011** | **2015** |
| **Mining, Logging & Construction** | 35.0 | 34.8 | 27.9 | 27.1 | 23.5 | 3.75% | 2.58% |
| **Manufacturing** | 82.8 | 79.3 | 76.1 | 74.9 | 73.2 | 8.87% | 8.02% |
| **Trade, Transportation & Utilities** | 174.9 | 177.0 | 177.2 | 176.6 | 179.6 | 18.74% | 19.69% |
| **Information** | 19.1 | 19.3 | 19.7 | 20.4 | 20.5 | 2.05% | 2.25% |
| **Financial Activities** | 44.2 | 44.9 | 43.3 | 42.5 | 41.9 | 4.74% | 4.59% |
| **Professional & Business Services** | 108.2 | 111.3 | 117.1 | 111.8 | 112.7 | 11.59% | 12.35% |
| **Education & Health Services** | 117.0 | 121.3 | 124.1 | 125.4 | 129.3 | 12.53% | 14.17% |
| **Leisure & Hospitality** | 73.0 | 76.8 | 79.2 | 80.1 | 82.5 | 7.82% | 9.04% |
| **Other Services** | 17.6 | 17.9 | 17.9 | 17.5 | 17.2 | 1.89% | 1.89% |
| **Government** | 261.6 | 260.9 | 237.8 | 231.6 | 231.8 | 28.03% | 25.41% |
| **Total Nonfarm** | 933.4 | 943.5 | 920.3 | 907.9 | 912.2 | 100.00% | 100.00% |

(Source: U.S. Department of Labor BLS: www.BLS.GOV/eag/eag.pr.htm.)

The numbers of employer establishments and employees declined from 2008 to 2011, improved in 2012, but then declined thereafter (Figure 2.4.11). From 2008 through 2015, the number of employer establishments declined by approximately 5.9% and the number of employees dropped by approximately 9.5%.

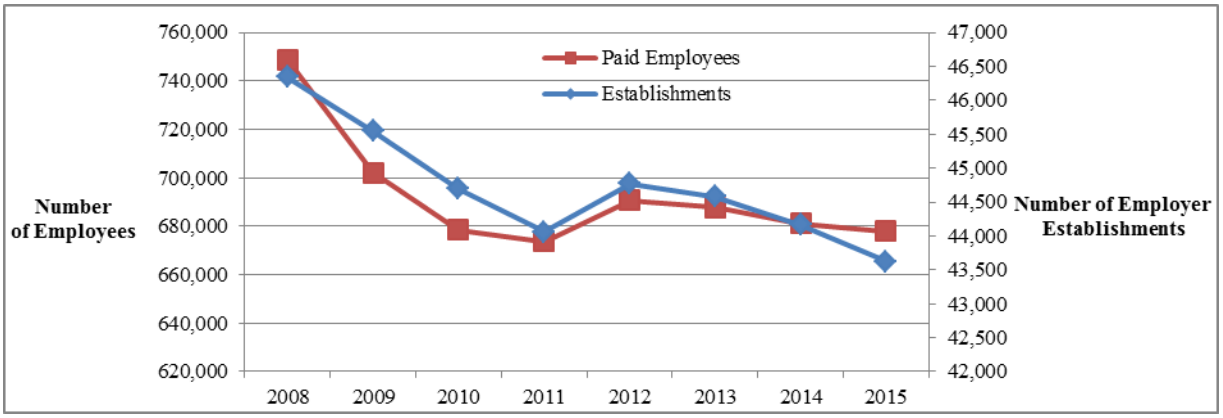



**Figure 3.4.11.** Numbers of employees and employer establishments, 2008 - 2015.
Note: This does not include most government employees, railroad employees and self-employed employees.
(Source: Census County Business Patterns)

Not all employer establishments are the same. From 2011 to 2015, the smallest employer establishments (1 to 4 and 5 to 9 paid employees) accounted for all of the losses of employer establishments (Table 3.4.5). However, there were gains in the numbers of larger employer establishments during that 5-year period. That explains the increase in the number of nonfarm employees from 2011 through 2015: 673,677 to 677,974 (Figure 2.4.11).

**Table 3.4.5.** Number of employer establishments by number of paid employees, 2011-2015.

| Year | Number of Employer Establishments by Number of Employees | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 to 4 | 5 to 9 | 10 to 19 | 20 to 49 | 50 to 99 | 100 to 249 | 250 to 499 | 500 to 999 | 1,000 or over | Total |
| **2011** | 24,534 | 8,474 | 5,262 | 3,628 | 1,113 | 685 | 230 | 97 | 33 | 44,056 |
| **2012** | 24,883 | 8,658 | 5,318 | 3,701 | 1,131 | 713 | 227 | 98 | 38 | 44,767 |
| **2013** | 24,714 | 8,517 | 5,421 | 3,707 | 1,192 | 675 | 223 | 98 | 38 | 44,585 |
| **2014** | 24,381 | 8,525 | 5,321 | 3,712 | 1,188 | 679 | 228 | 97 | 38 | 44,169 |
| **2015** | 24,145 | 8,321 | 5,320 | 3,655 | 1,119 | 685 | 233 | 101 | 41 | 43,620 |
| **Change** | **-389** | **-153** | **58** | **27** | **6** | **0** | **3** | **4** | **8** | **-436** |

(Source: Census County Business Patterns)

Agriculture had been experiencing a revival in recent years as people, especially millennials, were turning to growing crops and raising livestock in response to the continuing decline in the number of nonfarm jobs. Gross farm income grew from 2010 through 2014 (Table 3.4.6). Historically, Puerto Ricans had relied on 80% to 85% of their food being imported, and the Puerto Rican government was working to reduce that.

**Table 3.4.6.** Gross farm income, 2010 – 2014.

| Crops and Livestock Products | Gross Farm Income (Millions) | | | | | Change | |
|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2010-2014 | 2013-2014 |
| **Coffee** | $25.5 | $29.6 | $22.4 | $20.4 | $26.3 | $0.8 | $5.9 |
| **Rice** | $0.0 | $0.0 | $0.0 | $0.0 | $0.1 | $0.1 | $0.1 |
| **Sugar & molasses** | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| **Legumes** | $1.4 | $0.4 | $0.3 | $0.2 | $0.4 | -$1.0 | $0.2 |
| **Fruits** | $21.1 | $20.3 | $22.0 | $26.2 | $32.0 | $10.9 | $5.8 |
| **Starchy vegetables** | $83.3 | $62.3 | $56.2 | $66.4 | $109.6 | $26.3 | $43.2 |
| **Other vegetables** | $55.5 | $42.8 | $22.1 | $28.1 | $50.2 | -$5.3 | $22.1 |
| **Ornamental plants** | $33.7 | $30.7 | $34.6 | $34.9 | $39.3 | $5.6 | $4.4 |
| ***Sub-total (crops)*** | *$220.5* | *$186.1* | *$157.6* | *$176.2* | *$257.9* | *$37.4* | *$81.7* |
| **Milk** | $214.2 | $221.7 | $230.2 | $219.0 | $214.0 | -$0.2 | -$5.0 |
| **Eggs** | $13.5 | $13.1 | $15.8 | $15.4 | $19.3 | $5.8 | $3.9 |
| **Poultry** | $77.7 | $72.0 | $73.3 | $76.1 | $81.9 | $4.2 | $5.8 |
| **Beef** | $24.5 | $25.6 | $26.3 | $28.4 | $29.2 | $4.7 | $0.8 |
| **Pork** | $17.2 | $16.3 | $18.7 | $17.7 | $18.9 | $1.7 | $1.2 |
| **Goats and other meats** | $1.4 | $0.8 | $1.0 | $0.8 | $0.8 | -$0.6 | $0.0 |
| **Other livestock products** | $45.2 | $29.6 | $33.7 | $31.0 | $35.9 | -$9.3 | $4.9 |
| ***Sub-total (livestock products)*** | *$393.7* | *$379.1* | *$399.0* | *$388.4* | *$400.0* | $6.3 | $11.6 |
| **Other** | $190.4 | $192.4 | $174.0 | $183.4 | $200.3 | $9.9 | $16.9 |
| ***Total*** | *$804.6* | *$757.6* | *$730.6* | *$748.0* | *$858.2* | *$53.6* | *$110.2* |
| **Change in livestock stock** | $24.7 | $24.8 | -$14.9 | $84.8 | $71.4 | $46.7 | -$13.4 |
| **Grand total** | **$829.3** | **$782.4** | **$715.7** | **$832.8** | **$929.6** | **$100.3** | **$96.8** |

(Source: Puerto Rico Department of Agriculture)

From 2010 through 2015, the agriculture sector grew from 3% to 5% annually, and instead of having to buy imported rice, plantains, pineapples, vegetables, and other crops, the island's residents were having increasing opportunities to buy these locally grown and fresher (Associated Press 2016). For the first time in almost 30 years, residents could buy locally produced rice in 2016. The rice was mostly grown on the outskirts of the southwestern town of Guanica. In the south and west, approximately 870 acres were devoted to sugarcane production in 2016 and plans were to expand to 11,600 acres (Associated Press 2016). The amount of acreage under cultivation rose 50 percent from 2013 through 2016, generating at least 7,000 jobs. The largest numbers of farms were in the middle of the island, in the municipalities of Adjuntas, Barranquitas, Lares, Orocovis, and Utuado (Figure 3.4.12). On top of those figures, but not

counted because they are not sold, were the vegetables and livestock grown by households for their own consumption.

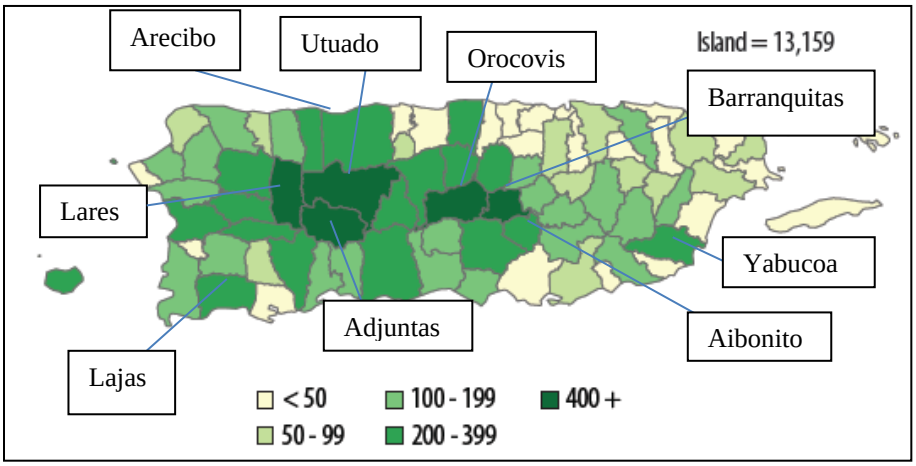



**Figure 3.4.12.** Number of farms by municipality, 2012.
(Source: USDA 2012 Census of Agriculture Highlights).

Despite the entrance of millennials into the agricultural sector in recent years, the average age of a farm's principal operator was 59 years, and approximately 96% of the 13,159 principal operators were 35 or older. Of the households of the principal operators, 7,876 reported total income of less than $20,000 (Food and Agricultural Organization of the United Nations 2018).

There is no evidence that millennials were similarly entering the commercial fishing sector, and the average age of a commercial fisherman on the island has been increasing. In 2002, the average age of a commercial fisherman on the island was 48 years and was 50 years by 2008 (Puerto Rico Department of Natural and Environmental Resources 2004, Matos-Caraballo and Agar 2011). In part the disinterest in commercial fishing may reflect Puerto Rico having the lowest per capita fish and shellfish consumption in the world. From 2011 through 2013, the island's per capita consumption of fish and shellfish was 0.8 lbs per person, while it was 47.2 lbs per person in the U.S. and 13.0 lbs in the U.S. Virgin Islands (NOAA NMFS 2016).

Fish and shellfish harvested by Puerto Ricans represent just a fraction of what is produced annually. In 2014, for example, Puerto Rico's commercial fishing fleet landed 2.3 million pounds of finfish and shellfish, generating more than $6.9 million in commercial wholesale value, which in turn generated approximately $20.7 million in retail sales for local restaurants and seafood markets. Together, that accounted for approximately 0.05% of the island's non-manufacturing GDP that year (Abt Associates et al. 2016).

The manufacturing sector has been and continues to account for the largest share of the island's GDP: approximately 46% annually (Table 3.4.7). The second largest sector is finance, insurance & real estate.

**Table 3.4.7.** Percent of GDP by sector, 2010 – 2014.

| Sector | Percent of GDP | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2011** | **2012** | **2013** | **2014** | **Average** |
| **Manufacturing** | 46% | 46% | 45% | 47% | 47% | **46%** |
| **Finance, Insurance & Real Estate** | 20% | 20% | 21% | 20% | 20% | **20%** |
| **Services** | 14% | 13% | 13% | 13% | 13% | **13%** |
| **Government** | 9% | 9% | 8% | 8% | 8% | **8%** |
| **Trade** | 8% | 8% | 8% | 8% | 8% | **8%** |
| **Transportation & Other Public Utilities** | 1% | 3% | 3% | 3% | 3% | **3%** |
| **Construction & Mining** | 2% | 2% | 1% | 1% | 1% | **1%** |
| **Agriculture** | < 1% | < 1% | < 1% | < 1% | < 1% | **< 1%** |
| **Total** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |

(Source: Government Development Bank of Puerto Rico's Economic Report for the Governor)

Net income rose from by $4,694 million from 2010 through 2014, and by $1,113.5 million from 2015 through 2016 (Table 2.4.8). The largest net gain from 2010 through 2014 was in the real estate, rental & leasing sector: $1,990 million. The second largest gain in net income during that time period was in the manufacturing sector. State government was the largest loser, with a loss of net income of $572.million.

The manufacturing sector had the largest gain in net income from 2015 through 2016: $913.4 million (Table 3.4.8). Despite the aforementioned positives in the agricultural sector, net income from agriculture dropped by $14.2 million from 2015 through 2016. The largest decline in net income during that time was in the finance & insurance sector with a loss of $142 million.

**Table 3.4.8.** Change in net income, 2010 – 2014 and 2015 - 2016.

| Industrial Sector | Change in Net Income (millions) | |
|---|---|---|
| | **2010-14** | **2015-16** |
| **Agriculture** | $46.4 | -$14.2 |
| **Mining** | -$8.3 | -$1.6 |
| **Utilities** | $82.9 | -$119.1 |
| **Construction** | -$282.0 | -$91.2 |
| **Manufacturing** | $1,125.5 | $913.4 |
| **Wholesalers Trade** | -$114.7 | -$60.9 |
| **Retail Trade** | $574.8 | $108.0 |

| | | |
|---|---|---|
| **Transportation and Warehousing** | -$65.6 | $25.1 |
| **Information** | $59.9 | $0.8 |
| **Finance and Insurance** | $469.8 | -$142.0 |
| **Real Estate and Rental and Leasing** | $1,990.0 | $355.4 |
| **Professional, Scientific, and Technical Services** | $336.5 | $74.8 |
| **Management of Companies and Enterprises** | -$4.4 | $14.0 |
| **Administrative Services and Support** | $302.5 | -$14.3 |
| **Educational Services** | -$41.2 | -$27.9 |
| **Health Care and Social Services** | $418.0 | -$26.1 |
| **Art, Entertainment and Recreation** | $57.4 | $10.3 |
| **Accommodation and Food Services** | $233.9 | $21.7 |
| **Other Services** | $38.0 | $1.6 |
| **State Government** | -$576.2 | $63.2 |
| **Municipal Governments** | $51.4 | $22.5 |
| **Total** | **$4,694.6** | **$1,113.5** |

(Source: Government Development Bank of Puerto Rico.)

The island's ongoing public debt problem has been in the making for decades and government borrowing significantly increased in response to the oil embargo of 1973. The oil embargo of the early 1970s was devastating to Puerto Rico's developing petrochemical sector. Puerto Rico's Government Development Bank (GDB) had been promoting capital-intensive industries, and especially petrochemical development by giving U.S. petrochemical companies loans and large subsidies since the 1950s. The Commonwealth Oil Refining Company (Commonwealth Oil) began in 1952 and established oil refining facilities in Peñuelas and Guayanilla. Later in 1965 the company completed production of its aromatics plant and in 1966 it began construction of its fourth and fifth petrochemical plants on the island. Commonwealth Oil became the largest investor-owned enterprise in Puerto Rico (Lehman Brothers Collection). As an independent refiner, it imported cheap crude oil from Venezuela and processed it on the island. At its peak, Commonwealth Oil consumed 35% of the island's energy-consuming capacity, yet generated only 5% of the island's income and 1% of its employment (Santana 1996). Between 1967 and 1971, investment in the petrochemical industry on the island increased from $500 million to $1 billion and the number of establishments increased from 24 to 36. Also during that time the number of petrochemical workers grew from 2,851 to 5,616 (Whalen 2001).

When the Organization of Petroleum Exporting Countries (OPEC) set its price guidelines in the early 1970s, Venezuela crude oil prices rose and the price of the Commonwealth Oil's refined oil became higher relative to other sources. Commonwealth Oil's former customers found cheaper alternatives and the company went bankrupt in 1978 (Ayala and Bernabe 2007). Puerto Rico's anticipated petrochemical industry never materialized and energy prices soared. Inflation followed and the cost of living rose dramatically on the island.

The federal government responded to the rising prices across the country with price controls on crude oil and petroleum products from 1973 to 1981. Congress also responded with creation of Section 936 in 1976 to benefit Puerto Rico. The Puerto Rico government's debt increased by approximately 90% from 1969 through 1973, and was encouraged to do so by the U.S. financial sector, especially the mutual funds companies, and the GDB.

The GDP entered the bond market in 1984. Mutual funds companies were attracted to Puerto Rico's bonds because they were and continue to be exempt from local, state, and federal taxes everywhere in the U.S. and Puerto Rico's constitution contains a clause that requires general-obligation bonds to be paid before virtually any other government expense. Moreover, the GDB already had established offices on Wall Street in the 1950s, which "was decisive in achieving the [GDB's] goal of expanding the bond market to general obligations of the Commonwealth" (GDB Gallery of Presidents 2008-2017). In 1987, the GDB sold $1.6 billion in Puerto Rico general obligation bonds, which was at that time the largest ever in the GDB's history and the second largest in the U.S. municipal bonds market.

Puerto Rico's total public debt increased as its economy and population shrunk. Between fiscal years 2005 and 2014, Puerto Rico's total public debt outstanding (sum of bonds and other debts held by and payable to the public and excluding pension liabilities and other post-employment benefits) grew from $39.2 billion to $67.8 billion, at an average annual rate of 6.3%. In 2013, the average state-debt-to-personal-income ratio for the 50 states was 3.4% (The Economist October 26, 2013), whereas the rating agency, Moody's Investor Services, estimated Puerto Rico's debt to personal income ratio at 89% (Moody's December 13, 2012). By 2013, the island's debt was the third-largest behind California's and New York's, despite having a far smaller and lower income population (The Economist October 26, 2013). Total public debt reached 66% of the island's GDP by 2014 (GAO October 2017). In 2014, the GDB sold junk-status bonds, the largest such sale of in U.S. history. As of November 2016, the outstanding debt was approximately $69.9 billion. Currently, the island's public debt is approximately $74.8 billion and $49 billion in pension-system obligations and much of that is interest.

According to a report by the ReFund America Project (2016), $37.8 billion of the island's outstanding debt is from capital appreciation bonds and the principal on those bonds is $4.3 billion and remaining $33.5 billion is interest, which is an interest rate of 785%. Another $36.9 billion of Puerto Rico's outstanding debt belongs to the Puerto Rico Sales Tax Financing Corporation (COFINA), and $23.9 billion of COFINA's debt is in capital appreciation bonds. The principal on those capital appreciation bonds is $3.3 billion and remaining $20.6 billion is interest, for an interest rate of 614% (ReFund America Project 2016). Tacked on to the capital appreciation bonds were huge fees paid to the Wall Street banks that were given the green light to put together the capital appreciation bonds on behalf of the Puerto Rico government. For example, Wall Street banks charged $221 million in issuance fees for COFINA's capital

appreciation bonds. The lead underwriters on Puerto Rico's capital appreciation bonds were Citigroup, Goldman Sachs, Lehman Brothers, Merrill Lynch (now owned by Bank of America), Morgan Stanley, Banco Santander, Prudential, and UBS (Refund America 2016).

The ReFund America Project estimates that Wall Street firms have raked in $1.6 billion in fees from Puerto Rico's borrowing practices. Moreover, it estimates that nearly half of the $134 billion in debt issued or remarketed from January 1, 2000 through June 30, 2016 for the Commonwealth and its public corporations had been "loan flipping," which is a predatory lending practice. Loan flipping is the practice of a lender refinancing a loan that, although it may put more funds in the borrower's account, adds excessive fees and often a prepayment penalty that easily exhaust the funds that were given to the borrower. Over time the borrower becomes hopelessly indebted (www.allbusiness.com). So, Puerto Rico was able to pay off old bonds by issuing new bonds, but by paying exorbitant fees and interest rates.

In December 2015, PREPA negotiated a voluntary agreement with creditors. PREPA was responsible for approximately $9 billion of the island's $72 billion in outstanding debt at that time.

In 2016, the Financial Oversight and Management Board (FOMB) was created for Puerto Rico under the Puerto Rico Oversight, Management, and Economic Stability Act (PROMESA). FOMB consists of seven members appointed by the President of the U.S. and one ex officio member designated by the Governor of Puerto Rico. One of the members is Carlos García who was President of the GDB from 2009 to 2011 and was the author of the Special Law Declaring a State of Fiscal Emergency, or Public Law 7, which in 2009 eliminated the cap that had been on bond fees to 2% of the bond principal. In addition to removing the limits on fees charged by lenders, Public Law 7 allowed the use of new debt to pay off old debt, which benefited García's former employer, Banco Santander Puerto Rico (Dayden October 2016).

Public Law 7 declared a state of economic emergency and was packaged as the island's economic recovery plan. In addition to increasing predatory lending practices, the law unilaterally suspended for two years all collective bargaining rights and social protections for public employees, and mapped out plans for a $2 billion reduction in the island's annual budget (Bonilla and Boglio Martínez 2009).

According to hedgeclippers.org, under García, a team of current or former Banco Santander executives was established to run the GDB. Also under García, the GDB led the transactions of close to $11 billion in COFINA and other bond issues (Bhatti September 2016). García had been President and COO of Banco Santander Puerto Rico from 2011 to 2013 and was on the Board of Directors of Santander Bancorp from 2001 to 2008. He rejoined Santander after leaving the GDB and was replaced as president of GDB by Santander executive Juan Carlos Batlle. A

second member of the FOMB is José Ramón González who, like García, is both a former president of GDB (1986 to 1989) and senior executive at Banco Santander Puerto Rico. Santander underwrote $2.5 billion in predatory loans given to the government and made an additional $23 million from those by loan flipping (Dayden 2016). A third member is José Carrión who chairs the FOMB and is a major shareholder with Banco Popular, which issued COFINA bonds. More information about these members and other members of FOMB can be found at https://juntasupervision.pr.gov/index.php/en/home/.

The first two meetings of FOMB were September 30 and October 14, 2016, in Lower Manhattan, not in Puerto Rico (https://juntasupervision.pr.gov/index.php/en/documents/). The third meeting was held in El Conquistador Business Meeting Facilities in Fajardo, Puerto Rico. Attendance at the third meeting was by invitation only; however, they are now are more public. As of January 17, 2018, the FOMB has met 11 times; five of the meetings have been in Lower Manhattan and the other six in Puerto Rico (Fajardo and San Juan).

In March 2017, FOMB voted unanimously to order Puerto Rico to implement new taxes, impose 10% cutbacks in its public pension system, lay off tens of thousands of workers, and slash bonuses. On May 5, 2017, the island government announced it was closing 179 public schools and laying off 2,000 teachers and relocating nearly 30,000 students in the process. As of May 2017, FOMB's plan for the island included reducing government funding to universities on the island by over 50%. That same month the government of Puerto Rico sought bankruptcy relief in federal court by declaring a form of bankruptcy ($72 billion), which is the largest municipal bankruptcy debt in history.

In July 2017, FOMB formally presented before the Federal Court in Puerto Rico the petition for restructuring a portion of the island's public debt after negotiations with island creditors fell apart. FOMB also demanded more austerity measures for the government. At the end of July, FOBM proposed massive furloughs, which were to begin September 1, 2017, and continue through fiscal year 2018 (Bernal 2017). The island's governor rejected FOMB's furlough program during FOMB's August 1 meeting.

On August 1, 2017, two lawsuits were filed that challenge the constitutionality of FOMB. One of the lawsuits was filed by U.S. hedge fund Aurelius Capital Management, which holds more than $470 million in Puerto Rico general obligation bonds, among other debt. The second lawsuit was filed by the Puerto Rico union, UTIER, which represents a third of the island's 9,550 employees of PREPA. Both argue that FOMB's seven members were never approved by the U.S. Senate and thus have no power, although Congress approved that law that created the board. FOMB members were chosen by the Obama Administration from a list submitted by Congressional leaders of both parties.

On August 4, 2017, FOMB sent an email to Governor Rosselló stating that the island's government must comply with FOMB's furlough program. The email also included the warning that "(s)hould the Government fail to implement the furlough program as described herein, (FOMB) intends to pursue all appropriate means to enforce the certified Fiscal Plan, as required by PROMESA. This may include seeking a judicial determination that the furlough program is a binding component of the Fiscal Plan that the Government lacks the authority to disregard."

FOMB followed through on that threat. On August 28, 2017, FOBM sued the island's governor for refusing to impose mandatory public employee furloughs, cut the public pension system by 10%, and take other measures that FOBM said were necessary to reduce the budget (Coto 2017).

**Post-Hurricane Maria Economy**

On September 27, 2017, FOMB approved the reallocation of $1 billion of the island's budget to be used for emergency funding.[31] FOMB also said it was prepared to do everything in its authority to support rebuilding the island.

Hsiang and Houser (2017) from the Climate Impact Lab estimated the impact of Hurricane Maria using an econometric model of the costs of cyclones over the past 60 years and applied it to the characteristics of Hurricane Maria and the economic conditions before the hurricane in Puerto Rico. They found that Maria could lower Puerto Rican incomes by 21% over the next 15 years — a cumulative $180 billion in lost economic output. They concluded that it could take 26 years for Puerto Rico to return to its pre-Maria economic conditions.

The Puerto Rican consulting firm Estudios Técnicos estimated the capital loss in the range of $16 to 20 billion (2017). Damages to the island's electric and communication infrastructures were estimated to be as high as $1.6 billion and $567 million, respectively. Estudios Técnicos also estimated a loss of income by employees of at least $1 billion. NOAA National Centers for Environmental Information estimated damages caused by Hurricane Maria of $90.0 billion[32].

On October 17, PREPA signed a $300 million contract with a Montana company, Whitefish Energy, to rebuild its damaged electrical infrastructure. On October 23, 2017, the Washington Post reported that PREPA made the unusual decision to hire Whitefish rather than activate the mutual aid arrangements it has with other utilities (Mufson et al. 2017). Later it was reported that the Federal Bureau of Investigation (FBI) was also investigating the contract, and on October 24th, the contract was canceled by Governor Rosselló (Irfan 2017). After that cancellation, crews from other utilities were brought into Puerto Rico.

[31] On October 4, 2017, the FOMB withdrew its lawsuit filed against the governor over his refusal to implement the FOMB's furlough program.

[32] https://www.ncdc.noaa.gov/billions/events.pdf

The Economist Intelligence Unit's November 2017 forecast projects the island's real GDP will shrink by about 8% in 2018. That would put Puerto Rico at the top of the list of slowest growing economies in the world. Only three (Puerto Rico, Venezuela and Equatorial New Guinea) are expected to have shrinking economies in 2018 (declining real GDP). The forecast by Focus Economics is not as negative; it estimates Puerto Rico's GNP will decline by 1.8% in fiscal year (FY) 2018, but then increase by 0.3% in FY2019.

On November 7, 2017, Governor Rosselló requested the Secretary of Commerce declare a federal fishery resource disaster because of Hurricanes Irma and Maria. In that request, it was estimated that Puerto Rico's fisheries generate direct economic effects of $29 million dockside value from commercial fishing, and there were over 600,000 recreational angler trips in 2016. Hurricane Maria was estimated to have reduced commercial fishing activity in Puerto Rico by 67% (Matos Caraballo 2017). The Secretary issued the fishery disaster declaration on February 8, 2018.

Puerto Rico is seeking $94.3 billion in federal aid to help it recover and $31 billion of that would go into rebuilding homes, another $17.7 billion would go to the island's electric utility, and $14.9 billion would go to healthcare (Daugherty, November 2017). The Census Information Center at University of Puerto Rico at Cayey estimates the percentage of the population below the poverty threshold may have risen to 52.3% after Maria (http://caribbeanbusiness.com, November 2017).

The percentage of Puerto Ricans leaving for the mainland is increasing after Hurricane Maria. Meléndez and Hinojosa (2017) estimate Puerto Rico may lose up to 470,335 residents (14% of its pre-Maria population) from 2017 to 2019, and many are families. Teralytics, a New York-based company, used a sample of nearly half a million smartphone users to estimate that between October 2017 and February 2018, nearly 6% of Puerto Rico's population left for the mainland (Echenique & Melgar May 11, 2018).

Without power and water, many of the island's over 1,100 schools were closed. Dozens were badly damaged, 190 served as community centers and more than 70 others have been used to shelter families who lost their homes (Sanchez and Sandoval, October 24, 2017). Thirty eight schools have been permanently closed, and Puerto Rico's Secretary of Education, Julia Keleher, estimates that student enrollment was approximately 350,000 before Maria and 331,000 after as of early December (the74million.org).

The temporary and permanent closures of schools have led to a large wave of students leaving the island to attend schools on the mainland, and most have gone to Florida. According to the Center for Puerto Rican Studies at Hunter College, 10,324 Puerto Rican students enrolled in

Florida school districts after September 20, 2017. Florida Virtual School has offered assistance to Puerto Rico's displaced students by accepting 20,000 of the island's students so they are able to continue their education, whether the students remain in Puerto Rico or have relocated to Florida[33]. More than 2,000 students from the island were attending Massachusetts schools after fleeing the hurricane (Masslive.com, December 19, 2017) and there have been similar increases in other states. Families that enroll children in public schools on the mainland are more likely to either permanently relocate to the mainland or at stay longer and that is expected to further reduce the island's labor force in years to come.

The island's average monthly labor force and employment were lower the first three months after the September hurricanes than the three months before (Table 3.4.9). The unemployment rate rose from 10.4% in August to 10.7% in October and 11.0% in December. Although the unemployment rate was higher during the first three months after the hurricane, the labor force grew during those months. More recently, as of September 2018, the unemployment rate was 8.4% and the labor force was slightly above what it was in June 2017.

**Table 3.4.9.** Labor force, employment, unemployment, and unemployment rate three months before and after September hurricanes, 2017.

| Month | Thousands of People | | | Unemployment Rate (Percent Unemployed) | Percent Change of Labor Force |
|---|---|---|---|---|---|
| | Labor Force | Employed | Unemployed | | |
| **June** | 1,098.7 | 985.4 | 113.3 | 10.3% | |
| **July** | 1,093.3 | 980.8 | 112.7 | 10.3% | -0.50% |
| **August** | 1,094.6 | 977.1 | 113.4 | 10.4% | -0.26% |
| | | | | | |
| **October** | 1,090.8 | 973.8 | 114.4 | 10.7% | 0.02%* |
| **November** | 1,092.5 | 974.0 | 118.5 | 10.8% | 0.15% |
| **December** | 1095.1 | 975.1 | 119.9 | 11.0% | 0.24% |

*: Change is from August to October, whereas others are one-month change.
(Source: U.S. Department of Labor BLS Economy at a Glance as of November 9, 2018)

The largest declines in nonfarm employment during the first three months after the September hurricanes were in the leisure & hospitality and trade, transportation & utilities sectors (Table 3.4.10). A comparison of employment in October 2017 and August 2018 shows the strongest recoveries have been in those sectors. Although the largest decline during that time was in the government sector, it has been largely due to austerity measures.

[33] http://www.fldoe.org/hurricaneinfo/

**Table 3.4.10.** Non-farm employment Labor force, employment, unemployment, and unemployment rate before and after September hurricanes.

| Nonfarm Employment | 1,000s of Employees 2017 | | | | | | | 1,000s of Employees 2018 |
|---|---|---|---|---|---|---|---|---|
| | Jun | Jul | Aug | | Oct | Nov | Dec | Aug. |
| **Mining, Logging and Construction** | 21.2 | 21.1 | 20.2 | | 20.1 | 20.3 | 21.1 | 20.5 |
| **Manufacturing** | 72.1 | 71.9 | 71.7 | | 70.0 | 70.2 | 69.8 | 70.1 |
| **Trade, Transportation & Utilities** | 173.7 | 172.9 | 171.4 | | 159.6 | 160.32 | 161.0 | 168.7 |
| **Information** | 17.9 | 17.5 | 17.5 | | 17.1 | 17.0 | 17.0 | 16.9 |
| **Financial Activities** | 42.9 | 42.9 | 42.7 | | 41.9 | 41.9 | 41.9 | 42.2 |
| **Professional & Business Services** | 114.6 | 114.5 | 114.2 | | 111.3 | 113.0 | 113.1 | 111.7 |
| **Education & Health Services** | 124.0 | 122.5 | 122.2 | | 117.9 | 116.3 | 116.4 | 117.6 |
| **Leisure & Hospitality** | 81.7 | 81.4 | 81.2 | | 67.8 | 72.9 | 77.0 | 79.9 |
| **Other Services** | 17.8 | 17.8 | 17.7 | | 17.5 | 17.4 | 17.5 | 17.3 |
| **Government** | 217.3 | 216.3 | 215.1 | | 213.0 | 212.9 | 211.6 | 208.0 |
| **Total** | **883.2** | **878.9** | **876.0** | | **836.2** | **842.2** | **846.4** | **852.9** |

(Source: U.S. Department of Labor BLS Economy at a Glance as of November 13, 2018)

According to the Puerto Rico Tourism Commission, as of January 3, 2018, 122 hotels, 105 casinos, 4,000 restaurants, and 107 attractions were open and operating across the island. As of May 2018, 130 out of 146 Puerto Rico Tourism Commission-sponsored hotels were open, which represented 89% of the inventory. By late May, 12,000 out of 15,000 hotel rooms were fully operational. The other 3,000 were being remodeled to offer a better product (www.travelweekly.com). Also by May, 16 out of 17 casinos and 1,885 restaurantswere open. Tourist attractions at major sites had reopened; however, El Yunque National Forest remained closed.

Most of Puerto Rico's farms are located in the central and western municipalities, and Hurricane Maria's path took it through much of the island's prime farmland (Figure 3.4.4). Puerto Rico's Secretary of Agriculture stated to the NY Times that 80% of the island's crops with a preliminary estimated value of $780 million were wiped out by Maria (Robles and Ferré-Sadurní 2017). Plantain, banana, and coffee crops were hit the hardest. Approximately half of the coffee plants were lost (Ayala 2017).

The chicken and egg industry lost 60% of its production (Ayala 2017). Approximately 2 million of the island's 2.6 million chickens were killed, many of them drowned, and poultry housing and processing equipment were destroyed (Dorell, October 7, 2017). Dairy cows died and surviving cows have been less productive than before. Communities and households lost gardens and family livestock. The federal government's response to the losses incurred by dairy farm operations included $12 million to the island's 253 licensed dairy operations to purchase feed for their estimated combined 94,000 cows for 30 days (USDA FSA 2017).

Both academics and the Puerto Rico government warned that the island's government would run out of cash in October, and in response, Congress approved a $4.9 billion emergency loan to help the cash-strapped island by the end of October (Schroeder 2017, Campbell and Stein 2017). However, the government did not run out of cash. According to FOMB (December 2017), there was evidence of over $6 billion being held on deposit in government bank accounts. On January 9, 2018, in a letter to Puerto Rico's financial authority (AAFAF), FEMA claimed that the island government had $1.7 billion in cash balances as of December 29, 2017, and reportedly another $6 billion in bank accounts, which was too much cash for the island to draw on the emergency loan (Schroeder 2017). On January 17, 2018, the emergency loan was temporarily withheld by FEMA and the Treasury Department for the reason that that the island has not faced the cash shortage that was expected to occur. That same day FOMB announced its January investigative hearing on the over $6 billion held by the island government in bank deposits.

In November 2017 a bill was introduced to the U.S. Senate (S. 2165) that would provide additional disaster recovery assistance for Puerto Rico and the U.S. Virgin Islands, and for other purposes (https://www.govtrack.us/congress/bills/115/s2165/text). This bill appears to have died in committee. A different bill was introduced to the U.S. House of Representatives (H.R. 260) at the beginning of January that would enable U.S. citizens of Puerto Rico to choose whether Puerto Rico will become a state or a nation through a direct vote of all of the electorate pursuant to provisions of the Consolidated Appropriations Act, 2014[34]. Because Puerto Rico is not a state, it is barred from the traditional bankruptcy protection under Title 11, Chapter 9 of the U.S. Code that states receive. The House bill also appears to have died in committee.

In December 2017, the Puerto Rico Legislature Assembly created the Municipal Emergency Support Law to address the municipalities' tax revenue losses caused by Hurricanes Irma and Maria. The law created a fund of $100 million. In a letter to Governor Rosselló dated January 10, 2018, FOMB rejected that legislation and instead proposed municipalities seek Community Disaster Loans[35].

As of December 20, 2017, more than $870 million in federal funds were provided to Puerto Rico survivors of Hurricanes Irma and Maria. That included, but was not limited to, money paid out in Federal Emergency Management Administration (FEMA) grants, U.S. Small Business Administration low-interest loans, and National Flood Insurance Policy claims (FEMA December 2017). However, as of November 1, 2018, Puerto Rico had received more than $4 billion from FEMA's Public Assistance Program in response to Hurricane Maria (FEMA November 1, 2018). Those funds are for expenses related to Hurricanes Irma and Maria. As of mid-November 2018, there have been accusations that the Puerto Rico government is using

[34] https://www.congress.gov/bill/115th-congress/house-bill/260
[35] https://juntasupervision.pr.gov/index.php/en/documents/

federal disaster funds to pay its debt rather than rebuild; however, there is no evidence to support that claim.

The status of Puerto Rico's post-Maria economy continues to change. Status.pr is a website that tracks the status of Puerto Rico's recovery efforts. As of November, 2018, PREPA was operating at full capacity and PRASA was operating at almost 99.4% capacity, but the latter varies by region[36]. In the San Juan Metro region, PRASA is operating at almost 100%, but in the north, 98.4%. Status.pr also shows 98.5% of telecommunications service has returned and 92% of supermarkets and 88% of gas stations are open.

More information about impact of recent hurricanes to Puerto Rico can be found in Section 3.5.11.

## 3.5 Description of the Puerto Rico Fisheries

### 3.5.1 Introduction

Fish and fishing contribute to the local economy and remain central to the island coastal culture that characterizes Puerto Rico. The fisheries include small-scale commercial fishing, recreational fishing, and subsistence fishing. Commercial fishing supplies sustenance and employment, and recreational fishing provides food and leisure activity for local residents and visitors. Subsistence fishing, or fishing for household consumption, remains a component of both the commercial and recreational fishing sectors. Sport fishing, or competitive fishing for game fish, represents a feature of recreational fisheries. In general, commercial and recreational fishermen target similar species of fish and shellfish, including reef fish, coastal and offshore pelagic fish, lobster, and conch, among others.

The fisheries of Puerto Rico are, with few exceptions, small-scale or artisanal in nature, involving fishing households, relatively small fishing vessels, and subsistence or commercial fishing for local consumption (Valle-Esquivel et al. 2011). All fishery resources are consumed on the island; there is little or no export. Commercial fishermen eat, prepare, and sell their catch, and invest considerable time maintaining and repairing their fishing gear and vessels. Recreational fishing is popular, approximately 10 percent of the population participates in recreational fishing activities. Recreational fishing takes place from shore, from private or charter vessels, by snorkel and SCUBA diving, or by a combination of these approaches. The largest commercial fisheries in Puerto Rico include deep-water snapper and grouper fishing on the west coast, and spiny lobster and queen conch fishing throughout the island. The largest recreational landings in Puerto Rico include dolphinfish (mahi mahi or dorado), wahoo, mackerel, most snappers from the Snapper Unit 1 stock complex (i.e., black, blackfin, silk,

[36] http://status.pr/

vermilion). Sections 3.5.2 and 3.5.3 provide information on each sector-specific fishery. More information about the history of fisheries in Puerto Rico and characteristics can be found in Valdés-Pizzini (2011).

### 3.5.2 Commercial Fishing Activity

Commercial Fisheries Description

The commercial fishermen of Puerto Rico pursue multiple species, commonly using multiple gear types with nearly two-thirds utilizing at least three gear types. These fishermen have been characterized as small-scale or "artisanal"[37] because their commercial fishing vessels tend to be less than (and commonly much less than) 45 feet (13.7 m) long, have small crews, yield small revenues, and their seafood processors are small-scale producers. Small-scale fisheries are defined as traditional fisheries involving families or households using relatively small vessels, taking short fishing trips to provide for local consumption or export (UN Food and Agricultural Organization). In Puerto Rico, there is little or no export of catch. Small-scale fisheries are common in the Caribbean, on the U.S. mainland, and around the world.

The commercial sector is responsible for the majority of landings. Although small-scale, Puerto Rico's commercial reported fisheries landings in 2016 totaled 1,351,132 pounds and contributed $5,641,528 to the economy (NMFS 2017). Commercial fishermen target multiple fishery species using multiple gear types during the same fishing trip. Gears principally used in the commercial fishery are lobster traps, fish traps, gillnets and trammel nets, cast nets, beach seines, spears, hand lines, long lines (both surface and benthic), trolling and hand collection, with many variations in both design and use Valle-Esquivel et al. 2011 in Appeldorn et al. 2016). Although historically, traps have dominated the catch, their use has declined over time leading to a more balanced fishery using lines, nets, traps, and spears (Appeldoorn et al. 2016). The essential fishing gear has traditionally been fish traps, hand-dragged nets such as *mallorquines,* and the trammel, lines for bottom fishing, and fishing poles. Commercial fishing activities are limited to the insular platform and to external banks (Valdés-Pizzini 2014). Commercial fishermen fish the Commonwealth waters from shore to 9 nautical miles (nm) and federal waters that extend to 200 nm, with most of their fishing activity remaining closer to the shore. Matos-Caraballo and Agar (2008) found that the continental shelf and shelf break were the preferred fishing grounds. Commercial fishing is a daily activity, in that fishermen leave in the morning or the evening and generally return to shore within twenty-four hours of departure.

The number of fishermen fishing in deep waters has also experienced fluctuations through the years. For example, a drop in number in 1996 and 1992 to 2008 could be attributed to higher fuel costs and tighter fishing regulations such as minimum size limits and closed seasons (Matos-

[37] The NOAA Fisheries Glossary Revise Edition June 2006 defines artisanal fishery as a fishery based on traditional or small-scale gear and boats.

Caraballo and Agar 2008). However, higher prices received for deep water species has increased the number of fishermen solely participating in the deep-water snapper fishery (Matos-Caraballo and Agar 2011a). Please see Sections 3.5.2.5 and 3.5.2.6 for additional information on the deep-water fisheries.

Matos-Caraballo and Agar (2011a) also note that a higher percentage of fishermen operate from the coast given high fuel costs. In general, the most targeted species are reef fish, spiny lobster, queen conch, and baitfish. Fishing conditions off Puerto Rico's coasts also vary considerably and this influences the species targeted in the different coasts.

Fishing activities are mainly managed through the use of fishing licenses, closed seasons for some species, area closures, size limits, and in Puerto Rico territorial waters, through the use of global quotas (limited entry) for the harvest of deep-water snappers (Keithly et al. 2013) (see Section 3.2.6).

#### 3.5.2.1 Commercial Fishermen

The Puerto Rico Department of Natural and Environmental Resources (DNER), the agency responsible for the administration of the commonwealth fishing licenses defines a commercial fisherman as: "Any person whose means of subsistence, in part or in full, comes from fishing, and who holds a commercial fisherman's license issued by the DNER." Although there are no federal licenses or permits specifically for commercially fishing for Council-managed species in U.S. Caribbean federal waters, federal regulations require a valid commercial fishing license issued by Puerto Rico or the USVI to engage in these activities.

Fishermen are well distributed around the coast. In 2008, approximately 34% resided on the west coast, 27% resided on the south coast, and close to 20% resided on each of the north and east coasts (Matos-Caraballo and Agar 2011). The average age of commercial fishermen was 49 years (Matos-Caraballo and Agar 2011b) with 29 years of fishing experience (Matos-Caraballo and Agar 2011).

The majority of fishermen work full-time fishing and carrying out fishing-related activities such as selling their catch, building and repairing gear, and maintaining their vessels. In 2008, nearly 75% of fishermen reported working full-time, averaging over 40 hours a week in fishing and fishing related activities (Matos-Caraballo and Agar 2011a). This included spending 30.32 hours catching fish, 5.1 hours maintaining and repairing vessels, and 5.1 hours maintaining and repairing gear (Matos-Caraballo and Agar 2011). In addition, fishermen reported spending 4.4 hours each week selling their catch (Matos-Caraballo and Agar 2011). Part-time fishermen supplement their work with employment in other areas like construction and related trades. In Puerto Rico, part-time and full-time fishermen often take on "chiripas," temporary or odd jobs,

when work or income from fishing wanes (Griffith and Valdés-Pizzini 2002; Griffith et al. 2007).

Determining the number of active commercial fishermen has proven difficult. According to the most recent census conducted in Puerto Rico, there were approximately 868 active commercial fishermen in 2008 (Matos-Caraballo and Agar 2011). However, after completing the 2008 survey, Matos-Caraballo and Agar received an additional report in February of 2009 from the DNER with a database of commercial fishing licenses showing 1,129 valid licenses. The number of active fishermen has been highly contested, as pointed out in Griffith et al. (2007), and in the past even a range of 1,500 to 2,500 has been suggested too low by fishermen. The confusion could be attributed to what an active fisherman is defined. Nevertheless, the number of fishermen had decreased from an earlier census conducted in 1988 when there were over 1,700 fishermen or the 2003 census which counted 1,132.

In 2011 and 2012, the number of licensed commercial fishermen in Puerto Rico greatly increased (E. Piñeiro, personal communication) (Table 3.2.1). Two factors may have contributed to that increase in the number of licensed commercial fishermen including: 1) a relaxation of the requirement to submit tax forms when applying for a full or part-time commercial license and 2) an extension of the beginner fisher license to an additional year of eligibility. These factors appear to have allowed fishermen in the recreational sector to move into the commercial sector so that they were able to use additional fishing gear (such as bandit gear) and are able to sell their catch, both of which are prohibited for recreational fishermen. Historically, commercial fishermen in Puerto Rico were required by DNER to show their tax return forms when applying for a full- or part-time commercial fishing license. The DNER would use the tax forms to determine what amount of each fisher's income originated from commercial fishing and determine which license (part or full) the fisher could apply. However, the 2010 Puerto Rico fishing regulations relaxed the tax return requirement for applying for a commercial license, allowing the applicant to show, instead, an affidavit if tax returns could not be provided. Also in 2010, beginner fishermen, who after one year had to apply for the commercial fishing license, now had the opportunity to extend the beginner permit for one more year if they were not able to comply with the requirements to obtain a full/part- time license. The relaxation of these requirements may have led to the entry of a new cohort of fishermen into the commercial sector. In 2016, there were 1,074 licensed fishermen (no distinction between active or not active) (some licensed fishermen fish occasionally and may not be active all year long). Until February 2018, there were 1,275 licensed fishermen in Puerto Rico (766 full time, 131 part time, and 378 beginner fishermen) (DNER pers. comm. Feb 2019) (Table 3.5.1).

**Table 3.5.1.** Number of active commercial fishermen in Puerto Rico.

| Year | # of active fishermen | # of full time active fishermen | # of part-time active fishermen |
|---|---|---|---|
| 1988 | 1,731 | 1,306 | 425 |
| 1996 | 1,758 | 1,262 | 496 |
| 2002 | 1,163 | 423 | 740 |
| 2008 | 868 | 650 | 218 |
| 2009 | 1,129 | No data | No data |
| 2011/2012 | 3,408 | No data | No data |
| 2009 | 452 | No data | No data |
| 2010 | 670 | No data | No data |
| 2011 | 551 | No data | No data |
| 2012 | 609 | No data | No data |
| 2013 | 647 | No data | No data |
| 2014 | 690 | No data | No data |
| 2015 | Not available | No data | No data |
| 2016 | 874 | No data | No data |
| 2017 | Not available | No data | No data |
| 2018 | 1,275[1] | 766 | 131 |

[1]The total number of fishermen in 2018 includes 378 beginner fishers.
(Source: Census Data, D. Matos, Fisheries Laboratory, Puerto Rico Department of Natural and Environmental Resources)

#### 3.5.2.2 Commercial Fishing Vessels

Commercial fishing vessels in Puerto Rico are relatively small, averaging 20ft in length (Matos-Caraballo and Agar 2011a) with most ranging between 18ft to 25ft in length (Griffith et al. 2007), although Valdés-Pizzini (2011) notes that the fleet is mostly comprised of small vessels from 15-25 ft in length. Several vessels have undergone modifications and are very diverse in form and function (Valdés-Pizzini 2011). The majority of vessels are composed of a fiberglass hull or, less often, fiberglass and wood, with even fewer made of wood (Matos-Caraballo and Agar 2011a). Most vessels feature a single outboard gas engine that averages between 25 and 80 horsepower (Griffith and Valdes Pizzini 2002; Matos-Caraballo and Agar 2011a). These small vessels are fast and relatively comfortable for shallow waters near ports. The vessels can also have one or two electric winches used on the shelf edge or in deep fishing banks to capture deep-water snappers (i.e., silk and queen snappers), and may have global position equipment (GPS) and depth sensors which aid in the identification of fishing areas (Valdés-Pizzini 2011).

### 3.5.2.3 Commercial Fishing Gear and Methods

A detailed description of the fishing gear and methods used in Puertorrican fisheries is provided in the 2010 and 2011 Caribbean ACL Amendments (CFMC 2011a, b) and in CODREMAR (1988) and are incorporated herein by reference. Gear and methods used in the Puerto Rico commercial fishery include hook-and-line, bottom lines, troll lines, rod and reel, longlines (Table 3.5.2), SCUBA and skin diving, traps and pots, and nets (Matos-Caraballo and Agar 2011a; CODREMAR 1988).

Automatic reel used for deep-water snapper fishing in Puerto Rico. (Source: E. Piñeiro)

Nearly two-thirds of fishermen (63.2%) use at least three gear types, with hook-and- line, fish trap, and gill nets reported by fishermen as the most common (Griffith et al. 2007). Hook-and-line is one of the oldest gears used by fishermen in Puerto Rico. In 2008, Matos-Caraballo and Agar (2011a) found hook-and-line the most common and productive gear type, accounting for 49% of the total landings. In particular, handlines were most popular, used by 56% of hook and line fishermen, followed by bottom lines, troll lines, and rod-and-reel (Matos-Caraballo and Agar 2011a). Hook-and-line gear effectively catches reef fish as well as coastal and offshore pelagic fish. See Table 3.5.3 below for the annual commercial landings for the top five gears (hand/diving gear, gillnets/other nets, hook-and-line (bottom), pots and traps (fish), and troll lines) reported for Puerto Rico from 1988 through 2016.

Diving, both SCUBA and skin (free), continues to increase in popularity among commercial fishermen. In 2008, Matos-Caraballo and Agar (2011a) found that fishing while SCUBA and skin diving were the second most productive gear types used, accounting for 29% of the total landings. Fishing with diving equipment (SCUBA) was popularized in 1982 and has become an important technique for fishing queen snapper, lobster, squid, conch, pelagic fish, and reef fish (Valdés-Pizzini 2011; Matos-Caraballo and Agar 2011a). Valdés-Pizzini (2011) notes that in 2002, diving surpassed fish traps, in terms of fisheries' production and this can be considered one of the most dramatic effort changes in Puerto Rican fisheries.

Conflicts arise between diving and trap fishing as trap fishermen often associate diving fishermen with trap catch theft and loss (Griffith et al. 2007).

Traps, both fish traps and lobster traps, are among the oldest gear types used by fishermen in Puerto Rico. Often referred to as "pots," traps are used to harvest reef fish, deep-water snappers, and lobster. In 2008, Matos-Caraballo and Agar (2011a) found traps the third most productive gear, accounting for 13% of the total landings. Although an effective gear, trap fishing requires time and space on the ocean floor, and Puerto Rico is encouraging the reduction of traps in the waters of the Commonwealth. While trap fishing remains important in the south and east coasts of Puerto Rico, trap fishing is declining in popularity. Valdés-Pizzini (2011) notes that the competition between divers and fish trap users caused many to reduce their fishing gear or the number of traps and to start using trammel nets and *mallorquines*, described below. Another factor that influenced the reduction in the usage of fish traps is the loss of fishing gear due to the cutting of buoys by other vessels and the force of hurricanes. For example, in the east coast of Puerto Rico, approximately 500 fish traps were estimated to be lost due to hurricane Maria (R. Espinosa, Conservación Conciencia, pers. comm. 2019). In addition, the high price of materials necessary to construct the traps has also contributed to the decline in its use.

Nets are another common gear used by fishermen in Puerto Rico, becoming popular since 1985 (Valdez-Pizzini 2011). In 2008, Matos-Caraballo and Agar (2011a) found nets to be the fourth most productive gear, accounting for over 9% of the total landings. Gill and trammel nets are productive in harvesting reef fish and lobster. However, federal regulations prohibit the use of gillnets or trammel nets to harvest Caribbean reef fish or Caribbean lobster in EEZ waters. Cast nets and beach seines remain important for securing bait and fish and shellfish near shore.

**Table 3.5.2.** Types of hook-and-line gear used in Puerto Rico fisheries.

| Types of Hook- and-Line Gear | Definition |
|---|---|
| Handline (*In Spanish:* cordel de mano, cordel de fondo, cordel de guinea, or brizilla) | single line with one or two hooks used in shallow water (less than 20 fathoms). The most common line used with lead is known by the local name of *de tendido* or *de fondo* or without lead it is known as *brizilla.* |
| Longline | fishing method using a horizontal mainline to which weights and baited hooks are attached at regular intervals. The horizonal mainline is connected to the surface by floats. The mainline can extend from several hundred yards to several miles and may contain several hundred to several thousand baited hooks. |
| Bottom line (*In Spanish: cala, ballestilla,* or *fuete*) | a bottom line with one or more hooks anchored with approximately 1 to 8 pounds of lead and fished at depths ranging from 50-150 fathoms (300-900 feet). The hooks may either be hung paired from one or more hard frames of galvanized wire (*ballestilla* is a horizontal bottom |

| | |
|---|---|
| | line: *Christmas tree* and *fuete* are different styles of vertical bottom lines. |
| Trot line (*In Spanish: palangre*) | longline used with baited hooks on separate branch lines which may be anchored or left drifting. The drop lines or steel wire have local names such as *penoles, brindales, rondales, reinales* or *'verguillas*. |
| Longline (*In Spanish: palangre de tiburón)* | The difference between a trot line and a longline is the size of the elements which make up the gear. The scale of a longline is greater than that of a trot line. Longlines generally have from 1 to 10 hooks with drop lines of 1.5 fathoms. The interval between hooks is approximately 3 fathoms. The mainline is heavy with a test strength of about 3,000 pounds. Hook sizes vary according to the fishery. Commonly used in Puerto Rico to catch sharks. |
| Troll lines (*In Spanish: silga, corrida, de alambrada, or currican*) | line with one or more barbed hooks at the end, baited with either a natural or an artificial lure and towed behind a moving boat |
| Rod and reel (*In Spanish: caña, vara)* | a rod and reel unit that is not attached to a vessel, or, if attached, is readily removable, from which a line and attached hook(s) are deployed. The line is payed out from and retrieved on the reel manually, electrically, or hydraulically. |
| Automatic reel | a reel that remains attached to a vessel when in use from which a line and attached hook(s) are deployed. The line is payed out from and retrieved on the reel electrically or hydraulically. |
| Bandit reel (gear) (*In Spanish: malacate*) | a rod and reel that remains attached to a vessel when in use from which a line and attached hook(s) are deployed. The line is payed out from and retrieved on the reel manually, electrically, or hydraulically. |

(Source: CODREMAR, Comprehensive Census of the Fishery of Puerto Rico [1988])

**Table 3.5.3.** Annual commercial landings in pounds for the top five gear types reported for Puerto Rico, 1988-2016.

| Year | By Hand, Diving Gear | Gill Nets, Other | Hook And Line, Bottom | Pots And Traps, Fish | Troll Lines | Total |
|---|---|---|---|---|---|---|
| 1988 | 291,396 | 478,821 | 711,361 | 1,040,773 | 411,689 | 2,934,041 |
| 1989 | 465,433 | 450,986 | 994,090 | 1,566,122 | 445,608 | 3,922,239 |
| 1990 | 530,659 | 547,220 | 914,549 | 1,344,339 | 508,859 | 3,845,625 |
| 1991 | 589,524 | 641,514 | 1,136,188 | 1,433,655 | 378,202 | 4,179,082 |
| 1992 | 386,330 | 253,442 | 981,020 | 935,208 | 226,488 | 2,782,488 |
| 1993 | 583,182 | 407,157 | 1,277,810 | 1,007,678 | 189,652 | 3,465,478 |
| 1994 | 585,595 | 488,878 | 1,282,833 | 1,081,509 | 296,998 | 3,735,814 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1995 | 721,849 | 437,279 | 1,752,399 | 1,157,585 | 447,079 | 4,516,190 |
| 1996 | 752,376 | 513,073 | 1,565,513 | 1,095,306 | 347,449 | 4,273,717 |
| 1997 | 685,856 | 584,028 | 1,429,440 | 1,070,026 | 437,819 | 4,207,169 |
| 1998 | 819,726 | 512,947 | 1,199,735 | 921,077 | 394,497 | 3,847,982 |
| 1999 | 723,545 | 580,186 | 1,222,532 | 876,633 | 383,503 | 3,786,399 |
| 2000 | 1,170,993 | 744,154 | 1,638,551 | 1,049,314 | 511,716 | 5,114,728 |
| 2001 | 933,256 | 665,669 | 1,527,659 | 1,106,441 | 354,560 | 4,587,585 |
| 2002 | 758,327 | 527,229 | 1,128,008 | 780,587 | 258,844 | 3,452,995 |
| 2003 | 726,142 | 442,049 | 1,424,717 | 788,063 | 392,494 | 3,773,465 |
| 2004 | 898,506 | 473,791 | 1,038,937 | 871,077 | 264,727 | 3,547,038 |
| 2005 | 1,376,300 | 482,481 | 1,972,874 | 1,449,818 | 346,246 | 5,627,718 |
| 2006 | 561,468 | 150,920 | 922,742 | 422,403 | 134,715 | 2,192,247 |
| 2007 | 586,569 | 158,921 | 803,834 | 298,165 | 169,801 | 2,017,290 |
| 2008 | 652,289 | 364,752 | 1,578,016 | 292,877 | 194,359 | 3,082,293 |
| 2009 | 693,755 | 176,801 | 1,026,198 | 345,317 | 163,728 | 2,405,799 |
| 2010 | 652,374 | 156,994 | 1,251,463 | 277,585 | 178,403 | 2,516,819 |
| 2011 | 538,584 | 129,894 | 791,405 | 236,519 | 83,135 | 1,779,536 |
| 2012 | 636,906 | 193,983 | 428,435 | 326,511 | 261,886 | 1,847,721 |
| 2013 | 538,216 | 128,991 | 235,688 | 181,880 | 107,985 | 1,192,761 |
| 2014 | 572,217 | 123,120 | 392,701 | 264,062 | 136,411 | 1,488,510 |
| 2015 | 579,629 | 125,472 | 359,745 | 293,348 | 147,221 | 1,505,416 |
| 2016 | 584,259 | 126,995 | 331,014 | 301,155 | 146,123 | 1,489,546 |
| **Total** | **23,701,776** | **13,880,588** | **35,008,031** | **31,902,811** | **10,116,944** | **114,610,150** |

(Source: Southeast Fisheries Science Center, Feb 2018)

#### 3.5.2.4 Targeted Species

Commercial fishermen in Puerto Rico target multiple species of fish and shellfish, including reef fish (especially snappers and groupers), coastal pelagics, deepwater pelagics, lobster, and conch (Figure 3.5.1). Finfish, historically the preferred food of local residents, constitutes the majority of the catch and value. Reef fish are the most important category of targeted commercial fish, followed by deep water snappers and spiny lobster, but, target species vary by coastal region.

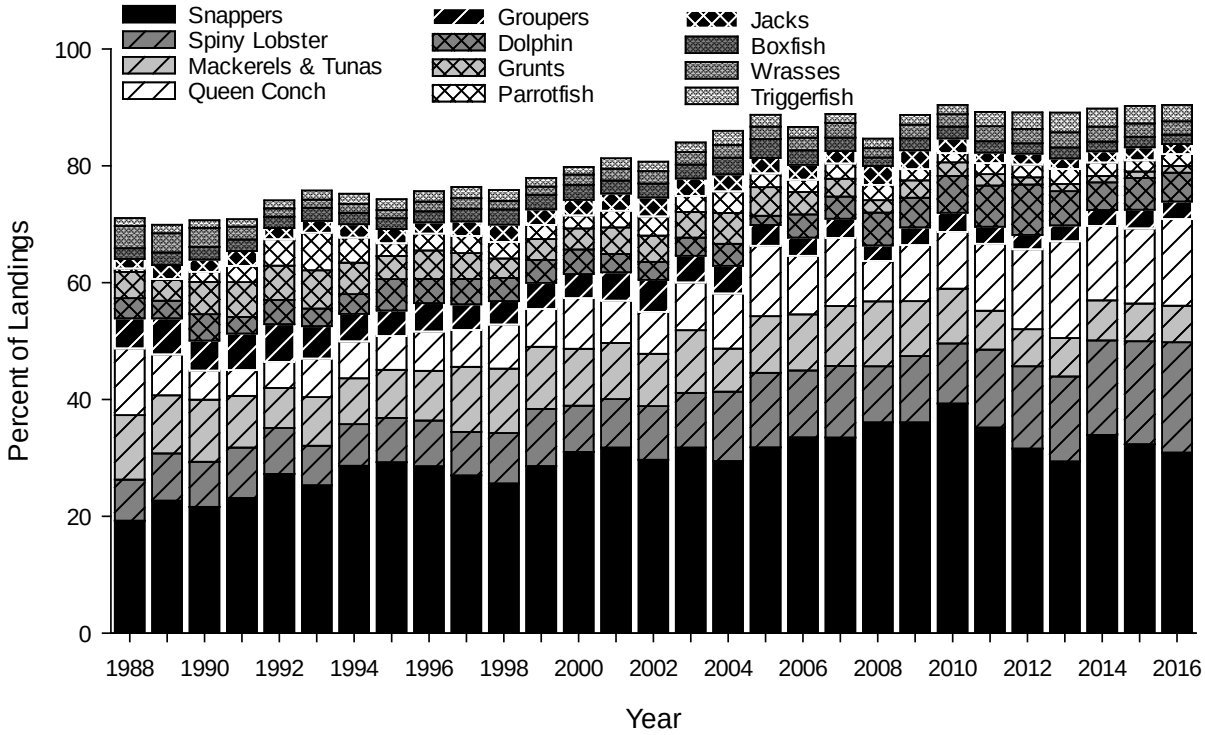



**Figure 3.5.1**. Most targeted (>70% of commercial landings) catch each year in Puerto Rico. (Source: Southeast Fisheries Science Center, Aug 2018)

In 2016, finfish[38] constituted 66% of the total catch reported, and shellfish[39] 34% of the overall reported catch (NMFS 2017). Similarly, finfish represented 51% of the total value and shellfish represented 49% of the total value (NMFS 2017). Top finfish species landed during 2012-2016 include yellowtail snapper, silk snapper, and dolphinfish (Figure 3.5.2)

[38] Finfish includes several reef fish species groups, coastal pelagics, tunas, and other marine finfishes.
[39] Shellfish includes crabs, spiny lobster, conch meats, octopus, and other shellfish.

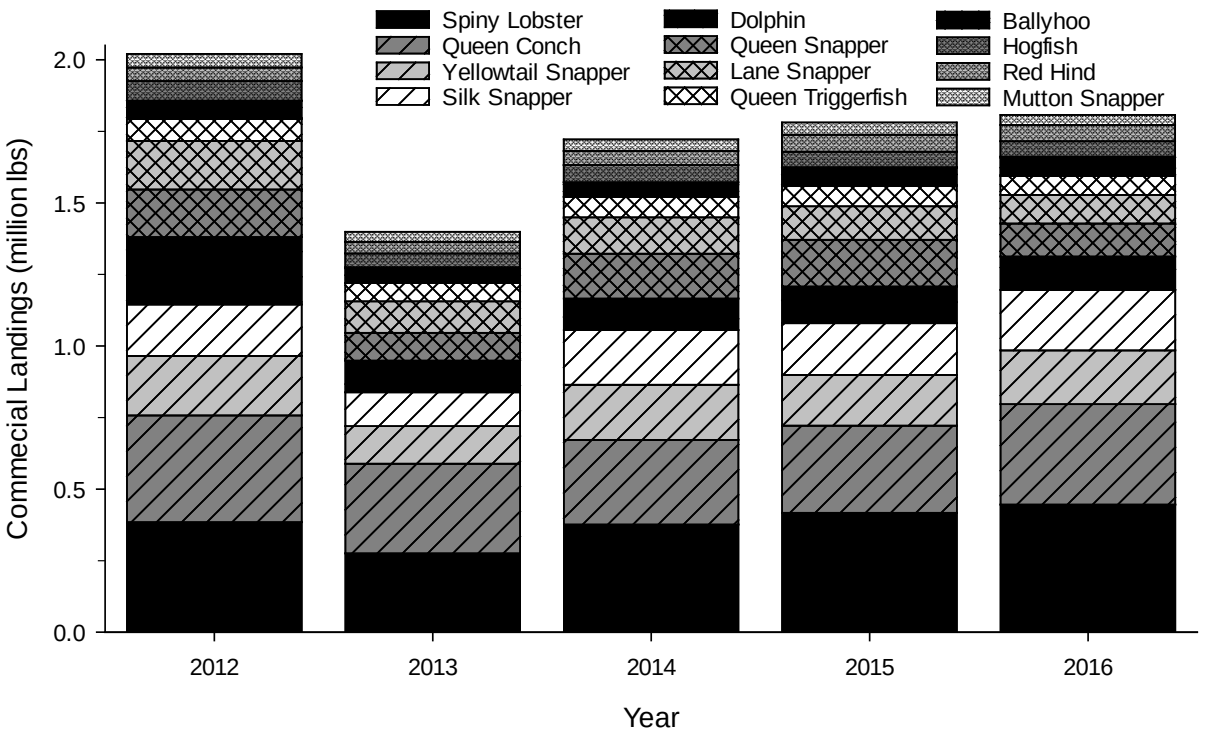



**Figure 3.5.2.** Most targeted (in million pounds) stocks harvested in 2012-2016 in Puerto Rico. (Source: Southeast Fisheries Science Center, Aug 2018)

Snappers and Groupers

Found in coastal and deepwater reefs, snappers and groupers are among the most targeted fishes. In 2016, snappers comprised 49% of the total reported landings of finfish and 65% of the value of finfish. Silk snapper (*Lutjanus vivanus*) comprised 32% of the snapper landings and 39% of the value, followed by snappers in the other category (unclassified) with 28% of the snapper landings and 33% of the value, yellowtail snapper (*Ocyurus chrysurus)* with 22% of snapper landings and 16% of the value, lane snapper (*Lutjanus synagris*), with 14% of snapper landings and 9% of the value, and mutton snapper (*Lutjanus analis*), with 4% of snapper landings and 3% of the value (NMFS 2017). The same year, groupers represented only 4.7% of the total landings of finfish and 4% of the value of finfish (NMFS 2017).

Most of the fishery for deep water snappers such as silk snapper (*Lutjanus vivanus*) and queen snapper (*Etelis oculatus*) takes place off the coast of Cabo Rojo and Rincón, in western Puerto Rico. Approximately 40 and 60 small-scale fishermen exploit this resource using hook and line gear, and to a lesser extent, pots (Keithly et al. 2013).

Coastal Pelagics and Tunas

Dolphin fish (*Coryphaena spp.*), mackerel (*Scomberomus regalis and S. cero*), and wahoo (*Acanthocibium solandri*) are among the most targeted coastal and deepwater pelagic species,

and tunas are the most targeted in offshore deepwater. Of these species harvested in 2016, dolphinfish comprised the largest landings (6.4%) and contributed the greatest value (6%) (NMFS 2017). Pelagic fish species, along with snappers and groupers, are preferred by tourists and are highly valued. The dolphinfish (*Coryphaena hippurus*), pompano dolphin (*Coryphaena equiselis*), the little tunny (*Euthynnus alletteratus*), blackfin tuna (*Thunnus atlanticus*), the king mackerel (*Scomberomorus cavalla*), cero (*Scomberomorus regalis*), and wahoo (*Acanthocybium solandri*) are all new to management in the Puerto Rico FMP and were included for management because of their importance and contribution to overall landings.

The king mackerel is a deepwater and coastal pelagic fish and is a popular game fish that reaches a size of 5 feet (1.5 m) and 100 pounds (McClane 1974). King mackerel appears to hold cultural significance among fishermen in Puerto Rico. Griffith et al. (2007) found that king mackerel was identified as one of the most important species by fishermen across Puerto Rico. This frequency and the association of king mackerel with events and festivals where it is served indicate its cultural significance (Griffith et al. 2007) (See Section 3.5.9 for additional information).

Other Important Fish Species

Some of the targeted species are significantly more important to commercial fishermen, and some hold cultural significance as well. When fishermen were asked in a survey to identify the most important species, the most common species listed were: silk snapper (14.1%), lobster (12.1%), yellowtail snapper (9.1%), king mackerel (5.5%), lane snapper (4.6%), conch (4.3%), and grouper (4.1%) (Griffith et al. 2007). Other important species were trunkfish (boxfish) and triggerfish (Griffith et al. 2007), ballyhoo (balao), jacks, parrotfish, grunts, scup or porgy, sharks, mullet, snook, squirrelfish, barracuda, and more (NMFS 2017). Although recognized as important, some of these species are not significant in terms of landings and value, or some of them infrequently occur in federal waters, at such, some of them are not managed by the Council (ballyhoo, mullet, sharks, snooks) or are not managed any longer under the Puerto Rico FMP (trunkfish, several species of jack, scups and porgies, squirrelfish). These species are under Puerto Rico Commonwealth management. Although landings and value are not significant, the great barracuda (*Spyraena barracuda*) was added as a new species for management in the Puerto Rico FMP as described in Chapter 2.

Ballyhoo (balao) is an important baitfish used to troll for marlin, sailfish, king mackerel, dolphin fish, and tuna (McClane 1974). Griffith et al. (2007) notes the presence of packaged ballyhoo in marine supply stores, apparently targeted for sale to recreational fishing charter boats participants. The mullet, also not managed in the Puerto Rico FMP, is one of the most popular baits used for blue marlin, sailfish, dolphin, and wahoo (McClane 1974).

Shellfish

Historically, lobster and conch were used for bait and, easily caught, were consumed during times of economic duress (Jarvis 1932; Griffith et al. 2007). Today, these shellfish are highly valued. Continually in demand by tourists and other visitors, local residents now consume lobster and conch as well. In 2016, conch constituted 39% of the total shellfish landings and 35% of the value of shellfish. The harvest of queen conch has been prohibited in federal waters of the Puerto Rico EEZ since 2005, but its harvest is allowed in Puerto Rico waters during an open season. In 2016, spiny lobster made up 57% of the shellfish landings and 61% of their value (NMFS 2017). Of particular importance to Puerto Rico fisheries is the octopus. However, species belonging to this group are not currently managed in the Puerto Rico FMP, as harvest is mostly restricted to state waters.

**Table 3.5.4.** Example of seasonality of fish per region in Puerto Rico and gears used for their harvest.

| Fish Species | Region | Season (Months) | Gears/Methods used | Other information |
|---|---|---|---|---|
| Dolphinfish (dorado) | Southwest | Jan-March | Rods and reels, hand lines | 30-35 miles from coast, deeper waters. |
| Yellowtail snapper | | | | Close to shore (3-4 miles out, over platform) |
| Mutton snapper | | | | |
| Red hind | | Jan-Feb | handlines | Over platform |
| King mackerel | | June/July/Aug-Oct | | Hurricane season, closer to shore preferred. Depends on lunar cycle |
| | | | | |
| Lobster, parrotfish, porgy, grunt | | Sep/Oct-Nov/Dec | | Fishing slow downs. Gear changed to traps, fish closer to reefs |

(Source: Griffith et al. 2007)

### 3.5.2.5 Fishing Areas

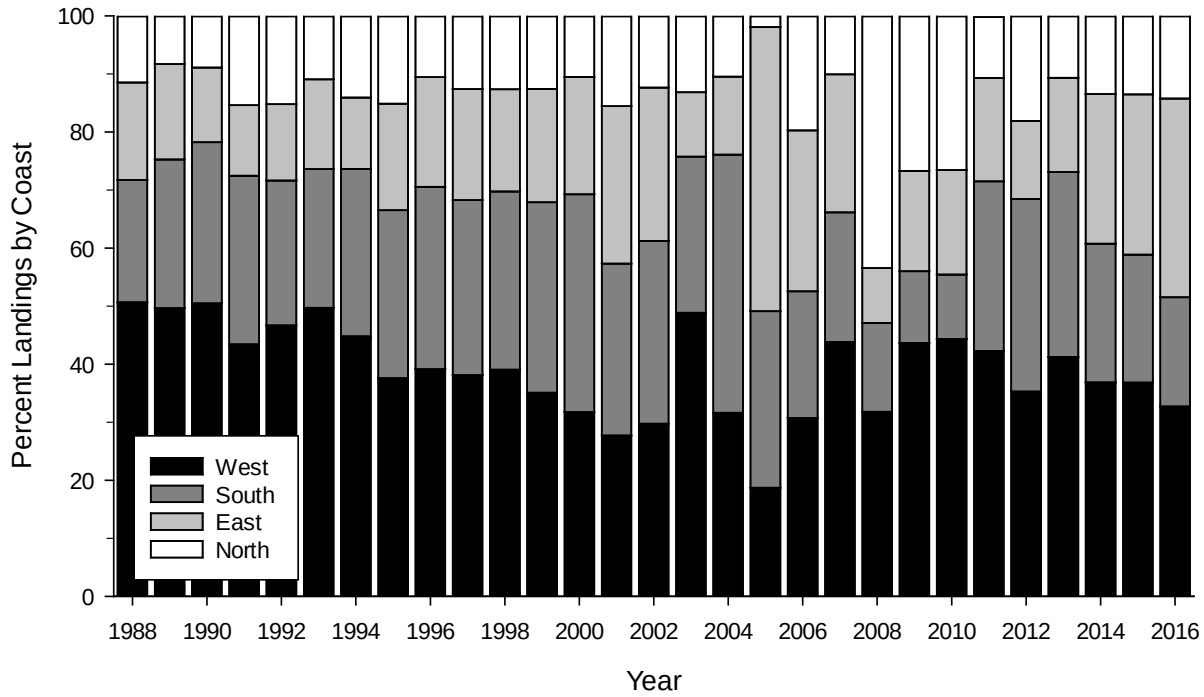



**Figure 3.5.3.** Percent of annual commercial landings by coast for Puerto Rico, 1988-2016. (Source: Southeast Fisheries Science Center, Aug 2018)

*West Coast*

The commercial fisheries of Puerto Rico are most productive and technologically advanced along the west coast of the island, translating to the greatest amount of commercial landings of which the west coast generally comprises 30-50% of the annual catch (Figure 3.5.3). Puerto Rico's west coast has an insular shelf area that is greater than the shelf areas of the north and south coasts (Collazo and Calderón 1987, 1988), and has the largest fishing zone in the territory with over 30 fishing areas (Griffith et al. 2002). Along the west coast is the Mona Passage, a 75-mile (121 km) wide and 3,300-ft (1006 m) deep passageway between the main island of Puerto Rico and the island of Mona, which contains islands, deep water, rocky stretches of bottom, and shallower inshore, muddy and rocky bottom areas that are easily accessible in small vessels (Griffith et al. 2002). Deepwater snappers and groupers, and deepwater pelagic fish such as blue marlin, dolphin fish, king mackerel, tunas, and other valued species, are found in the Mona Passage. These same species, other reef fish, pelagic fish, and shellfish are caught in coastal waters as well. Fishermen also fish around the island of Mona, Monito, and Desecheo, and deepwater banks such as the ecologically important Bajo de Sico, Tourmaline, and Abrir La Sierra (Matos-Caraballo 2008), which are also federally and state protected spawning banks.

The most important gears used in the west coast are bottom lines, SCUBA, troll lines and fish pots (Matos-Caraballo and Agar 2008). Important species are yellowtail, lane and mutton snapper, followed by deepwater snappers (silk and queen), and pelagic species such as dolphinfish, tunas (skipjack, yellowfin, blackfin), and king mackerel, and baitfish such as ballyhoo (Matos-Caraballo and Agar 2011). Spiny lobster and queen conch are also important species harvested in the area. There is also fishing for ornamental species.

Although the west coast fisheries from Aguadilla to Cabo Rojo are productive, the fisheries of Cabo Rojo and the port of Puerto Real are particularly rich. Cabo Rojo's varied marine and coastal habitats, from coastal lagoons to coral reefs to shelf drop-offs, result in the largest biomass of fish and shellfish and the production of 40% of the total landings in Puerto Rico (Griffith and Valdés-Pizzini 2002). Puerto Real is home to the largest and most industrial fishing fleet in Puerto Rico, with "trawlers" averaging 36 ft (11 m) in length using electric reel-lines and winches, inboard diesel motors, and kitchen and sleeping quarters to fish the offshore waters and shelf drop-off with smaller 22 ft "launchers" using electric reels and traps to target snappers, groups and dolphin fish (Griffith and Valdés-Pizzini 2002). Smaller boats ("yolas") are used for daily trap fishing of lobster and reef fish, line and net fishing, and diving for lobster, conch and reef fish (Griffith and Valdés-Pizzini 2002).

Most of the deep-water snapper-grouper fishery takes place off the coast of Rincón (western Puerto Rico) and Cabo Rojo (southwestern Puerto Rico). Approximately 40-60 small-scale fishermen fish for these resources using hook and line gear and traps, to a lesser extent. Species targeted are mostly silk snapper and queen snapper (Keithly et al. 2013). The commercial snapper unit 2 (SU2) fishery (queen and cardinal snapper), and particularly the component of the fishery executed along the west coast of Puerto Rico, historically involves a small number of dedicated fishermen. The fishery characteristically targets patchy, deep-water habitats influenced by dynamic oceanographic conditions. As a result, only a dedicated cohort of commercial fishermen maintains long-term participation and consistent success in the fishery. Participant fishermen from Puerto Rico have been identified based on past licensing and landings data, and have been permitted by Puerto Rico's DNER to exclusively harvest queen and cardinal snapper from Puerto Rico's state waters (CFMC 2015). More information about this special permitting can be found in Section 3.2.6.

West coast commercial fishermen historically account for the largest number of annual fishing trips, from 45 percent in 2010 to 47 percent in 2011 of all trips off Puerto Rico. The west coast also accounts for the largest share of historical annual landings. From 1988 to 2016, the west coast represented approximately 39 percent of all landings by weight. The south coast ranked second with 28 percent of all landings, followed by the east coast with 20 percent and last the north coast with 14%.

*South Coast*

The south coast, from Lajas to Guayama, is characterized by varied habitats from reefs to deep-water habitats that are fished for snappers, groupers, cero and king mackerels, tunas, barracuda, and billfishes (McClane 1974). Features that make the south coast more suitable for fishing operations include a larger insular shelf area, a somewhat less abrupt drop-off, the presence of a number of cays and sandy beaches that make the use of beach seines possible, and less exposure to storms, which is more conducive for the use of fish traps and pots. Also, the size of the insular shelf area off the south coast is about 1.85 times the size of the shelf off the north coast (Collazo and Calderón 1987, 1988) providing much larger spatial extent for some fisheries, particularly traps and nets, than on the north coast. The gear types/methods most used in the south coast are fishing with SCUBA, fish traps or pots, bottom lines, and, to lesser extent, nets (Matos-Caraballo and Agar 2008). The better topographic conditions of the coast allow for fishermen to target more spiny lobster and queen conch (Matos-Caraballo and Agar 2008), and these are very important fisheries in this coast. South coast commercial fishermen make more trips annually than those on the north and east coasts according to the 2002 and 2008 censuses. From 1988-2016, commercial landings from the south coast averaged about 28% of the total landings during that time (Figure 3.2.3). The percent of annual commercial landings from the south coast has steadily decreased in recent years (2014-2016) from 24% to 19%. Most harvested reef fish species are yellowtail, mutton and lane snappers, porgy, parrotfish, hogfish and grunts. Deepwater species are also harvested (e.g., silk snapper) as well as pelagics such as dolphinfish and king mackerel, and baitfish such as ballyhoo and herring. Octopus is also a very important landed species in the south (Matos-Caraballo and Agar 2008).

In La Parguera, historically a small fishing village in Lajas, Valdés-Pizzini and Schärer-Umpierre (2014) identified habitats and associated species recognized and fished by fishermen. Sea grasses and bedrock pavement with some hard and soft coral are fished for lobster, conch, yellowtail snappers, mutton snappers, grunts, and hogfish; coral reefs for snappers, lane snapper, red hind grouper, trunkfish, grunts, hogfish, parrotfish and octopus; and shelf drop-off for dolphin fish, mackerels, groupers, deepwater snappers, yellowtail snapper, red hind grouper, blue runners, and jacks (Valdés-Pizzini and Schärer-Umpierre 2014).

As in many coastal areas undergoing development, La Parguera commercial fishermen compete for fishery resources with recreational fishermen, including sports fishermen, and subsistence fishermen. An increased number of recreational (leisure fishing) and sports (e.g. tournaments) fishermen targeting the same species as commercial fishermen, in particular dolphinfish, and significant declines in landings since 2001, have resulted in conflict (Valdés-Pizzini and Schärer-Umpierre 2014).

*East Coast*

The east coast has the largest insular shelf size, and it represents 46% of Puerto Rico's insular shelf (Collazo and Calderón 1987, 1988). The east coast also lies on the same geological platform as St. Thomas and St. John. Depths of the waters along the east coast are less than 240 ft (73 m) throughout, which partially explains why the large majority of east coast commercial fishermen fish on the insular shelf: 94% in 2002 and 93% in 2008. The east coast features productive fishing grounds between Fajardo and Ceiba and the islands of Culebra and Vieques, where coral reef and deepwater habitats yield snappers, groupers, pelagic fish, lobster, and conch (Griffith et al. 2007), as well as wahoo and blue marlin (McClane 1974). This area also has a number of banks, islets, and cays (Jarvis 1932 in Matos-Caraballo and Agar 2011a). From 1988-2016, commercial landings from the east coast averaged about 20% of the total landings during that time (Figure 3.2.3). The percent of annual commercial landings from the east coast has steadily increased in recent years (2014-2016) from 26% to 34%.

Because of the shallow shelf, fishermen can harvest multiple species with different gear types such as lines, traps, and SCUBA (Matos-Caraballo and Agar 2008). The most targeted species are the reef fish yellowtail, lane, and mutton snappers, hogfish, porgies, white grunt, and parrotfish (Matos-Caraballo and Agar 2011a). Deepwater snappers are also among the most targeted species, followed by coastal pelagics, spiny lobster, queen conch, and baitfish (Matos-Caraballo and Agar 2008). In their fisherman census of 2008, Matos-Caraballo and Agar (2008) noted that the east coast accounted for 58% of the shark longlines, 32% of troll lines, 33% the anchored bottom lines, and 30% of the traps (both lobster and fish) in Puerto Rico. Skin divers and SCUBA divers in the region represented 42% and 27%, respectively, of participants in fisheries with this gear/methods in Puerto Rico.

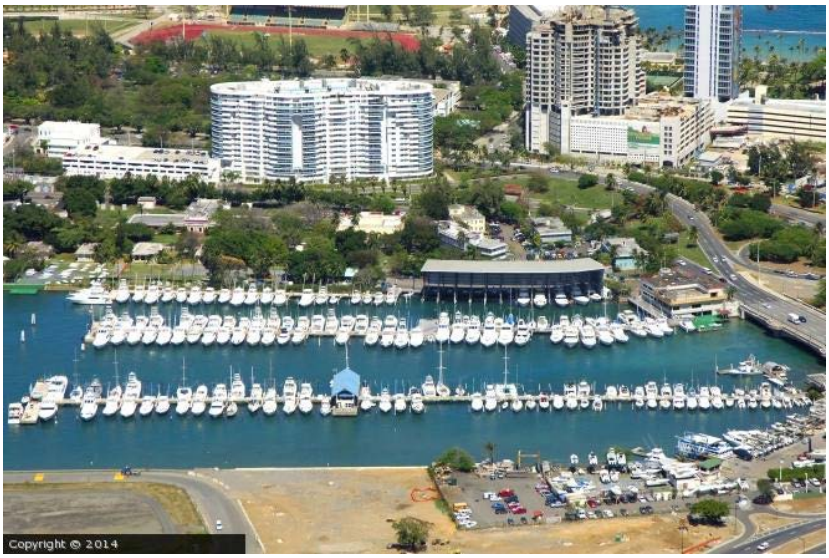
*North Coast*

Fishermen in this region are limited by a narrow continental shelf, with the 100-fathom (600 ft; 183 m) curve occurring between one and two miles (1.6 km and 3.2 km) off the coast and the shelf drop off is close to the 28,000 ft (8,534 m) deep Puerto Rico trench, limiting the amount of fishable area (Jarvis 1932; Whiteleader1971; Suarez-Caabro 1979 in Matos-Caraballo and Agar 2008). This in combination with adverse weather, high wave action during six months of the year, and a coastal topography that offers few protected areas in which to anchor fishing boats result in the north coast being the least productive region of the island, with fewer reported commercial fishing trips by north shore fishermen than their counterparts on the other coasts (Matos-Caraballo and Agar 2008). From 1988-2016, commercial landings from the north coast were the least of all the coasts, at only 14% of the total landings during that time (Figure 3.5.3). Annual commercial landings from the north coast was greatest in 2008, but have otherwise remained consistently less than landings from the other coasts.

Matos-Caraballo and Agar (2008) discuss that because of the limited shelf, fishermen in the north coast fish in different locations, favoring the continental shelf (90%), the shelf break

(84%), shore (67%), and, in deep waters (46%). Also, because of the coastal topography offering little protection against heavy swells and rough seas, north coast fishermen favor the use of hook and lines, followed by net gears to a lesser extent, while SCUBA and traps are not that favored (Matos-Caraballo and Agar 2011a).

In the north coast, reef fish are the most landed species, being yellowtail snapper, triggerfish, and parrotfish the most targeted, followed by deepwater snappers (silk and queen), pelagic species such as dolphinfish, king mackerel, and little tunny and target baitfish (herring, mullets, mojarras) (Matos-Caraballo and Agar (2011a). Of the shellfish landed, spiny lobster dominates the catch, followed by queen conch. The north coast also produces blue marlin, white marlin, dolphin fish, wahoo, tunas, and sailfish in deep waters fished by both recreational (McClane 1974) and commercial fishermen.



Marina in San Juan, in the north coast of Puerto Rico.

Figure 3.5.4 shows the distribution of fishing center throughout Puerto Rico coastal areas. More information about fishing centers and communities can be found in Section 3.10.

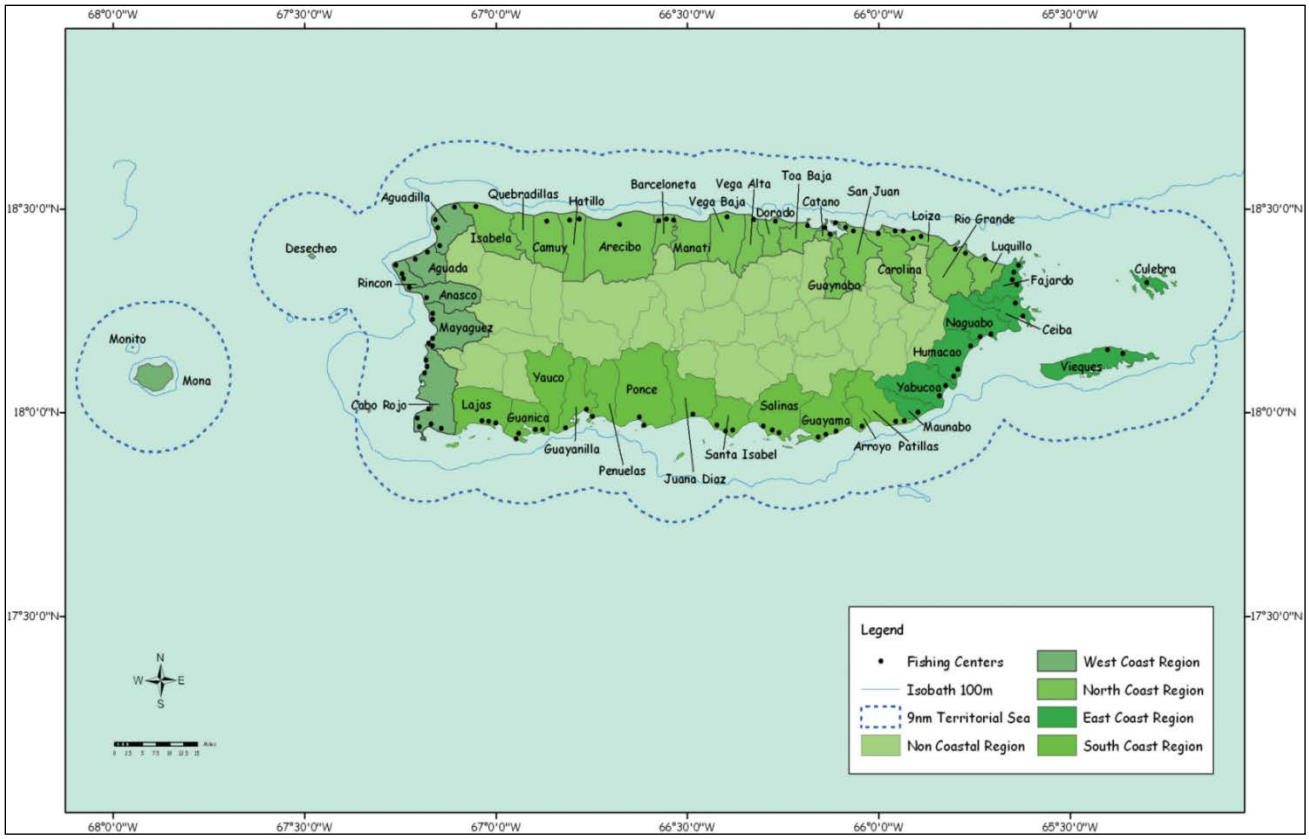



**Figure 3.5.4.** Distribution of fishing centers in the Commonwealth of Puerto Rico by region. (Source: Matos-Caraballo and Agar 2011a)

### 3.5.2.6 Licenses, Permits and Fees

Puerto Rico Federal Waters

Fishing vessel permits are not required to commercially harvest any Council-managed species in federal waters of the U.S. Caribbean (CFMC 2013c). Also, there are no federal licenses or permits required for the recreational harvest of reef fish, queen conch, spiny lobster, or aquarium trade species in the EEZ of the U.S. Caribbean. Efforts are underway to evaluate the development of a federal permit system in federal waters. Since 2010, all anglers fishing recreationally in U.S. Caribbean federal waters are required to be registered through the National Angler Registry (https://www.countmyfish.noaa.gov/register/). In addition, there are Highly Migratory Species (HMS) permit requirements that apply to the commercial and the recreational sectors fishing in the U.S. Caribbean EEZ. For more information on the HMS permit requirements please visit http://www.nmfs.noaa.gov/sfa/hms/compliance/permits_reporting/.

Puerto Rico Commonwealth Waters

In Puerto Rico Commonwealth waters, a commercial fishing license is required for all commercial fishermen including for full-time resident and non-resident fishermen, part-time fishermen, beginners fishermen, ornamental fisheries, and owners of rental boats including party/headboat and charter boats. As an obligation of the harvest permit, commercial fishermen are required to submit monthly catch reports to the Puerto Rico DNER. Additional commercial permits are required for the harvest of spiny lobster, queen conch, common land crab, incidental catch, and sirajo goby (i.e., cetí) fisheries (Table 3.5.5).

**Table 3.5.5.** Commercial licenses and permits in Puerto Rico and associated costs.

| | **Required License** | **Cost of License** |
|---|---|---|
| **Commercial** | Full Time Fisher (Pescador Comercial a Tiempo Completo) | $40.00 |
| | Beginners License (Pescador Comercial Principiante) | $40.00 |
| | Part Time Fisher (Pescador Comercial a Tiempo Parcial) | $40.00 |
| | Full Time Non-Resident Fisher (Pescador Comercial No Residente) | $250.00 |
| | "Charter Boat"or "Headboat" (Dueños de Bote de Alquiler) | For residents 16-21 feet $125.00, 22-30 feet $200.00, and 31 and higher $400.00. For non-resident 16-21 feet $250.00, 22-30 feet $375.00, and 31 and higher $750.00. |
| | | |
| | **Required Permits** | **Cost of Permit** |
| | Queen and Cardinal Snappers (Cartucho y Muniama de Afuera) | No cost |
| | Land Crabs (Juey Común) | $15.00 |
| | Incidental harvest (Pesca incidental) | $5.00 |
| | Sirajo Gobies (Cetí ) | $5.00 |

(Sources: DNER Regulations 7949; CFMC 2015).

*Limited Entry Program for the Harvest of Deep-Water Snappers in Puerto Rico Commonwealth Waters*

Puerto Rico's DNER Administrative Order 2013-11 (DNER 2013) was implemented in August 14, 2013 to regulate the harvest of queen snapper (*Etelis oculatus,* (in Spanish, "cartucho") and the cardinal snapper (*Pristipomoides macrophthalmus* [in Spanish, muniama de afuera]) (Snapper 2) and to grant special permission to those commercial fishermen dedicated to the capture of these species, while closing harvest to these resources to the rest of the commercial and recreational fishermen. This special permit was implemented to manage the number of fishermen accessing Snapper 2 and to thereby reduce the likelihood of overfishing the resource.

The special permits were awarded to commercial fishermen that had a full-time or part-time commercial fishing license and could show evidence, through historical landings (i.e, harvest of these two species during at least five years and reported annual captures of over 500 pounds), that they targeted these two species (CFMC 2015). The special permit granted also limits fishing trips per fisher to a maximum of 120 trips per year for the harvest of these two species. In 2013, this special permit was granted to 45 fishermen, and fishermen that were not selected for the permit had an opportunity to request a revision of the denial. Although this permit system was supposed to be valid just from September 25, 2013 until December 31, 2014, this administrative order continues to this day.

### 3.5.3 Recreational Fishing Activity

In Puerto Rico, recreational fishing is a popular, family-oriented activity that holds social, economic, and cultural importance for residents and visitors alike (Griffith et al. 2007). Recreational fishing also provides food, livelihoods, income, and other benefits to residents of Puerto Rico and USVI. Fishermen employ a range of approaches to access fish, including fishing from shore, fishing from private or charter vessels, and skin and SCUBA diving. Recreational fishermen frequently target the same species as commercial fishermen and use similar gears to harvest those fish, but are not allowed to sell their catch. Instead, recreational fishermen pursue fishing for purposes ranging from subsistence[40] fishing solely for household consumption of all the catch, to sport fishing solely for pleasure with little to no consumption of catch.

Background data on Puerto Rico recreational fisheries is scarce as to provide estimates of the level of dependence on these fisheries (Griffith et al. 2007). However, fishing tournaments by marinas and *Club Náuticos* (Nautical Clubs) are sources of income and employment for Puerto Ricans. The economic impacts of billfish tournaments have been estimated in the range of $25,000,000 to over $43,000,000, and this accounts also for over 200 seasonal or part-time jobs (Griffith et al. 2007).

#### 3.5.3.1 Recreational Fishermen

NMFS' Marine Recreational Information Program (MRIP) estimates the number of recreational anglers (hook and line fishermen) in Puerto Rico were 156,864 in 2015 and 124,674 in 2016, with approximately 96% of these anglers being resident in the Commonwealth in 2016 (MRIP Query Jan 2018). Currently, Puerto Rico statutes include a provision for mandatory licensing of recreational fishermen, although that licensing requirement has not been implemented. The implementation of the recreational license by the Puerto Rico government would allow a more complete estimate of the number of recreational fishermen, their level of effort, and their catch.

[40] For purposes of this FMP, subsistence fishing will be treated as a separate group of fishers.

Tables 3.5.6 and 3.5.7 show the participation in recreational fishing in Puerto Rico (territorial and EEZ waters combined) and the number of fish caught and released.

**Table 3.5.6.** Recreational fishing participation by region (individuals) in Puerto Rico, 2000-2016.

| Year | Coastal Resident | Out-of-State | Total |
|---|---|---|---|
| 2000 | 197,942 | 51,927 | 249,868 |
| 2001 | 193,371 | 28,757 | 222,128 |
| 2002 | 196,820 | 41,175 | 237,995 |
| 2003 | 185,004 | 34,906 | 219,910 |
| 2004 | 140,943 | 22,890 | 163,833 |
| 2005 | 109,116 | 32,626 | 141,743 |
| 2006 | 192,539 | 20,466 | 213,005 |
| 2007 | 165,335 | 20,095 | 185,429 |
| 2008 | 127,863 | 21,681 | 149,544 |
| 2009 | 110,236 | 22,352 | 132,589 |
| 2010 | 92,191 | 11,096 | 103,287 |
| 2011 | 98,662 | 13,795 | 112,457 |
| 2012 | 83,837 | 10,003 | 93,839 |
| 2013 | 122,002 | 5,515 | 127,518 |
| 2014 | 101,248 | 10,300 | 111,548 |
| 2015 | 144,877 | 11,987 | 156,864 |
| 2016 | 119,984 | 4,690 | 124,674 |

(Source: MRIP, Jun 2018 (http://www.st.nmfs.noaa.gov/recreational-fisheries/access-data/run-a-data-query/index))

**Table 3.5.7.** Total recreationally caught and released numbers of fish in Puerto Rico, 2000-2016.

| Year | Caught | Released |
|---|---|---|
| 2000 | 3,457,265 | 279,388 |
| 2001 | 1,849,449 | 318,289 |
| 2002 | 1,266,495 | 158,801 |
| 2003 | 1,527,092 | 149,932 |
| 2004 | 870,977 | 262,028 |
| 2005 | 923,948 | 233,213 |
| 2006 | 664,881 | 181,767 |
| 2007 | 1,067,644 | 220,482 |
| 2008 | 1,341,256 | 176,930 |
| 2009 | 663,593 | 119,179 |
| 2010 | 392,623 | 156,115 |
| 2011 | 387,306 | 58,980 |

| Year | Caught | Released |
|---|---|---|
| 2012 | 477,723 | 48,664 |
| 2013 | 497,202 | 101,692 |
| 2014 | 1,164,740 | 173,376 |
| 2015 | 612,418 | 345,404 |
| 2016 | 1,178,263 | 353,343 |
| **Total** | **18,342,875** | **3,337,583** |

(Source: Mrcat_all00_17wv5_12Mar18)

#### 3.5.3.2 Recreational Fishing Vessels

While many recreational fishermen fish from shore, others fish by boat. The total number of angler trips by fishing mode from 2000 through 2016 ranges from a minimum of 424,586 to a maximum of 1.4 million trips (Table 3.5.8). In 2016, of the almost 654,000 recreational fishing trips, 47% were from the shoreline and 53% were from private/rental boats. However, the number of trips from charter boats were not available for this year, therefore these percentages may change. The number of trips from the shoreline has varied from 40-65% of the total number of recreational trips per year since 2000, and the number of private/rental boats from 36 to 59%; and charter boat trips (excluding 2014 and 2016 which were unavailable) range from of the total angler trips 0.35 to 2.6% of the trips per year for those years.

**Table 3.5.8.** Total angler trips by fishing mode in Puerto Rico, 2000-2016.

| Year | Charter Boat | Private/Rental Boat | Shore | Total Angler Trips |
|---|---|---|---|---|
| 2000 | 16,899 | 552,914 | 792,890 | 1,362,703 |
| 2001 | 10,919 | 504,349 | 896,675 | 1,411,943 |
| 2002 | 34,277 | 572,844 | 693,938 | 1,301,059 |
| 2003 | 21,764 | 471,741 | 617,900 | 1,111,405 |
| 2004 | 22,028 | 389,469 | 638,802 | 1,050,299 |
| 2005 | 17,969 | 379,910 | 468,843 | 866,722 |
| 2006 | 16,823 | 431,274 | 507,026 | 955,123 |
| 2007 | 10,734 | 453,907 | 615,455 | 1,080,096 |
| 2008 | 12,622 | 362,739 | 423,190 | 798,551 |
| 2009 | 2,610 | 287,957 | 345,584 | 636,151 |
| 2010 | 4,113 | 312,419 | 219,651 | 536,183 |
| 2011 | 4,730 | 186,939 | 232,917 | 424,586 |
| 2012 | 1,839 | 208,462 | 140,266 | 350,567 |
| 2013 | 6,470 | 228,661 | 275,132 | 510,263 |
| 2014 | Unavailable | 258,864 | 275,636 | 534,500 |
| 2015 | 2,350 | 296,745 | 368,465 | 667,560 |
| 2016 | Unavailable | 344,112 | 309,502 | 653,614 |

(Sources: NMFS (2017); MRIP, Jun 2018 (http://www.st.nmfs.noaa.gov/recreational-fisheries/access-data/run-a-data-query/index)).

#### 3.5.3.3 Recreational Fishing Gear

Recreational fishermen predominantly use hook and line gear to fish. Apeldoorn and Valdés-Pizzini (1996) found that 80% of recreational vessels used hook and line or rod and reel gears to fish. Griffith et al. (2007) reported that recreational fishermen used three major gears: hook and line (40%), cane pole (14.4%), and SCUBA diving gear (10.4%). Like commercial fishermen, preference for SCUBA gear and skin diving is increasing among recreational fishermen.

#### 3.5.3.4 Recreationally Targeted Species

Recreational fishermen target many of the species that commercial fishermen target. These include several species of reef fish, shellfish, coastal and offshore pelagic fish. Recreational hook and line fishermen target reef fish, primarily snappers and groupers, and catch silk snapper (14%) and yellowtail snapper (12%) (Griffith et al. 2007). Recreational hook and line fishermen also target and catch coastal and offshore pelagic species, including dolphin fish, tunas, mackerels, and wahoo, among others. Recreational fishermen using SCUBA also spearfish reef fish, particularly snappers and groupers, and coastal pelagic fish.

MRIP records obtained from the SEFSC on January 12, 2018 indicate that marine recreational anglers caught 120 fish species in Puerto Rico in 2016. Three of top 10 most commonly caught species (in numbers of fish) were dolphin, the bait species redear sardine, and the blue runner (Table 3.5.9). The fish caught the most in 2016 was dolphinfish, at 24% of the total catch. Dolphinfish also accounted for the highest harvested fish by weight of all species in 2016 and represented 65% of the total annual landings (Table 3.5.10). Other top recreational species, in both numbers of individuals caught and weight, include great barracuda, mutton snapper, blue runner, red hind, and yellowtail snapper. Only one of the highest landed species (by weight) is not included in the Puerto Rico FMP (See Action 2 in Chapter 2) (greater amberjack) and four of the top 10 are newly added species: dolphin, wahoo, cero, and great barracuda. MRIP does not include invertebrate species (e.g., spiny lobster or queen conch), so reported values are only for finfish species. Tables 3.5.11 and 3.5.12 show the species most landed in the most recent three years of available data.

**Table 3.5.9.** Top 10 fish species reported (in number of fish) in MRIP landings in Puerto Rico in 2016.

| Species | Number of Individuals | % of Total Catch |
|---|---|---|
| Dolphin | 284,192 | 24 |
| Redear sardine | 139,386 | 12 |
| Blue runner | 65,470 | 6 |
| Great barracuda | 62,915 | 5 |

| Species | Number of Individuals | % of Total Catch |
|---|---|---|
| Atlantic thread herring | 55,319 | 5 |
| False pilchard | 46,906 | 4 |
| Yellowtail snapper | 43,123 | 4 |
| Red hind | 36,546 | 3 |
| Mutton snapper | 35,963 | 3 |
| Silk snapper | 31,677 | 3 |
| Subtotal | 801,497 | 68 |

(Source: Mrcat data)

**Table 3.5.10.** Top 10 fish species reported (in estimated number of pounds) in MRIP landings in Puerto Rico in 2016.

| Species | Weight (lbs) | % of Total Annual Landings |
|---|---|---|
| Dolphin | 2,630,162 | 65 |
| Great barracuda | 330,174 | 8 |
| Wahoo | 175,551 | 4 |
| Mutton snapper | 119,307 | 3 |
| Greater amberjack | 91,818 | 2 |
| Yellowfin tuna | 66,812 | 2 |
| Blue runner | 54,667 | 1 |
| Cero | 46,880 | 1 |
| Red hind | 38,268 | 1 |
| Yellowtail snapper | 36,929 | 1 |
| Subtotal | 3,590,570 | 89 |

Mrcat data

**Table 3.5.11.** Top 10 fish species reported (in number of fish) in MRIP landings in Puerto Rico, 2014-2016.

| Species | 2014 | 2015 | 2016 | Average |
|---|---|---|---|---|
| Dolphin | 85,186 | 72,421 | 284,192 | 147,266 |
| Bigeye scad | 131,221 | -- | -- | 131,221 |
| Redear sardine | 186,565 | 1,717 | 139,386 | 109,223 |
| Blue runner | 140,527 | 60,971 | 65,470 | 88,989 |
| Ballyhoo | 131,221 | 699 | -- | 65,960 |
| Great barracuda | 38,503 | 56,270 | 62,915 | 52,563 |
| Lane snapper | 65,072 | 14,488 | 27,060 | 35,540 |
| Atlantic thread herring | 18,758 | 17,519 | 55,319 | 30,532 |
| Tilapia genus | 11,571 | 48,541 | -- | 30,056 |
| Yellowtail snapper | 10,936 | 32,687 | 43,123 | 28,915 |

Source: Mrcat data

**Table 3.5.12.** Top 10 fish species reported (in estimated number of pounds) in MRIP landings in Puerto Rico, 2014-2016.

| Species | 2014 | 2015 | 2016 | 3-year average |
|---|---|---|---|---|
| Dolphin | 493,751 | 507,507 | 2,630,162 | 1,210,473 |
| Great barracuda | 202,059 | 295,301 | 330,174 | 275,845 |
| King mackerel | 423,649 | 18,283 | 21,148 | 154,360 |
| Wahoo | 25,840 | 160,196 | 175,551 | 120,529 |
| Mutton snapper | 13,602 | 46,192 | 119,307 | 59,700 |
| Blue runner | 53,138 | 40,749 | 54,667 | 49,518 |
| Greater amberjack | -- | 1,664 | 91,818 | 46,741 |
| Crevalle jack | 76,847 | 32,155 | 27,770 | 45,590 |
| Yellowfin tuna | 32,304 | 12,516 | 66,813 | 37,211 |
| Yellowtail snapper | 9,365 | 27,992 | 36,929 | 24762 |

(Source: Mrcat_all00_17wv5_12Mar18)
Dashes indicate no reported landings.

The stocks with the highest average number of pounds harvested recreationally from 2014 through 2016 are dorado, wahoo, yellowtail snapper (SU5 under the Puerto Rico FMP, based on Action 3, Preferred Alternative 3, and SU4 under the Reef Fish FMP), mutton, dog, schoolmaster (SU4 under the Puerto Rico FMP, based on Action 3, Preferred Alternative 3, and components of SU3 under the Reef Fish FMP), barracuda, mackerel (king and cero), and jacks (Table 3.5.13).

**Table 3.5.13.** Recreational landings in pounds by stock/stock complex in Puerto Rico, 2014-2016. Dashes indicate no reported landings.

| Stock/Complex | 2014 | 2015 | 2016 |
|---|---|---|---|
| Snapper Unit 1 | 11,299 | 10,968 | 25,089 |
| Snapper Unit 2 | - | 794 | 11,623 |
| Snapper Unit 3 | 29,484 | 7,671 | 14,327 |
| Snapper Unit 4 | 13,602 | 46,192 | 119,307 |
| Snapper Unit 5 | 9,365 | 27,992 | 36,929 |
| Snapper Unit 6 | - | - | 2,834 |
| Grouper Unit 1 | 6,717 | - | - |
| Grouper Unit 2 | - | - | - |
| Grouper Unit 3 | 171 | 3,959 | 14,202 |
| Grouper Unit 4 | - | - | 11,794 |
| Grouper Unit 5 | - | - | - |
| Grouper Unit 6 | 19,407 | 4,529 | 38,268 |
| Parrotfish Unit 1 | 32,566 | - | - |
| Parrotfish Unit 2 | 10,210 | 19,394 | 1,315 |
| Surgeonfish | - | - | - |
| Angelfish | - | - | - |

| Stock/Complex | 2014 | 2015 | 2016 |
|---|---|---|---|
| Grunts | 2,512 | 905 | 4,466 |
| Triggerfish | 36,978 | 27,577 | 2,714 |
| Wrasses Unit 1 | 42,881 | - | 2,004 |
| Wrasses Unit 2 | 1,010 | 1,495 | - |
| Dolphin | 493,751 | 507,507 | 2,630,162 |
| Barracuda | 202,059 | 295,301 | 330,174 |
| Jacks Unit 1 | 76,847 | 32,155 | 27,770 |
| Jacks Unit 2 | - | - | 4,916 |
| Jacks Unit 3 | - | 44,267 | 4,408 |
| Tripletail | 1,279 | 3,613 | 8,517 |
| Tuna | 9,103 | 4,354 | 49,683 |
| Mackerel | 443,177 | 21,451 | 68,029 |
| Wahoo | 25,840 | 160,196 | 175,551 |
| Rays Unit 1 | - | - | - |
| Rays Unit 2 | - | - | - |
| Rays Unit 3 | 5,582 | 58,644 | - |

(Source: Mrcat_all00_17wv5_12Mar18)

### 3.5.3.5 Tournament Fishing

In Puerto Rico, recreational fishermen target big game billfish including blue marlin, white marlin, and sailfish, among others in organized tournaments. Blue marlin and other big sport fish are abundant off the North Coast with its a steep drop-off; and blue marlin are found off the West Coast, East Coast, and South Coast (McClane 1974). Other fish species targeted by recreational fishers are also good to eat, such as tunas, dolphin fish, king mackerel, and wahoo. These latter species are new to Council management in the Puerto Rico FMP.

**Table 3.5.14.** Number of saltwater tournaments and sponsoring clubs in Puerto Rico from 1985-2014.

| Year | Tournaments | Clubs/Marinas |
|---|---|---|
| 1985* | 12 | 11 |
| 1986* | 13 | 13 |
| 1987* | 15 | 14 |
| 1988* | 18 | 15 |
| 2005** | 24 | 16 |
| 2013*** | 11 | 19 |
| 2014**** | 16 | ? |

(Sources: * Berrios et al. (1989); **Griffith et al. (2007); ***La Regata Newspaper year 16 #5; ****Asociación de Pesca Deportiva de Puerto Rico- Calendario 2014).

Fishing tournaments are important activities, usually focusing sport fishermen efforts on a particular species (Table 3.5.14). In Puerto Rico, annual fishing tournaments for large pelagic species bring in anglers from the U.S. mainland and provide seasonal employment and incomes

to local residents. The recreational fisher who lands the largest catch, often the greatest weight of the targeted species, receives a prize, with a portion or all of the net proceeds provided to a worthy cause. In a study of 124 fishing tournaments between 1999 and 2002, Rodriguez-Ferrer et al. (2005) found blue marlin the most targeted tournament species in Puerto Rico, with dolphin fish the second most targeted species and wahoo the third most targeted species. However, dolphin fish was the most boarded (i.e., weighed and landed) species of these tournaments. Blue marlin and other billfish are typically tagged and released rather than harvested. Even in tournaments with a focus on billfish, dolphin fish, wahoo, tunas, and great barracuda remained among the most commonly boarded species. However, it is typical in these tournaments for information on non-target species to be incomplete or missed altogether because these species are often filleted and gutted before weighing of tournament targeted species is complete and port samplers have a chance to sample these non-target species (Rodriguez-Ferrer et al. 2005).

Dolphin fish, a migratory pelagic species, is of value to commercial and recreational fishermen alike. A study comparing commercial landings of dolphin fish with recreational fishing tournament landings of dolphin fish found a significant difference in the size of fish landed, with commercial fishermen landing the most overall weight and tournament fishermen landing the largest dolphin fish (Rodriguez-Ferrer et al. 2006). Research determined that bigger dolphin fish, and a greater total biomass of dolphin fish, are off the south coast of Puerto Rico (Rodriguez-Ferrer et al. 2006). Competition for dolphin fish on the south coast and in the La Parguera area has resulted in conflict between commercial and recreational fishermen (Valdés-Pizzini and Schärer Umpierre 2014).

Marinas, nautical clubs, and sport fishing tournaments are important to recreational fishermen and recreational fishing. Marinas provide a location to convene fishermen and dock, launch and land recreational vessels. Nautical clubs bring recreational fishermen together and sponsor sport fishing tournaments. There are at least 15 recreational fishing and boating clubs around the island that sponsor tournaments, which are important to the recreational fishing community, economically.

#### 3.5.3.6 For-Hire/Charter Fishing

Puerto Rico's charter fishing industry is unevenly spread over the island, with the San Juan area, the Northeast, and the West/Southwest regions supporting the most charter boats, while in other areas, an occasional commercial fisherman may enter the industry seasonally or on a temporary basis (Griffith et al. 2007; M. Hanke, charter operator, pers. comm. 2018).

Anglers aboard private and rented vessels target multiple species, but those in federal waters tend to focus on large migratory species. Recreational fishing aboard for-hire fishing businesses tends to be focused on catching large migratory and coastal pelagic species (CFMC 2011a, b; IAI 2007); however, this depends also on the coast and seasonality of species desired (M. Hanke,

charter operator, pers. comm. 2018). The seasonality for most species depends on the presence of specific bait in the area, which gather and organize the activity (M. Hanke, charter operator, pers. comm. 2018). The availability of some species also depends on the substrate/habitat fished. For example, in state waters off the Fajardo area in northeastern Puerto Rico, charter trips targeting tarpon, snook, bonefish, jacks, barrcudas, king mackerels, and other species, concentrate in river mouths, seagrass, sandy, and mud habitats, as well as in reefs and sponge-dominated hard bottoms. In federal waters off Puerto Rico, tunas, marlins, dorado (dolphin fish) and wahoo are typically harvested outside the insular platform, in waters over 1000 ft (305 m) deep (M. Hanke, charter operator, pers. comm. 2018). Table 3.5.15 below shows examples of species harvested by for-hire vessels. These are listed by area where they are usually fished (inshore, offshore) and also provides information on seasonality.

**Table 3.5.15.** Example of species sought by fishermen contracting charter vessels when fishing inshore (all state waters) and offshore (approximately 50% federal and 50% state waters), and seasonality of these species by coast (where information is available).

| Species | Area | Seasonality |
|---|---|---|
| ***Inshore*** | Northeast Coast – State Waters | Most available all year, demand driven by tourism |
| Tarpon | | |
| Snook | | |
| King mackerel | | |
| jacks | | |
| Bonefish | | |
| Reef Fish (Snappers and Groupers) | | |
| Other species | | |
| ***Offshore*** | Northeast Coast (Atlantic Ocean) - 50% federal waters, 50% state waters | |
| Tunas<br>- Blackfin tuna | | All year |
| Dorado (Dolphin) | | November - March |
| Wahoo | | June - December |
| Billfishes | | |
| - Sailfish<br>- White marlin | | October – December |
| - Blue marlin | | July - December |
| Rainbow runner | | |
| King mackerel | | April and May |
| Groupers<br>- Yellowfin | | March - May |
| Snappers | | |
| Swordfish | | |
| | | |

| | | |
|---|---|---|
| Wahoo | Southeast Coast (Caribbean Sea) | September - December |
| Dorado (dolphin fish) | | March - July |
| White Marlin | | April and May |

(Source: M. Hanke, charter operator, pers. comm. 2018).

The number of for-hire operators (Charter operators) in Puerto Rico in 2018 is approximately 47. For-hire fishing vessels in the U.S. Caribbean operate within the broader scenic and sightseeing water transportation industry. This industry also includes dinner cruises, sightseeing cruises, whale watching, and other recreational boat trips. According to 2010 County Business Patterns data (U.S. Census Bureau County Business Patterns, 2013), there were nine businesses with 100 to 249 employees in the industry in Puerto Rico. It is most likely that many of these businesses were not operating in the charter fishing or party boat fishing industry. However, for purposes here, all are presumed to be full or part-time participants in the for-hire fishing industry.

The clientele that contracts for-hire vessels varies and depends on the coastal area. For example, in the north/northeast coast of Puerto Rico, approximately 70% of the clients are non-local tourists from mid-high economic levels, and less local clients. In the west and south coasts, the clientele is composed more of locals and tourists (M. Hanke, charter operator, pers. comm. 2018).

#### 3.5.3.7 Licenses, Permits, and Fees

*Puerto Rico Federal Waters*

There are no federal licenses or permits required for the recreational harvest of any species managed by the Council in the Puerto Rico EEZ. However, there are specific requirements for for-hire vessels and HMS fishermen operating in state and/or federal waters.

Since 2010, all anglers fishing recreationally in the U.S. Caribbean including Puerto Rico are required to register through the national registry (https://www.countmyfish.noaa.gov/register/). Tables 3.5.16 and 3.5.17 show the number of anglers resident or non-resident who purchased registrations through the National Anglers Registry, respectively, in years 2012 through January 2018. "Anglers" in the tables below refer to anglers with an address in that state (Table 3.5.16) or anglers which have marked that state as an intended fishing location on the registration regardless of where the angler acutally resides (Table 3.5.17).

**Table 3.5.16.** Number of anglers fishing recreationally in Puerto Rico that are residents from 2012 through January 2018.

| Year | Puerto Rico |
|---|---|
| 2018 | 0 |

| Year | Puerto Rico |
|---|---|
| 2017 | 19 |
| 2016 | 29 |
| 2015 | 30 |
| 2014 | 74 |
| 2013 | 207 |
| 2012 | 237 |

(Source: NMFS Office of Science and Technology [February 2018])

**Table 3.5.17.** Number of anglers who intended to fish in Puerto Rico (registered).

| Year | Puerto Rico |
|---|---|
| 2018 | 4 |
| 2017 | 95 |
| 2016 | 116 |
| 2015 | 158 |
| 2014 | 257 |
| 2013 | 484 |
| 2012 | 672 |

(Source: NMFS Office of Science and Technology [February 2018])

In addition, there are recreational permit requirements for the harvest of highly migratory species (HMS) in the U.S. Caribbean EEZ including Puerto Rico. In 2017, there were 405 HMS Angling permit holders in Puerto Rico. For more information on the HMS permit requirements please visit http://www.nmfs.noaa.gov/sfa/hms/Compliance_Guide/index.htm

*Puerto Rico Territorial Waters*

Although Puerto Rico fishing regulations state that a license for all recreational fishermen 13 years and older (excluding fishermen on charter or head boats) is required, this requirement is not currently enforced.

Most for-hire vessels opearating in both state and federal waters are required to obtain a U.S. Coast Guard Operator of Uninspected Passenger Vessels (OUPV/Six-pack Captain's License) (as a minimum), insurance, the DNER charter fishing license, a permit from the Puerto Rico Tourism Company, and the HMS permit, if targeting those species.

### 3.5.4 Subsistence Fishing

Some recreational fishermen fish only for subsistence, which is primarily fishing to provide food for household consumption (Griffith et al. 2007). Subsistence fishing remains an important aspect of fishing in Puerto Rico, but is not fully understood with respect to participation, catch, or disposition of that catch. During stressful times and high levels of unemployment, subsistence fishing becomes an important activity to provide high quality protein to households.

Griffith et al. (2007) discuss that the subsistence fishery is made up mostly of people from working class backgrounds whose gear use is very similar to recreational gears. Subsistence fishing gear is primarily hook and line, including handline and cane pole, with few people using SCUBA gear, and the fishermen most commonly target snappers, groupers, dolphin fish, and king mackerel (Griffith et al. 2007). Subsistence fishermen appear to rarely target shellfish (Griffith et al. 2007).

Lack of selectivity, coupled with large landings, indicates intermixing between recreational and subsistence fishermen, making it difficult to differentiate the two (Schmied and Burgess 1987).

### 3.5.5 Foreign Fishing

Under Section 201(d) of the Magnuson-Stevens Act, fishing by foreign nations is limited to that portion of the OY that cannot or will not be harvested by vessels of the United States. See also 50 CFR 600.310(e)(3)(v). There is enough capacity within the U.S. EEZ off Puerto Rico to harvest and process the available optimum yield. Therefore, all management measures apply to the domestic fishermen and no portion of the optimum yield is allocated by the Council to a foreign fleet.

### 3.5.6 Illegal, Unreported, and Unregulated Fishing

Foreign fishing in the EEZ waters surrounding Puerto Rico is allowed as long as fishing vessels meet numerous requirements established in Section 201 of the Magnuson-Stevens Act, 16 U.S.C. 1821. For example, a foreign fishing vessel could legally be fishing in the EEZ if it has on board a valid permit issued under a governing international fishery agreement. However, there could be illegal, unreported, and unregulated (IUU) fishing taking place in the U.S. Caribbean EEZ waters off Puerto Rico. The IUU fishing is a global problem that threatens ocean ecosystems and sustainable fisheries. The IUU products often come from fisheries lacking the strong and effective conservation and management measures to which U.S. fishermen are subject. The IUU fishing most often violates conservation and management measures, such as quotas or bycatch limits, established under international agreements. By adversely impacting fisheries, marine ecosystems, food security and coastal communities around the world, IUU fishing undermines

domestic and international conservation and management efforts. Furthermore, IUU fishing risks the sustainability of a multi-billion-dollar U.S. industry.

### 3.5.7 Tribal Fishing Rights

The Magnuson-Stevens Act requires that FMPs contain a description of the nature and extent of Indian treaty fishing rights (16 U.S.C. 1853 (a)(2)). Historically, the United States has not negotiated any treaties over fishing rights with Native Tribes in the U.S. Caribbean, including in federal waters off Puerto Rico.

### 3.5.8 Economic Characteristics of the Puerto Rico Fisheries

#### 3.5.8.1. Introduction

Puerto Rico has the lowest per capita fish and shellfish consumption in the world. From 2011 through 2013, the island's per capita consumption of fish and shellfish was 0.8 lbs live weight per person, while it was 47.2 lbs per person in the U.S. and 13.0 lbs in the U.S. Virgin Islands (NOAA NMFS 2016). That consumption rate is indicative of the relative (un)importance that commercial fishing has to Puerto Rico's economy as a whole as measured by Gross Domestic Product (GDP) or Gross National Product (GNP).[41]

#### 3.5.8.2 Commercial Sector

Fish and shellfish commercially harvested in Puerto Rico represent just a fraction of what is produced and sold in markets annually on the island. From 2002 through 2004, for example, the wholesale value of annual finfish and shellfish landings represented approximately 0.01% of the island's Gross Domestic Product (GDP) each year. More recently, the $6.13 million in ex-vessel revenue in 2015 represented approximately 0.01% of the island's GDP that year (Table 3.5.18). That contrasts with 2015 landings in the U.S. that had a market value of $5.2 billion and accounted for 0.028% of the nation's GDP, and the $3.87 million in ex-vessel revenue from landings in the USVI that represented 0.10% of the territory's GDP in 2015. If Gross National Product (GNP) is used instead of GDP, the ex-vessel value of Puerto Rico's 2015 landings account for 0.01% of FY2015 GNP, which was $69.570 billion (Government Development Bank (GDB 2017)).[42]

[41] Goods and services produced by individuals for their own or families' consumption, such as preparing meals and care of dependents, are not included in GDP or GNP. Examples of such goods and services relevant to fisheries are the landings of finfish and shellfish harvested by Puerto Rico's commercial and recreational fishers that are taken to their homes and the meals prepared from those landings for their own and families' consumption. These goods and services, although personally and socially valuable, are not included because they are not sold.

[42] The Puerto Rico Planning Board provides GNP by fiscal year, which is from July 1 through June 30 each year. It does not publish quarterly GNP data, so GNP for calendar year 2015 is not available.

**Table 3.5.18.** Landings, ex-vessel revenue, GDP and percentage of GDP from ex-vessel revenue for Puerto Rico, U.S. and US Virgin Islands, 2015.

| Region | Landings (lbs) | Ex-Vessel Revenue (2015 $) | GDP (2015 $) | Ex-Vessel Revenue Percentage of |
|---|---|---|---|---|
| **P.R.** | 2,880,909* | $6,130,400* | $103,100,000,000 | 0.01% |
| **U.S.** | 9,717,627,000 | $5,203,004,000 | $18,624,500,000,000 | 0.03% |
| **U.S.V.I.** | 642,807 | $3,873,344 | $3,765,000,000 | 0.10% |

*: These figures have not been updated and are used strictly for comparative purposes here.
(Source: Fisheries of the United States (FEUS) 2015 for landings and ex-vessel revenue and Bureau of Economic Analysis (BEA) for 2015 GDP.)

Commercial landings generate retail sales for local restaurants and seafood markets. In 2015, U.S. commercial landings generated $144 billion in sales impacts that represented 0.77% of U.S. GDP. Combined annual wholesale and retail sales in Puerto Rico in 2015 represented approximately 0.02% of Puerto Rico's GDP that year and in the U.S. Virgin Islands, the combined sales represented 0.58% of the USVI's GDP that year (Table 3.5.19).[43]

**Table 3.5.19.** Wholesale and retail sales from landings of all commercially caught species, GDP and percentage of GDP, 2015.

| Area | Ex-Vessel Revenue | Estimates of Sales Impacts | GDP (2015 $) | Sales Impacts as Percentage of |
|---|---|---|---|---|
| **P.R.** | $6,130,400 | $24,389,289 | $103,100,000,000 | 0.02% |
| **U.S.** | $5,203,004,000 | $144,000,000,000 | $18,624,500,000,000 | 0.77% |
| **USVI** | $3,873,344 | $21,676,735 | $3,765,000,000 | 0.58% |

(Source: FEUS 2015 for U.S. sales impacts, Abt et al. 2016 for estimate of multiplier to estimate sales impacts in Puerto Rico, Kirkley et al. 2008 for estimate of multipliers to estimate USVI sales impacts)

The above landings and ex-vessel revenues were produced by the island's licensed commercial fishermen. There were 1,074 in 2015[44]; however, not all are expected to have been active in 2015 or any other particular year. Active fishermen differ by their household's dependence on fishing income and if they fish full- or part-time. In 2008, for example, 74% of 868 interviewed fishermen stated they fished full-time and 61% derived 75% to 100% of their household income from fishing (Matos-Caraballo and Agar 2011).

Commercial fishermen are workers in the broader occupational category of farming, fishing and forestry; and in 2015, 2,080 (0.23%) of the island's estimated 890,760 employed workers were in farming, fishing and forestry occupations (PR Department of Labor and Human Resources

[43] Sales impacts are not the only economic impacts produced by these landings. There are also income, total value added, and jobs.
[44] http://www.elnuevodia.com, May 16, 2016.

(DLHR), Bureau of Labor Statistics 2017). In May 2016, there were 1,750 in those occupations, which was a decrease of 330 workers from the year before (BLS 2016). DLHR expects a decline in employment in farming, fishing and forestry occupations from 2014 to 2024 (DLHR, Bureau of Labor Statistics 2017). Despite the expected loss of workers in farming, fishing and forestry occupations, however, DLHR expects an increase in employment in the agriculture, forestry, fishing and hunting industry.[45]

The median annual wage and median hourly wage of farming, fishing, and forestry occupations in Puerto Rico in 2015 were $18,550 and $8.92, respectively (PR DLHR, Bureau of Labor Statistics 2017). That same year, the median annual wage and median hourly wage for those same occupations were higher in the USVI and U.S. (Table 3.5.20).

**Table 3.5.20.** Median annual and hourly wage for farming, fishing and forestry occupations in Puerto Rico, U.S. and U.S. Virgin Islands, 2015.

| Area | Median Hourly Wage Farming, Fishing & Forestry | Median Annual Wage Farming, Fishing & Forestry | Median Hourly Wage All Occupations |
|---|---|---|---|
| **P.R.** | $8.92 | $18,550 | $9.61 |
| **U.S.** | $10.46 | $21,760 | $13.55 |
| **USVI** | $10.89 | $22,650 | $13.34 |

(Sources: Puerto Rico DLHR Bureau of Labor Statistics 2017, U.S. DOL Occupational Employment Statistics, and U.S. Virgin Islands DOL 2017)

Workers in farming, fishing and forestry occupations tend to be the working poor. In 2001, for example, the poverty rate for workers in those occupations was the highest poverty rate (14.3%) among all occupational groups in the U.S. (BLS 2013). Unemployment also tends to run high in these occupations. For example, in 2015, the average annual unemployment rate for farming, fishing and forestry occupations was 11.0% as opposed to 5.3% for all occupations in the U.S. (St. Louis Federal Reserve Bank).

Many of Puerto Rico's commercial fishermen act as seafood dealers and retailers from their homes to generate additional income. In 2008, 35.9% of interviewed fishermen stated that they sold their catch themselves (home-based retail) and they used multiple strategies to do so: delivering fish orders to homes of their regular clients, packing their catches in iced boxes and hauling them to locations where the catches are put up for sale, and selling directly from their homes (Matos-Caraballo and Agar 2011). Another 5.8% of the fishermen had their own fish

[45] Senior managers, botanists, entomologists, fisheries biologists, soil scientists, and other comparably skilled specialists employed by farming, fishing and forestry operations are not considered to be in farming, fishing or forestry occupations.

stores. Among the others, 32.8% stated they sold their catches to wholesale/fish stores, 5.9% to restaurants, and 27.9% to fishing associations.

Puerto Rico's active licensed fishermen are self-employed and their numbers do not show up in national surveys of employer establishments in the agriculture, forestry, fishing and hunting industrial sector. For example, County Business Patterns data for 2015 indicates there were 14 employer establishments in the agriculture, forestry, fishing and hunting industrial sector (NAICS 11) and they collectively employed 172 people as of March that year. That was down from 16 employer establishments in 2014, but up from 8 in 2013 (Census Bureau, County Business Patterns). The much larger numbers of active self-employed fishermen are missing from those figures.

The fishermen who act as wholesalers and retailers when selling their catches are also missing in national surveys. The Census Bureau conducts the Economic Census every 5 years, for years ending in "2" and "7." The most recently available Economic Census for Puerto Rico is for 2012, and according to it, there were 5 employer establishments in the fish & seafood merchant wholesalers industry (NAICS 42446) and 7 in the fish & seafood markets industry (NAICS 44522) that year (Table 3.5.21). The Economic Census does not count the self-employed who set up home-based wholesale and retail businesses to sell their catch. The figures also do not include Puerto Rico's 42 fishing associations that have operated as fish & seafood markets. Note that the employer establishments in the fish & seafood merchant wholesalers industry (NAICS 42446) that are counted declined by 50% from 2007 to 2012.

**Table 3.5.21.** Number of employer establishments and employees in Puerto Rico, 2007 and 2012.

| NAICS | Industry | Establishments | | Employees | |
|---|---|---|---|---|---|
| | | 2007 | 2012 | 2007 | 2012 |
| **3117** | Seafood product preparation & packaging | 1 | 2 | | 100 - 240 |
| **42446** | Fish & seafood merchant wholesalers | 10 | 5 | 150 | 110 |
| **44522** | Fish & seafood markets | 7 | 7 | 28 | 0 - 19 |

(Source: Census 2007 and 2012 Economic Census)

In 2007, there was one employer establishment in the seafood product preparation and packaging industry (NAICS 3117), and in 2012 there were two (Table 3.9.4). These establishments are part of the broader food manufacturing industry (NAICS 311). One of the two manufacturers is the Best Seasonings Group (dba Sofrito Montero) in Juana Diaz, which in addition to making sauces produces a crabmeat stew. According to ESNoticiapr.com, the company creates 20 direct jobs.

Emigration of Puerto Ricans to the mainland has benefited Best Seasonings and other island-based food manufacturers as supermarkets on the mainland have expanded stocking items that are popular to increasing numbers of Puerto Rican customers, such as Best Seasonings sauces (ESNoticiapr.com 2018).

Wild harvest is not the only source of finfish and shellfish in Puerto Rico. Aquaculture production has reached as high as 462 metric tons (Figure 3.5.5). However, it dropped from 457 metric tons in 2004 to 20 metric tons in 2011 and has stayed there since.

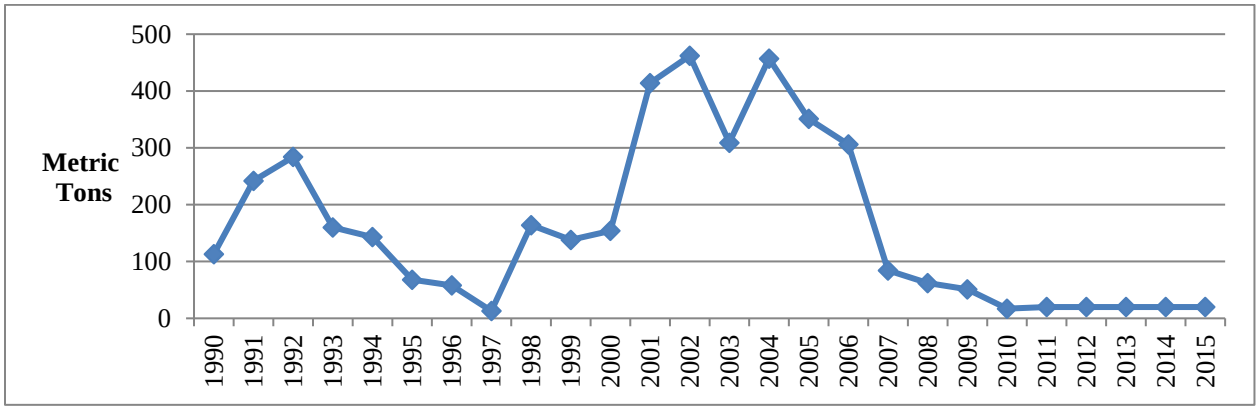



**Figure 3.5.5.** Aquaculture production in Puerto Rico, 1990 – 2015.
(Source: World Bank)

**Table 3.5.22.** Number of aquaculture farms, sales, and pounds, 2007 and 2012.

| Aquaculture Operations | Farms | | Sales | | Pounds | |
|---|---|---|---|---|---|---|
| | 2007 | 2012 | 2007 | 2012 | 2007 | 2012 |
| **Total aquaculture** | 40 | 51 | $832,725 | $687,976 | | |
| **With in-ground fish ponds** | NA | 48 | | | | |
| **With above-ground fish tanks** | NA | 37 | | | | |
| **Tilapia** | 21 | 37 | $63,406 | $40,241 | 63,406 | 40,241 |
| **Shrimp (prawns freshwater)** | 20 | 4 | $45,264 | Withheld | 45,264 | Withheld |
| **Other food fish** | NA | 30 | NA | $70,160 | | |
| **Ornamental fish** | 7 | 6 | $256,800 | Withheld | | |
| **Other aquaculture** | NA | 29 | NA | $194,770 | | |

(Source: USDA Census of Agriculture 2012).

Despite the dramatic decline in aquaculture production, the number of aquaculture farms increased from 40 in 2007 to 51 in 2012 (Table 3.5.22). Nonetheless, combined sales declined by 17.4% during that same time (Department of Agriculture Census of Agriculture 2012). The

number of shrimp/prawn farms declined by 80% in those five years. According to New and Kutty (New et al. 2010), the decline of shrimp/prawn farms in Puerto Rico is largely due to poor post-harvest quality and other factors. Because of this poor quality, local restaurants avoided buying the product and instead, prawn farmers were keeping harvested prawns for their own consumption, gifting them to neighbors or possibly selling to neighbors at a discount.
There are multiple barriers to successful commercial aquaculture on the island, such as high costs of land and water; lack of steady supplies of post larval prawns, juvenile tilapia, and other young fish/shellfish; and the higher production costs relative to marine shrimp, mainland tilapia, and other finfish/shellfish farming beyond the island (New and Kutty in New et al. 2010). Furthermore, the more recent regularly occurring electrical blackouts have also discouraged aquaculture on the island.

Puerto Rican businesses involved in international trade of fresh/frozen/chilled finfish and shellfish (NAICS 1141) are net importers, not exporters. From 2008 through 2016, for every dollar of product exported by these businesses another $32.17 to $317.38 of product was imported (Table 3.5.23). This does not include shipments to and from the U.S or re-exports.[46]

**Table 3.5.23.** Value of imports and exports in fresh/frozen/chilled finfish and shellfish (NAICS 1141) industry, 2008 – 2016.

| Year | Imports Value | Exports Value | Ratio Imports to Exports |
|---|---|---|---|
| **2008** | $36,361,279 | $558,707 | 65.08 |
| **2009** | $44,052,711 | $138,801 | 317.38 |
| **2010** | $42,703,879 | $466,430 | 91.55 |
| **2011** | $51,721,557 | $779,803 | 66.33 |
| **2012** | $51,053,171 | $536,713 | 95.12 |
| **2013** | $37,253,583 | $683,317 | 54.52 |
| **2014** | $44,528,053 | $1,383,972 | 32.17 |
| **2015** | $48,722,140 | $405,373 | 120.19 |
| **2016** | $43,556,633 | $1,029,175 | 42.32 |

(Source: Census Bureau, U.S. International Trade Data)

Fisheries products imported into the country through the Port of San Juan far outweigh those products exported through that port as shown in Figure 3.5.6. Tunas (yellowfin whole frozen, albacore frozen, etc.) were the most popular imports through the Port of San Juan until 2012.

[46] Re-exports of fisheries products are commodities that have entered the country through the Port of San Juan as imports and are not sold, and at the time of re-export are in essentially the same condition as when imported into the country. Re-exports are substantially less than exports.

Tuna products accounted for the largest share of imports entering through the Port of San Juan by weight and dollars when tuna canneries were operating on the island, but tuna products declined sharply when the last tuna cannery on the island closed in June 2012 (Figure 3.5.7).

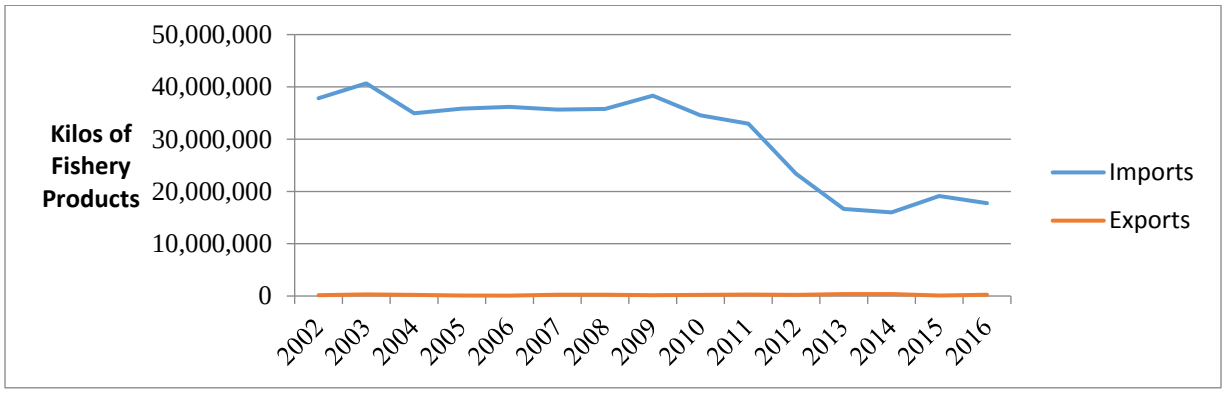



**Figure 3.5.6.** Kilos of fishery products imported and exported through the Port of San Juan, 2002- 2016.
(Source: NMFS Office of Science & Technology, Commercial Fisheries Statistics)

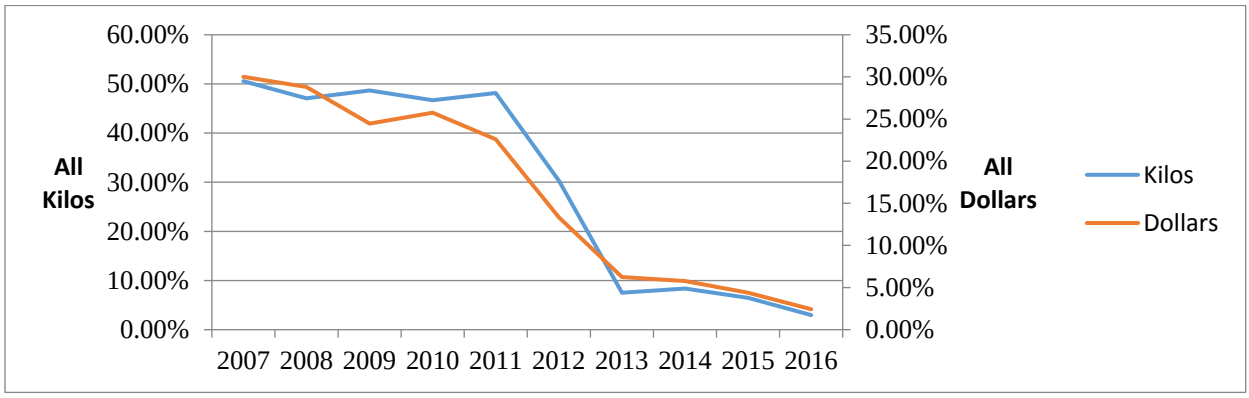



**Figure 3.5.7.** Tuna's percentage of all imported fishery products, by weight and dollars, 2002-2016.
(Source: NMFS Office of Science & Technology, Commercial Fisheries Statistics)

In the 1970s, the five tuna canneries in Puerto Rico accounted for more than half of U.S. tuna processing. However, when the main source of tuna shifted to the western Pacific in the 1980s, Puerto Rico no longer had a competitive advantage. From 1982 to 1992, an estimated 10,000 jobs were lost (Smith 2012). In 1990, Van Camp, which canned Chicken of the Sea tuna, closed its plant in Ponce, and Japanese conglomerate Mitsui closed its Neptune cannery in Mayagüez. Combined, the two closings put 2,000 people out of work in 1990. That same year, Bumble Bee's plant in Mayagüez was downsized and with that was the additional loss of 800 jobs. The other two were Mitsubishi Food's Caribe Tuna in Ponce and H.J. Heinz's StarKist Foods in

Mayaguez (USITC 1990). The StarKist cannery was the largest tuna cannery in the world and at its peak it employed an estimated 11,000 workers working three shifts. Caribe Tuna closed in 1995 and StarKist followed in 2001. The last to go was Bumble Bee's downsized operation in 2012, which left about 260 people out of work.

In 2015, approximately $45.7 million of freshwater and saltwater finfish and shellfish products were shipped from the U.S. to Puerto Rico and approximately $0.8 million was shipped from Puerto Rico to the U.S. (Census Economic Indicators Division 2016). For every dollar of finfish and shellfish products shipped to the U.S. approximately $59 of products were shipped from the U.S. to Puerto Rico in 2015. Puerto Rico was a net buyer of seafood products both internationally and domestically.

#### 3.5.8.3 Recreational Sector

Over the 15-year period from 2001 through 2015, there has been a general decline in the number of saltwater anglers in Puerto Rico. During the three 5-year periods (2001-2005, 2006-2010, and 2011-2015), there were continuous declines in the average annual numbers of resident and non-resident anglers (Table 3.5.24). These non-resident anglers are tourists.

**Table 3.5.24.** Average annual numbers of resident and non-resident saltwater anglers in Puerto Rico, 2001 – 2015.

| 5-Year Period | Average Annual Number of Saltwater Anglers | | |
|---|---|---|---|
| | Residents | Non-Residents | Total |
| **2001-2005** | 165,051 | 32,071 | 197,122 |
| **2006-2010** | 137,633 | 19,138 | 156,771 |
| **2011-2015** | 110,125 | 10,320 | 120,445 |

(Source: MRIP, Jan 2018 (http://www.st.nmfs.noaa.gov/recreational-fisheries/access-data/run-a-data-query/index)).

There have been simultaneous decreases in the numbers of saltwater angler trips (Table 3.5.25). Furthermore, the average annual number of trips per angler fell from six (2001-2005) to five (2006-2010) and then to four (2011-2015). Along with the decline in the average annual numbers of anglers and trips, there was a decrease in the average annual number of fish harvested per angler from 6 to 5 (Table 3.5.26). The average number of fish harvested per trip, however, stayed at one.

**Table 3.5.25.** Average annual numbers of angler trips by mode in Puerto Rico, 2001 – 2015.

| 5-Year Period | Average Annual Number of Saltwater Angler Trips |
|---|---|

| | Charter | Private/Rental | Shore | Total |
|---|---|---|---|---|
| **2001-2005** | 21,391 | 463,663 | 663,232 | 1,148,286 |
| **2006-2010** | 9,380 | 369,659 | 422,181 | 801,221 |
| **2011-2015** | 3,847* | 235,934 | 258,483 | 497,495 |

*: Number of trips for charter vessels in 2014 is not available. Average is of the other four years.
(Source: MRIP, Jan 2018 (http://www.st.nmfs.noaa.gov/recreational-fisheries/access-data/run-a-data-query/index)

**Table 3.5.26.** Average annual number of marine fish harvested and released and average number of fish harvested per angler and per trip, 2001 – 2015.

| 5-Year Period | Average Annual Number of Fish | | Average Number of Fish Harvested | |
|---|---|---|---|---|
| | Harvested | Released | Per Angler | Per Trip |
| **2001-2005** | 1,287,592 | 224,453 | 6 | 1 |
| **2006-2010** | 825,999 | 170,895 | 5 | 1 |
| **2011-2015** | 627,878 | 145,623 | 5 | 1 |

(Source: MRIP, Jan 2018 (http://www.st.nmfs.noaa.gov/recreational-fisheries/access-data/run-a-data-query/index)

Recreational saltwater fishing trips have associated expenses. These trip-related expenses can include bait, ice, charter fees, boat fuel, boat and equipment rentals, lodging, public and other vehicle transportation, access and parking, and food. There are also durable goods expenditures associated with recreational fishing, such as, but not limited to, rods and reels, tackle, boat purchases and maintenance, boat accessories, and clothing.

Recreational saltwater fishing on the island is an important economic activity and is estimated to generate $754.8 million annually in trip and durable good expenditures and $646.6 million of figure is from annual durable good purchases (Gentner Consulting Group 2010). Resident anglers are estimated to generate 79.2% of the $108.2 million in annual trip expenditures and non-resident anglers the remaining 20.8% of the total trip expenditures. Resident anglers' expenditures are driven by shore mode food expenditures while non-resident anglers' expenditures are driven by transportation expenditures.

These expenditures represent only part of the value of Puerto Rico's recreational fishing sector. Fish and shellfish harvested by saltwater anglers for their own or family's consumption are not included in traditional economic (market) valuation of the recreational sector, although those fish harvested may have substantial personal and social values, especially to the individuals and families that rely on recreationally caught fish and shellfish to feed themselves and their families throughout the year and especially at times of economic hardship. There is relaxation, camaraderie of being with family and friends, being out in nature, the thrill of adventure, and

other factors that cause one to value recreational fishing beyond the expenses. One method used to put a dollar value on those values is determining saltwater angler's willingness to pay in excess of expenses, and that extra amount (above expenses) is termed consumer surplus. Estimates of consumer surplus from recreational saltwater fishing in Puerto Rico have been made, specifically for billfish. Clark et al. (1999), for example, estimated consumer surplus of recreational billfish fishing of $545 per trip and an average annual consumer's surplus of $11,135; however, billfish are not among the species managed by the Council.

## 3.5.9 Social and Cultural Characteristics of the Puerto Rico Fisheries

The following description of the social environment is an overview of historical and recent fishing patterns and location of fishing infrastructure and fishermen in Puerto Rico. The description relies a great deal on work by Overbey (2016) and incorporates much of the information compiled in that report. It is important to note that this baseline description is prior to the devastating hurricanes of 2017. A section describing the impacts of hurricanes Maria and Irma on the island and its fisheries will follow the overall description of the social and cultural characteristics.

### 3.5.9.1 Historical Fishing in Puerto Rico

Inhabitants of Puerto Rico have relied on fishing and fishery resources for thousands of years. The Taino depended on the abundant fish and shellfish in the coastal waters of Puerto Rico to feed their population. Among other techniques, the Taino harvested fish with fishing weirs, a fixed trap fishing gear later adopted by the Spaniards (Griffith and Valdés-Pizzini 2002). Coastal and marine resources helped the Taino, the Carib, the Spanish, Europeans, Africans, and other settlers to survive and thrive.

Price (1966) traces the origins of modern Caribbean fishing to Island Arawaks (like the Taino) and Island Caribs to whom they taught their fishing skills. European colonizers marveled at the fishing prowess of the Island Arawaks and Island Caribs especially fishing with hand lines and hooks made from turtle carapace from dugout canoes (Price 1966). Island Caribs shared fishing skills and technology, including fish pots, spears, and corrals, and developed others with European settlers and enslaved Africans privileged to fish for their own food and that of the plantation manager. Possessing successful fishing skills enabled enslaved Africans to develop independence and confidence and easily transition to life as free fishermen, either before or after emancipation (Price 1966). This culture of fishing continued to develop across the Caribbean, where fishermen and fishing communities now exhibit characteristics like those observed by Price (1966) in Martinique: individualism and independence, pride, entrepreneurial values, and a family organization that sets them apart.

Today, fish and fishing remain central to Puerto Rico's culture. Puerto Rico's fisheries include small-scale commercial fishing, recreational fishing, and subsistence fishing. Commercial and recreational fishermen target similar species of fish and shellfish. These include reef fish, coastal and offshore pelagic fish, lobster, and conch, among others.

### 3.5.9.2 Fishing Communities

Several recent reports describing the fishing communities of Puerto Rico identify areas with critical fishing infrastructure and highlight their dependence upon fishing (Griffith et al. 2007; Valdés-Pizzini et al. 2010). Although it has been discussed that some islands might be considered fishing communities in their entirety, these distinct areas are where fishing might be more directly tied to a smaller political unit than the entire island of Puerto Rico (Griffith et al. 2007). Figure 3.5.8 displays the coastal municipalities with Census Designated Places (cities, towns, communities, etc.).

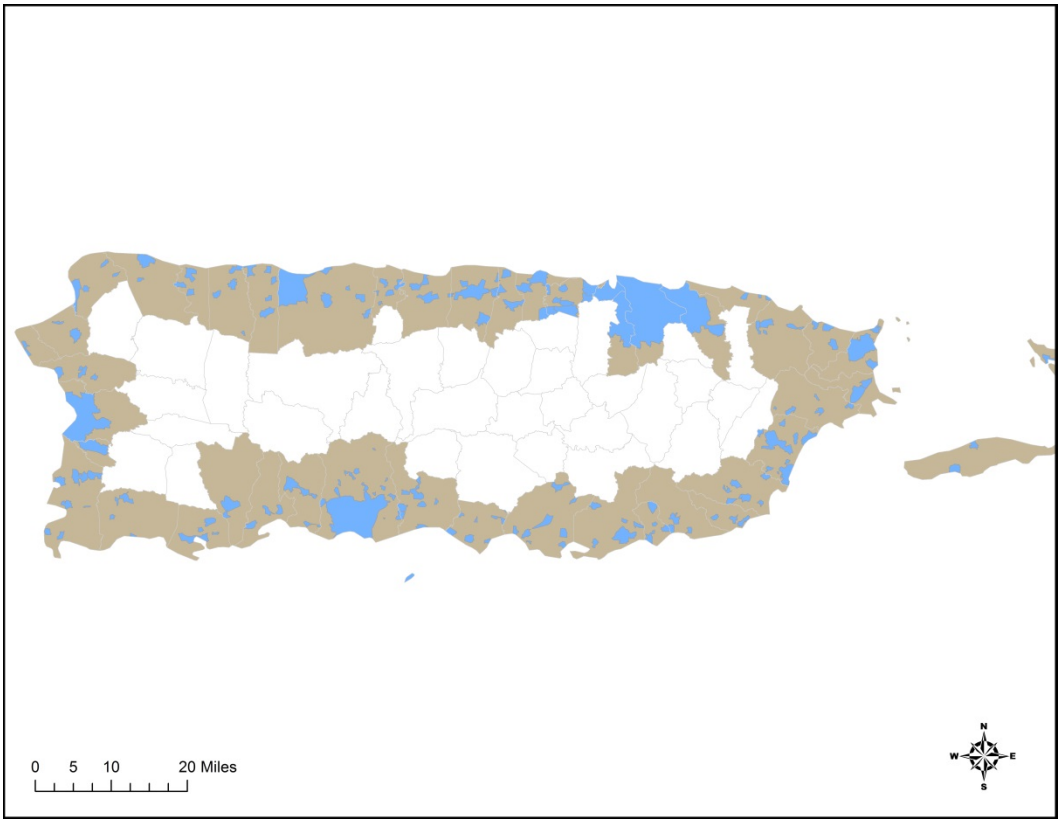



**Figure 3.5.8.** Puerto Rico coastal municipalities with census designated places.

Griffith et al. (2007) found that traditional coastal fishing communities where fishermen live and work were being altered by coastal development and gentrification. As a result, commercial fishermen and native residents are being displaced and dispersed to more inland locations in the

municipality. Fishermen have adapted to the change by trailering their vessels to launch and landing locations to access waters to fish (Griffith et al. 2007). Our description here will focus on those coastal municipalities where we find both fishermen and the supporting infrastructure. Matos-Caballero and Agar (2011b) found active commercial fishermen residing within 39 coastal municipalities. These municipalities are where fishermen both live and work, with about 92% of fishermen landing their catch in the same municipality in which they reside.

Those municipalities with the most fishermen are presented in Figure 3.5.9. On the west coast, most fishermen resided in Cabo Rojo, Rincón, Mayagüez, and Aguadilla (Matos-Caballero and Agar 2011b). On the south coast, most fishermen resided in Lajas, Salinas, Guánica, and Ponce (Matos-Caraballo and Agar 2011b). On the east coast, most fishermen resided in Vieques, Fajardo, and Naguabo (Matos-Caraballo and Agar 2011b). On the north coast, most fishermen resided in San Juan and Arecibo (Matos-Caraballo and Agar 2011b).

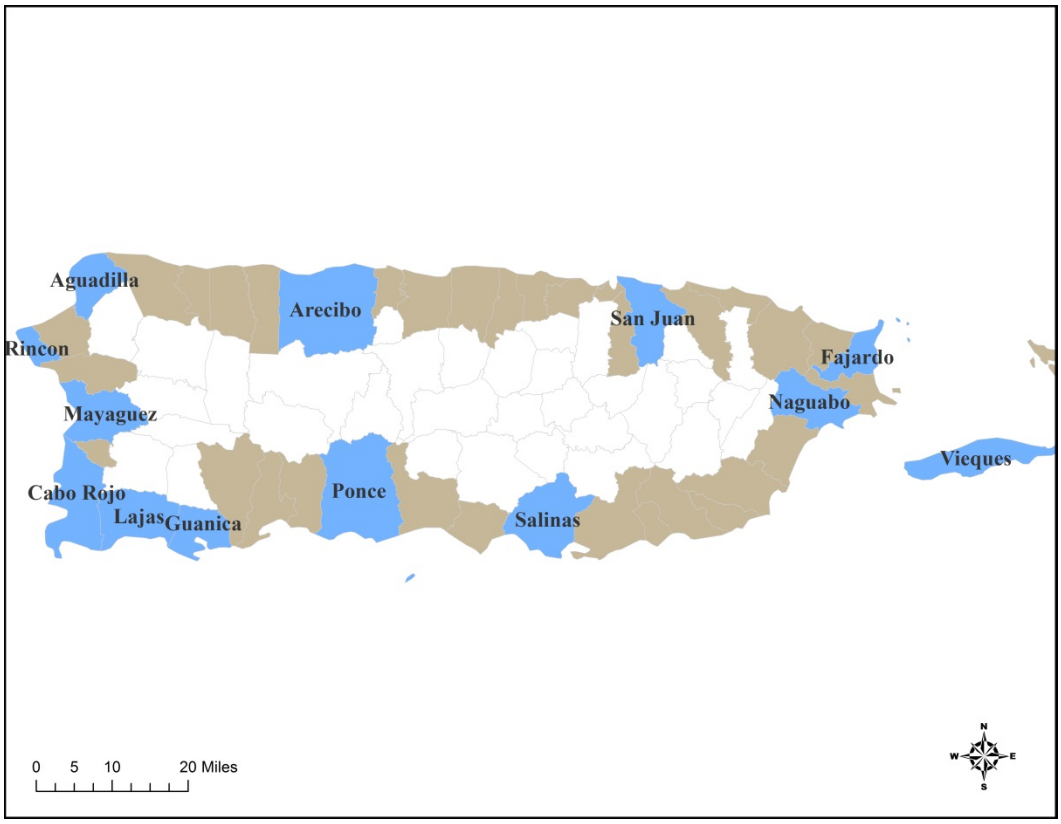



**Figure 3.5.9**. Puerto Rico coastal municipalities with most fishing engagement. (Source: SERO Social Science Branch/US Census Bureau Tigerline Shapefiles 2018)

Griffith et al. (2007) identify communities highly dependent on fishing, that included La Parguera in Lajas, Puerto Real in Cabo Rojo, La Playa in Ponce, Punta Santiago in Humacao;

Pozuelo in Guayama, La Estrella in Rincón, and the Downtown Harbor neighborhoods of Fajardo (Maternillo, Mansión del Sapo, and Puerto Real).

A recent description of the La Parguera region of Southwest Puerto Rico takes a more ecological approach to the study of the social and natural environment (Valdés-Pizzini and Schärer-Umpierre 2014). In their report, Valdés-Pizzini and Schärer Umpierre (2014) use a Drivers-Pressure-State-Impacts-Responses approach to explore the relationships between the ecosystem and the many human factors that shape the process; that description includes fishermen and their relationship to the marine environment. As discussed earlier in Section 3.2.5, they point to numerous outside pressures, in addition to the fishing pressure, that have had important impacts upon the fishermen in that area.

Villas Pesqueras

*Villas pesqueras* (translated in English as fishing centers) are a unique and significant feature of commercial fishing in Puerto Rico. Established by the government of Puerto Rico, *villas pesqueras* function like a cooperative, a place for commercial fishermen to work, meet, and unite and for government to monitor and manage the fisheries (Griffith and Valdés-Pizzini 2002). Some *villas pesqueras* also have a restaurant or cafeteria or fish market within the facilities where fishermen can sell their products (Figure 3.5.10). Of the 42 coastal municipalities in Puerto Rico, almost all have a *villa pesquera*, with some municipalities having more than one (Griffith et al. 2007) (Figure 3.5.11). Currently, there are more than 50 *villas pesqueras* in Puerto Rico (El Nuevo Día 2015; M. Lugo, NMFS Southeast Regional Office, pers. comm. 2014). The Puerto Rico government through its Department of Agriculture owns most of the villas (n=46) and for some of them has reached agreements with municipalities for them to rent to fishermen groups or to fishermen's associations[47]. Other *villas pesqueras* belong to fishermen's associations or are privately run. The Puerto Rico Agriculture Department also grants subsidies to the fishermen's associations, both for the acquisition of boats and for other fishing materials that they need, but for these, the associations have to be registered ("Villa Pesquera se transforma", March 28, 2015).

[47] Fishermen's association, organization, or group - Any bona fide entity that engages in commercial fishing operations and activities related to such fishing in Puerto Rico.

*Villas pesqueras* provide a pier for commercial fishermen to dock, launch, and land their vessels; lockers to store their equipment; and space to process and sell their catch (Griffith et al. 2007). In the 1960s, the government began building facilities in fishing communities and at landing sites across Puerto Rico to help develop the fisheries (Griffith et al. 2007; Griffith and Valdés-Pizzini 2002). The goal of *villas pesqueras* would be to gather and assist fishermen in advancing production and distribution of fishery resources, and to enable the government in collecting data on landings and managing the fisheries (Griffith and Valdés-Pizzini 2002).

**Figure 3.5.10.** *Villa Pesquera* in Cabo Rojo, Puerto Rico.

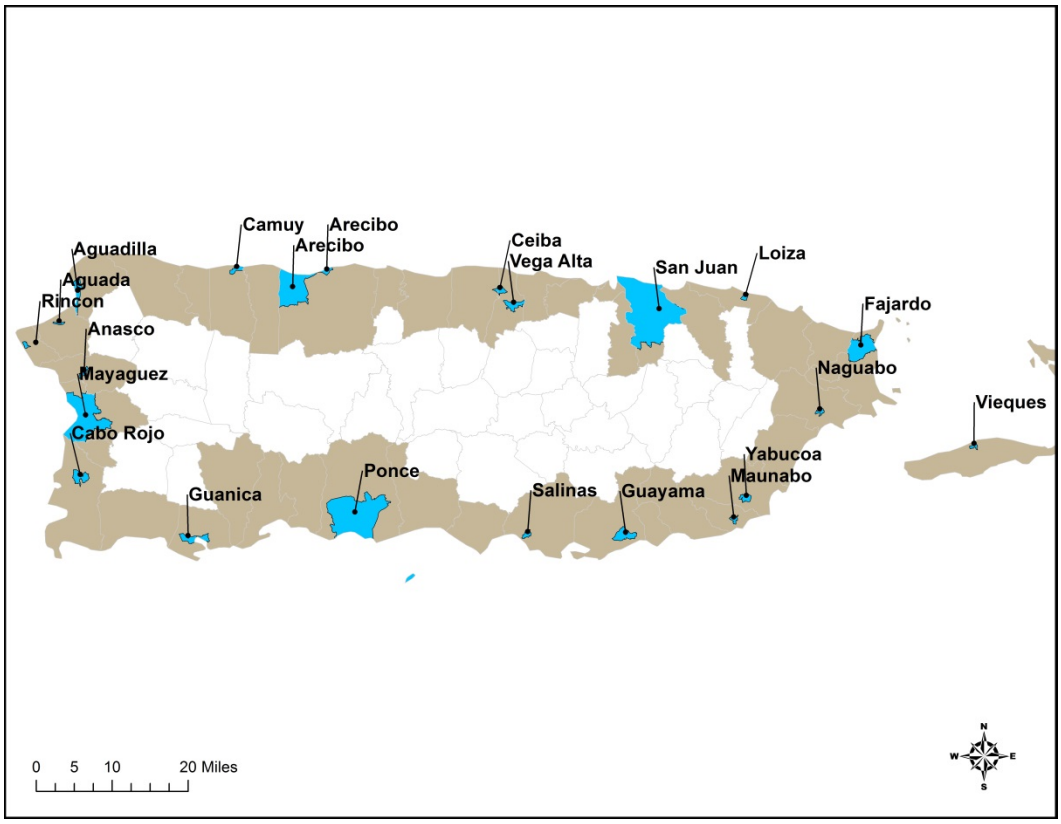



**Figure 3.5.11.** Puerto Rico coastal communities with villas pesqueras.
(Source: SERO Social Science Branch/US Census Bureau Tigerline Shapefiles 2018)

Although the nature, level of activity, and success of villas pesqueras vary across Puerto Rico, these associations have served to convene commercial fishermen, sometimes resulting in cohesion and political action. In 2008, 60% of fishermen reported belonging to a fishing association (Matos-Caraballo and Agar 2011c). While not all fishermen join a fishing association, villas pesqueras are politically and economically powerful in some communities (Griffith and Valdés-Pizzini 2002).

#### 3.5.9.3 Characteristics of Commercial Fishing

Commercial fishing in Puerto Rico is small-scale, with fishermen targeting multiple species and using multiple types of gear. Most catch is sold locally and there is little or no export of catch in Puerto Rico. Small-scale fisheries are most often organized around the families or households and use small vessels, taking short fishing trips (Overbey 2016).

Most commercial fishermen are middle-aged and have fished for most of their adult life. The average age of commercial fishermen was 50 years old with 29 years of fishing experience (Matos-Caraballo and Agar 2011a). The majority of commercial fishermen have a high school education or higher. Matos-Caraballo and Agar (2011a) found that 53% of fishermen had a high school or college degree, received professional training, or attended some college. Approximately 47% did not complete high school (Matos-Caraballo and Agar 2011a).

<u>Family Income</u>

Most small-scale fishing is family-based, with fishing involving the family household. In a survey of commercial fishermen Griffith et al. (2007) found that 40% to 45% of fishing families derive their whole income from fishing. Similarly, Matos-Caraballo and Agar (2011c) found that commercial fishermen derived more than 75% of their household income from fishing, with 84% reporting that income from fishing contributed to more than 50% of their household income. The fishermen's household of working spouses, children, and others contribute as well, suggesting that fishing and other coastal occupations subsidize one another.

Most commercial fishermen work full-time fishing and carry out fishing-related activities such as selling their catch, building, and repairing gear. In 2008, nearly 75% of fishermen reported working full-time, averaging over 40 hours a week in fishing and fishing related activities (Matos-Caraballo and Agar 2011c). This included spending over 30 hours a week catching fish, over 5 hours a week maintaining and repairing vessels, and over 5 hours a week maintaining and repairing gear (Matos-Caraballo and Agar 2011c). In addition, fishermen reported spending more than 4 hours a week selling their catch (Matos-Caraballo and Agar 2011c).

Part-time commercial fishermen supplement their work with employment in other areas like construction and related trades. In Puerto Rico, part-time and full-time fishermen often take on

"chiripas," temporary or odd jobs when work or income wanes (Griffith and Valdés Pizzini 2002; Griffith et al. 2007). In a survey of commercial fishermen Griffith et al. 2007 found 47% of commercial fishermen work at other jobs usually in construction and trades to provide for the family income.

Boat Ownership – Captain and Crew

Most commercial fishermen own one vessel, with some owning two or more. As a small scale fishery, commercial fishing vessels in Puerto Rico are relatively small, as discussed earlier in Section 3.2.2.

Fishing trips usually include two persons, a captain (commonly, the owner of the vessel) and crew (or helper). In a survey of 256 self-identified commercial fishermen, 88% identified as "vessel captain" with 12% identifying as "crew" (Griffith et al. 2007). The majority of commercial fishermen, over 80%, reported using relatives and friends as crew (Griffith et al. 2007). In the 2008 census of 868 active commercial fishermen, 74% identified as captains and 26% identified as helpers or crew (Matos-Caraballo and Agar 2011c).

Most fishermen work on a share basis, whereby one share of the catch goes to the vessel to cover trip expenses and one share of catch goes to each of the crew involved (Griffith and Valdés-Pizzini 2002). Some fishermen may pay crew in wages (Griffith and Valdés-Pizzini 2002).

Role of Family/Household in Fishing

Like small-scale fisheries in the U.S. and around the world, the family or household plays an important role in commercial fishing in Puerto Rico. Fishing is a family enterprise, and family members are involved in many different aspects from fishing to marketing to accounting.

"Family" denotes kinship among large extended families. Most fishermen's family or household size is small yet comparable to the average family or household size in Puerto Rico as a whole. Griffith et al. (2007) reported an average household size of 3.2 members, including the fisherman. Matos-Caraballo and Agar (2011c) reported an average household size of 3.1 members, including the fisherman, although household size ranged from between 1 to 10 persons.

Commercial fishermen are likely to fish with family, in a two-person crew, the vessel owner/captain may fish with a son, wife, daughter, brother, uncle, nephew, or cousin.

While commercial fishermen are predominantly men in Puerto Rico, women fish also. Women commercial fishermen have been documented (Griffith and Valdés-Pizzini 2002). Among them are spouses or daughters of fishermen.

Family assists with fishery-related activities like cleaning and preparing the fish, marketing the fish, repairing vessels and gear, and building gear (Griffith et al. 2007; Griffith and Valdés-Pizzini 2002). Women, often the spouses of commercial fishermen, are most likely to maintain the accounting, record-keeping, and other activities associated with the business. Spouses of fishermen often work outside the home and contribute additional income to the household and benefits such as health insurance and more to the family (Griffith and Valdés-Pizzini 2002).

In addition, family assists in times of difficulty. Family households provide financial and other support to members who are unemployed (Griffith and Valdés-Pizzini 2002).

Disposition of Catch and Subsistence

Commercial fishermen in Puerto Rico sell approximately 75% of their catch, using the remaining 25% for household consumption and sharing with family, friends, and others. In a survey of commercial fishermen, Griffith et al. (2007), found that 78% of the fishermen sold 75% or more of their catch with few to none selling all of their catch. Their ethnographic research supported the findings, with fish constituting a major portion of fishermen's and their family's diet, and fishermen sharing catch with family, neighbors and the elderly (Griffith et al. 2007).

Fishing for household consumption and sharing of catch with family and others in the community is a common characteristic of small-scale fisheries. In these settings, fishing is more than a market-driven economic activity. While the catch may be sold, fish also provide subsistence for fishermen, their families, and others. In small-scale fisheries, fishing serves many purposes: providing an income and food for the family to live, sharing food with others to live, and giving special food as gifts, among others. Fishermen are embedded in family and social relations within the communities in which they live and those relationships often extend across Puerto Rico and usually beyond.

Markets

Commercial fishermen in Puerto Rico market their catch in formal and informal ways. Many fishermen sell their catch directly. Villas pesqueras provide fishermen a formal means of selling their catch in a market space. Fishermen may market their catch at home, advertising at the gate, with a few fishermen selling from a separate structure near the house (Griffith and Valdés-Pizzini 2002). Many fishermen market their catch on the street, selling smaller fish whole and larger pelagic species cut into steaks in plastic bags (Griffith and Valdés-Pizzini 2002). In La Parguera in Lajas, commercial fishermen sell their catch at the villa pesquera, to fish vendors, and to their highest paying customer restaurants that cater to tourists (Griffith and Valdés-Pizzini 2002).

Fishermen may sell their catch to private dealers. In Puerto Real in Cabo Rojo, commercial fishermen sell the catch to private fish houses "neveras," run by fish dealers who sell the catch to restaurants and others (Griffith and Valdes-Pizzini 2002).

Matos-Caraballo and Agar (2011b) found that fishermen spent an average of about 4 hours a week marketing their catch, suggesting that fishermen have learned better marketing skills and techniques. For instance, fishermen will switch buyers if another fish buyer increases the price for their catch, and most fishermen use two or more strategies to sell their catch (Matos-Caraballo and Agar 2011b). See Section 3.5.8 (Economic Characteristics of Puerto Rico Fisheries for more information on this topic).

Cultural Values

Fish and fishing play important roles in the social and cultural environment of Puerto Rico. Fish remains central to the diet of religious observers during the Lent season in the predominantly Catholic Christian Commonwealth. For example, fish demand during Holy Week is higher than throughout the year and some of the species most requested are deep-water snappers, specially queen snapper, red hind grouper, spiny lobster, queen conch, yellowtail snapper, blackfin tuna, dolphin, wahoo, and mackerel (N. Crespo, west coast fisher, pers. comm., March 2018). Fish and shellfish are featured at the festivals associated with the saints in Puerto Rico or other cultural festivals, such as the Festival del Pescao in Cabo Rojo, which has been celebrated every April for decades as a way of paying tribute to the industry that has been its historical sustenance, while for fishermen it is a way to interest the youngest in the trade (Alvarado León 2015). In addition, particular species of fish are targeted in fishing efforts at often species-named fishing tournaments.

Fishing is seen as a valued activity, and fish and shellfish are often given by fishermen as gifts to family and friends as well as shared among community members through fish fries and other special events. Commercial fishermen in Puerto Rico view fishing as a "moral enterprise," with the harvest from fishing providing food security for families and others, income to raise families, and high quality, fresh seafood for consumers (Griffith et al. 2007).

Commercial fishermen pride themselves on their ability to offer high quality fresh fish to family, friends, the community, tourists, and others. Griffith et al. (2013) found that Puerto Rican commercial fishermen view the quality of their fresh fish, although smaller in amount, as competitive with and more valued than imported seafood products of industrial food producers and distributors.

Historically, lobster and conch were used for bait and, easily caught, were consumed during times of economic duress (Jarvis 1932; Griffith et al. 2007). Today, these shellfish are highly valued. Continually in demand by tourists and other visitors, local residents now consume

lobster and conch as well. In 2012, conch constituted more than half of the total shellfish landed and half of the value of shellfish, and lobster made up more than a third of the shellfish landed and nearly half of their value (NMFS 2013). By 2016 lobster leads in both pounds of shellfish landed and value of shellfish landings. Octopus is also among the shellfish harvested.

Some species, like king mackerel are significantly more important to commercial fishermen and hold cultural significance as well. King mackerel is often served at festivals and events and is recognized as one of the most important species among commercial fishermen (Griffith et al. 2007).

Although commercial fishermen harvest highly valued quality fresh fish and shellfish, they cannot meet all the demand for seafood in Puerto Rico. Of the seafood consumed in Puerto Rico, 75% comes from imports (Valdés-Pizzini and Schärer-Umpierre 2014). Imports are mostly frozen, salted or canned and often cost less than locally harvested fish and shellfish. Restaurants, a valued customer of commercial fisheries, usually use imported seafood to meet customer demands during tourist season at reduced cost.

Imported seafood is tied to the history and culture of Puerto Rico. With Spanish colonization, salted codfish, sardines, and mackerel from Spain were introduced and became a part of residents' diet (Griffith et al. 2013). Subsequent imports of salted fish, cod, haddock, and herring from New England and Newfoundland in 19th and 20th century provided key sources of protein (Griffith et al. 2013). Griffith et al. (2013) assert that Puerto Ricans inherited a taste and dependence on cod from the Spanish.

In an interesting exploration of work and lifestyle and their importance to well-being in southeastern Puerto Rico, Garcia-Quijano et al. (2015) describe two different modes of production that derive from either a foraging lifestyle that includes fishing or a non-forager lifestyle. Those who use coastal resource foraging (CRF) tend to demonstrate a higher satisfaction and higher quality of life than those who are non-foragers. Their conclusions tend to be consistent with other studies that describe a moral economy surrounding small scale fishing centered around a quality household and community.

#### 3.5.9.4 Characteristics of Recreational Fishing and Tourism

Detailed descriptions of the recreational fisheries in Puerto Rico can be found in Sections 3.3 and 3.9.3. The discussion here will focus on the close ties to tourism and fishing and how that connection is important to certain sectors of the economy especially recreational fisheries. Recreational fishermen rely on fishing to provide enjoyment and food for their families, with subsistence fishermen reliant on fishing for their food. Yet this activity is also important for many visitors to the island who want to enjoy recreational fishing as part of their experience and who may want to catch fish for food. Coastal beaches and activities such as fishing, diving,

snorkeling, and boating attract visitors and residents alike. Increasingly, tourism promotes "the island experience" and eco-tourism in Puerto Rico.

Residents of Puerto Rico also depend on the harvest of fish to provide seafood for their diet. Commercial fishermen rely on fishing to provide household income, food for their families and others, and gifts for family, friends and community. But tourism also relies on fishing to provide entertainment for visitors and seafood for restaurants. Commercial fishermen contribute to tourism by harvesting fish and shellfish for restaurants that serve tourists. Fishermen also harvest baitfish for tourists and charter boats.

Tourism contributes to the overall economy of Puerto Rico. In 2012, nearly 4.2 million visitors expended $3.2 billion in the Commonwealth, averaging expenditures of $761 per visitor (Puerto Rico Planning Board 2012). The net income from tourism to the Commonwealth in 2005 was $771 million (Puerto Rico Planning Board 2012).

### 3.5.10 Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, directs all federal agencies to identify and address "disproportionally high and adverse human health or environmental effects" on minority and low-income populations to achieve environmental justice (59 F.R. 7629, February 16, 1994). In Puerto Rico, the majority of the population, including the majority of commercial fishermen, would be considered minority populations. Puerto Rico, too, is characterized by low income, high unemployment, with a disproportionate number of residents living below the poverty level.

Puerto Rico faces economic challenges and its population is characterized by low income and high unemployment. Puerto Rico's rate of unemployment in 2017 ranged from 10.9% in January to 9.6% in May, with a national average of 4.0% in June of 2018 (U.S. Bureau of Labor Statistics 2018). In addition, a disproportionate number of residents are living below the poverty level. In 2010, 1,659,792 people, or 45% of the resident population, lived below the poverty line (U.S. Census Bureau 2010). Although the number of people living below the poverty line decreased in 2017 to 1,451,672, the overall poverty rate of 43.5% was still high with the national average of 12.7% (U.S. Census Bureau 2018).

Like the resident population of Puerto Rico, many commercial and recreational fishermen may find it difficult to make ends meet. Although commercial fishermen provide income and fish for household consumption, members of fishermen's families usually assist with the business of fishing and contribute to household income through outside employment. Commercial and recreational fishermen, like other residents, are affected by the larger economy in Puerto Rico with some or a member or members of their family experiencing low-income, unemployment or poverty.

High unemployment, poverty, low wage occupations, and the limited availability of jobs may be precipitating the out-migration of residents and fueling the decline in population in Puerto Rico. Abel and Dietz (2014) see the "surge" in out-migration as a more important factor than birthrate in Puerto Rico's population loss. Abel and Dietz (2014) note that out-migration has not resulted in "brain drain" because the majority of those leaving Puerto Rico are young, unskilled workers. However, out-migration and population loss presents economic difficulties if Puerto Rico does not act to grow its economy, create job opportunities, reduce crime, and improve the Commonwealth as a good place to live and work (Abel and Dietz 2014). This process may be exacerbated by recent natural disasters. Since the hurricanes of 2017 the actual unemployment rate has decreased, however, the total labor force has fallen to new lows with numbers falling below 1.1 million (U.S. Bureau of Labor Statistics 2019).

Finally, the majority of commercial and recreational fishermen, like other residents of Puerto Rico, are recognized as minority populations within the broader population of the U.S. As minority populations and, in many cases, low-income populations, fishery managers may want to ensure that conservation and management measures maintain the overall good health and environment of these fishermen.

In order to assess whether a community may be experiencing environmental justice issues, a suite of Community Social Vulnerability Indices (CSVIs) created to examine the social vulnerability of coastal communities was developed for the majority fishing communities in the U.S (Colburn and Jepson 2012). Originally, the territories were not included in the development of the CSVIs. A recent attempt to develop similar indicators at the community or Census Designated Place level for Puerto Rico and the USVI was not successful. However, by changing the unit of analysis to the county rather than census designated places a viable suite of social vulnerability indices were successfully created using the same methodology for all counties within the coastal Southeast including Puerto Rico and the USVI. Using the same variables with minor adjustments, a principal component factor analysis was conducted with results meeting the same criteria used previously in creating the CSVIs. The resulting index factor scores for each community will be reported here.

The three indices reported most often in the Southeast are poverty, population composition, and personal disruptions. The variables included in each of these indices have been identified through the literature as being important components that contribute to an individual's or community's vulnerability. Indicators such as increased poverty rates for different groups, more single female-headed households and children under the age of 5, disruptions such as higher separation rates, and unemployment all are signs of vulnerable populations. These indicators are closely aligned to previously used measures of environmental justice, which used thresholds for the number of minorities and those in poverty, but are more comprehensive in their assessment.

For those municipalities that exceed the threshold it would be expected that they would exhibit vulnerabilities to sudden changes or social disruption that might accrue from regulatory change.

As is evident in Figure 3.5.12, the majority of municipalities show substantial vulnerabilities with most exceeding both thresholds of half and one standard deviation for two of the indices and some exceeding both thresholds for all indices. Cabo Rojo, Arecibo, and San Juan are the only municipalities that do not exceed the ½ standard deviation for personal disruption. However, these vulnerabilities do not take into consideration the recent devastation from Hurricanes Irma and Maria. It is expected that even though these municipalities have high vulnerabilities depicted here, they could now have even higher vulnerability scores as a result of the impacts from recent hurricanes.

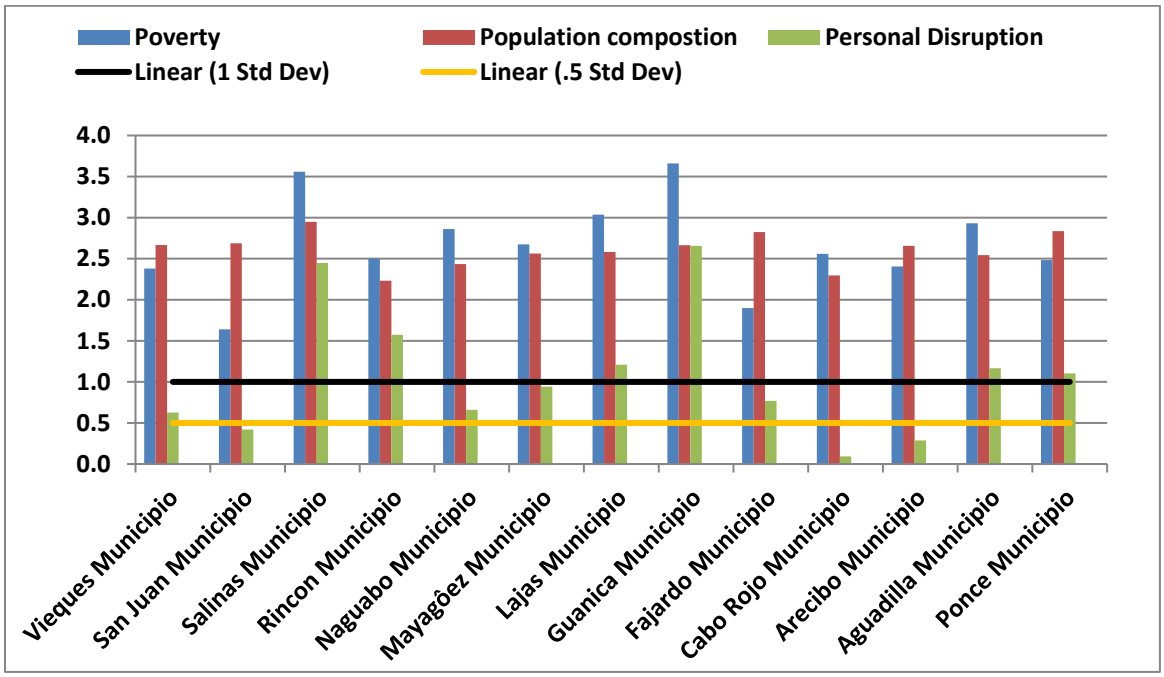



**Figure 3.5.12.** Social vulnerability for Puerto Rico coastal municipalities with most fishing engagement.
Source: SERO County Social Vulnerability Indicators database (ACS 2010) 2018)

## 3.5.11 Impact of Recent Hurricanes

### 3.5.11.1 2017 Hurricane Impacts on Puerto Rico Fisheries: Irma and Maria

On September 6, 2017, the center of Hurricane Irma, the most powerful Atlantic hurricane on record (Category 5 on the Saffir-Simpson scale[48]) barely missed Puerto Rico and the USVI with

[48] https://www.nhc.noaa.gov/aboutsshws.php

those massive winds. However, Puerto Rico received category 4 winds, leaving a large portion of the island without electric power. Two weeks later, on September 20, 2017, Hurricane Maria made a direct hit on Puerto Rico as a powerful Category 4 hurricane with maximum sustained winds of 155 miles per hour (mph). Hurricane Maria impacted the island with wind and rain for longer than 30 hours (Meyer 2017); and caused great devastation and destruction throughout the whole island. Four months after the hurricane hit, 60% of the population was without electrical power and clean water access remains compromised in several areas. Additional details about the impact of these recent hurricanes is found in Section 3.4.

As expected, the combination of these two powerful hurricanes caused catastrophic effects not only to the livelihoods of Puerto Ricans but also to the Puerto Rican economy. Fishing activities were also severely affected by the disruption caused by the hurricanes, and to this day, fishing operations, both commercial and recreational, are impaired from operating at usual levels. Testimony at the 161st Council Meeting, held in San Juan Puerto Rico in December 2017, indicated that three months after Hurricane Maria made landfall, the commercial fishing activity was operating at 33% of its normal capacity pre-Maria (Matos-Caraballo 2017).

At that same meeting, fishermen provided an overview of the immediate effects of this catastrophe. In the town of Naguabo, in eastern Puerto Rico, fishermen indicated that effects of hurricane Maria have dramatically changed their lives and fisheries (See Figures 3.5.13-3.5.16 for photos of hurricane damage to coastal areas and fishing facilities). These effects are felt throughout the whole island.

Below is a summary of the most significant effects experienced three months after Hurricane Maria hit. These effects are common throughout the island:

- No fishing activity in many areas due to lack of electricity and water services varying in length. For example, Matos-Caraballo (2017) noted that in December 12, 2017, 50% of the fishing centers (*villas pesqueras*) lacked electricity;
- Drop in fish sales/pricing. In the absence of electricity and ice to preserve the catch and the small number of restaurants open, fishermen were forced to sell their catch at reduced prices. For example, fishermen in the west coast of Puerto Rico were forced to sell lobsters for $2.00 – 3.00/pound, when the usual price is $8.00/pound (N. Crespo, west coast fisher, pers. comm. 2017);
- Many restaurants remained closed, others operated part time and did not invest money in buying fish and seafood (N. Crespo, west coast fisher, pers. comm. 2017). Matos-Caraballo (2017) estimated that 33% of the seafood restaurants were still closed in December 12, 2017;
- Low tourism activity, which likely affected the demand for fresh fish and seafood;

- Inability to store catch due to lack of electricity and thus refrigeration, forcing fishermen to sell their catch the same day. Loss of catch harvested prior to hurricane hit;
- Fishermen selling their catch in the street as opposed to through the *villa pesquera* or through dealers, etc.;
- Deep-water snapper fishermen reluctant to go out fishing because of fear of not having a market for their fish and thus not being able to cover costs of trip (N. Crespo, west coast fisher, pers. comm. 2017);
- Damage to vessels (e.g., sinked vessels) and vessel engines stored at *villas pesqueras*;
- Light to severe or total damage to *villas pesqueras*, fish houses, restaurants associated to villas pesqueras, and/or to facilities and to equipment to process and store fish (e.g., freezers), boat ramps, docks, etc.;
- Loss of fish traps at sea; loss of diving equipment
- Lack of gas and diesel to operate electric generators that would allow filling SCUBA tanks, thus little to no fishing through diving in several areas;
- Migration of fishermen to the continental U.S. due to lack of economic opportunities;
- Lost income and difficulties to overcome economic losses;
- Fishermen report changes in seafloor such as destruction of reefs, displacement of sand and sediment, loss of old fishing sites, shrinking of beaches;
- The hurricane slowed the season for lobster, conch, and octopus;
- Few fishermen remained active as it was difficult to fish and make income from fishing;
- Fishermen concerned about the lack of assistance from the local and federal governments to the commercial sector so they can get back to work.

Information provided by the Asociación de Pescadores de Playa Húcares in Naguabo shows a 95% loss in conch sales in November 2017 when compared to the same date in 2016. This resulted in a 95% loss in fisher's income from this fishery (Conservación ConCiencia 2017). Meanwhile, the total losses in income for fishermen surveyed (n=12) harvesting lobsters, conch, and octopus with diving equipment and traps was estimated by the Asociacion to be 92% in November 2017 when compared to the same date the previous year.

**Figure 3.5.13.** Effects of Hurricane Maria in Playa Húcares, Naguabo, eastern Puerto Rico.
(Source: C. Velazquez 2017)

**Figure 3.5.14.** Effects of Hurricane Maria on fishing vessels and launching ramps in Los Machos, Ceiba, eastern Puerto Rico.
(Source: C. Velázquez 2017)

**Figure 3.5.15.** Effects of Hurricane Maria in Crashboat, Aguadilla, in northern Puerto Rico.
(Source: C. Velázquez 2017)

**Figure 3.15.16.** These pictures show the Villa Pesquera Villa del Ojo Playuela in Crashboat, Aguadilla, in western Puerto Rico before (left) and after (right) hurricane Maria.
(Sources: C. Velázquez 2017; Matos-Caballero 2017)

The short-term impacts of the hurricanes was severe, but the longer-term impacts are not yet fully known. Damage assessments on fisher's losses including infrastructure (facilities), gear, vessels and engines, and revenue, although underfunded and understaffed, are underway. Rapid ecosystem assessments that seek to provide a view of how the hurricanes affected the coral reef ecosystem, the principal habitat supporting fisheries in Puerto Rico has been just completed (See Section 3.5.11.2 below). It is estimated that Hurricane Maria snapped hundreds of thousands of corals off reefs around the island (Coto 2018). Recently, funding has been secured to start the

repair and restoration process. NMFS was awarded nearly $1.5 million project to help restore between 100 and 300 corals a day in Puerto Rico for two months. While most of the focus is on the island's northeast region, depending of availability of funds, other areas will be targeted as well (Coto 2018).

**Fisheries Disaster Declaration**

The National Marine Fisheries Service (NMFS) administers disaster assistance under two statutes, the Magnuson-Stevens Act and the Interjurisdictional Fisheries Act. Under both statutes, a State Governor or an elected or duly appointed representative of an affected fishing community can request a fishery disaster determination from the Secretary of Commerce (Secretary). The Secretary may also initiate a review. If the Secretary determines that a fishery disaster has occurred, the fishery is eligible for disaster assistance subject to appropriation of funds by Congress[49].

Pursuant to these authorities, during fall of 2017, the Governors of Puerto Rico, USVI, and Florida asked the Secretary of Commerce to determine whether a commercial fishery failure occurred due to a fishery resource disaster, namely the destructive hurricanes. On February 8, 2018, the Government of the United States through the Secretary of Commerce, formally declared catastrophic disasters as a result of Hurricanes Irma and Maria. Through these disaster declarations, fisheries in Puerto Rico, the USVI and Florida will be eligible for small-business loans and other federal aid.

Other aid could come through the Federal Emergency Management Agency, Economic Development Administration, and Department of Housing and Urban Development[50].

#### 3.5.11.2 Socio-Economic Impacts of Recent Hurricanes

A few months after Hurricane Maria, a rapid assessment of the damages and losses to the fishing sector was conducted with in-person interviews of both commercial and recreational fishermen along with fishing associations and seafood retailers. Preliminary estimates from the rapid assessment suggest that total economic losses were close to $20.5 million and that approximately 146 jobs may have been lost, in some cases temporarily (J. Agar, NMFS Southeast Fishery Science Center, pers. comm. 2018).

Interviews conducted with commercial fishermen suggest that their economic loss might have reached near $8.4 million, including damages, with $3.0 million of that from forgone fishing revenue. It was estimated that 1,039 commercial fishermen had suffered impacts (damages and

[49] http://www.nmfs.noaa.gov/sfa/management/disaster/index.html
[50] https://www.commerce.gov/news/press-releases/2018/02/us-secretary-commerce-declares-fisheries-disasters-following-hurricanes

losses) from the hurricanes personally and the subsequent damage to the island (J. Agar, NMFS Southeast Fishery Science Center, pers. comm. 2018).

The for-hire fishery in Puerto Rico is small and estimations of the number of participants are uncertain as permitting is not strictly enforced. However, for the rapid assessment it was estimated that there were approximately 47 for-hire operations that had sustained some type of damage from the hurricanes. The estimated total loss was around $1.3 million with $724,419 of that attributed to foregone revenue lost (J. Agar, NMFS Southeast Fishery Science Center, pers. comm. 2018).

Other businesses related to commercial fishing were also surveyed in the assessment and included 35 fishing cooperatives and associations and 19 seafood stores. Total losses for the group was over $6.8 million and a total of 65 jobs estimated to be lost. However, the exact number of businesses was likely underestimated so impacts could also be underestimated (J. Agar, NMFS Southeast Fishery Science Center, pers comm. 2018).

Generally, the rapid assessment was a snapshot of circumstances at the time. Because of a slow recovery and the lack of electricity in some areas on the island, the losses reported may be underestimations for some fishermen, associations, and retail operations as they continued to experience losses of income from the inability to fish or buy fish. More recent news articles from Puerto Rico have noted that the commercial fishing industry may never recover to pre-storm levels as former participants have immigrated to other locales. In March 2018, reports of recovery were bleak as only 50% of fishing communities were functioning partially with problems of sediment accumulation restricting access, damages to facilities and lack of funds for repairs plaguing many recoveries (González March 2018).

Specific areas that were reportedly having difficulties include communities of Arroyo and Loiza which were lacking electricity and Ponce which had issues with sedimentation of boat access areas. Rincón was practically destroyed and waiting to hear from the Department of Agriculture about decisions for their facilities. In addition, some fishermen from Rincón have left and it is unclear if they will return. According to the Department of Agriculture, 80% of the fishing villages had seen fishing production reduced by 81% in February of 2018 (González March 2018).

Assistance has been made available to the states and territories from the U.S. Congress as funds from the Fisheries Disaster declaration on February 9, 2018 were allocated on June 20, 2018. Puerto Rico was allocated $11.5 million from the $200 million for all fisheries disasters that stemmed from the 2017 hurricane season.

## 3.6 Administrative Environment

The administrative environment affecting the Puerto Rico FMP is discussed in detail in Section 1.6 of this document. Additional information regarding fishery management in territorial or federal waters can be found in the Caribbean SFA Amendment (CFMC 2005) and in the 2010 Caribbean ACL Amendment (CFMC 2011a). Information about commercial and recreational fisheries in Puerto Rico can be found in Sections 3.2 and 3.3.

## 3.7 Issues of Concern to Fisheries Management

### 3.7.1 Introduction

Both commercial and recreational fishermen as well as other stakeholders, have concerns about the long-term future of fishery resources and the habitat that support those fisheries. Fishermen generally are concerned about the threats of pollution, degradation of coastal habitats, sedimentation, and decline in the stocks of certain fish species.

Imported seafood poses another threat to commercial fishermen and fisheries. Of the seafood consumed in Puerto Rico, more than 75% comes from imports (Valdés-Pizzini and Schärer-Umpierre 2014). Although commercial fishermen harvest fresh fish and shellfish for many, they cannot meet all consumer demand for seafood in Puerto Rico. Imports are mostly frozen, salted or canned and often cost less than locally harvested fish and shellfish. Additionally, commercial fishermen note that many imports include illegal catch, particularly undersized fish and shellfish. Restaurants, a valued customer of commercial fisheries, usually use imported seafood to meet customer demands during tourist season at reduced cost. When imports replace local fresh fish and shellfish, the commercial fisheries market and the livelihood of commercial fishermen is adversely affected. Valdés-Pizzini and Schärer-Umpierre (2014) note that investigating the market controls over the effort and products captured could provide much insight into the current uses of the marine resources.

The next sections and sub-sections list these and some additional concerns expressed by fishermen and stakeholders with respect to several topics such as resource health and availability, socio-economic concerns, management and operational concerns, and others. Some of the identified issues of concern are general and apply to both recreational and commercial sectors, while others are specific for a sector in particular. Appendix E lists fisheries data requirements for effective management of fishery resources in Puerto Rico.

### 3.7.2 Fishermen and Stakeholder Concerns

Development of the coast pose threats of pollution and may degrade coral reefs and other habitats and contribute to decline of fishery resources. Overfishing, destruction of habitats,

sedimentation, and water pollution have been linked to declining fishery resources (Valdés-Pizzini 2011). Fishermen are concerned, also, about competition with recreational fishermen for the same resources, potential loss of access to launching and landing sites, and further displacement of commercial fishing and fishing-related activities from coastal communities. There are concerns that parameters such as the ones described above and others (e.g., destruction of ecosystems, decline in stocks, invasion of exotic species, displacement of traditional communities, advance of conservation efforts, climate change) are not being adequately incorporated into the management of fishery resources (Valdes-Pizzini 2011).

Tables 3.7.1-3.7.5 list fishermen's and stakeholder's concerns under each topic. Where available, sources for the references are listed in parentheses.

**Table 3.7.1.** Fishermen's and Stakeholder's concerns about the health of fish resources and ecosystems, resource availability, and threats to fish populations.

| Resource Health |
|---|
| - Some fish populations not increasing in abundance despite changes in the gears used to catch fish.<br>- Impact of invasive species such as lionfish on target species (Testimony at Council meetings, informational meetings, other venues; Ñeco 2013).<br>- Critical state of the ecosystems and critical habitats and their impact on the reproductive capacity of fish, and if and how these changes being quantified (Valdés-Pizzini 2011).<br>- Constant threat of non-sustainable development, sedimentation, deforestation, erosion, non-point and point sources of pollution, untreated seawage dumped at sea and high number of septic tanks close to the coasts and their threats to coral reefs, seagrasses, cays, mangroves, coastal lagoons, estuaries, which serve as habitat to fish (Valdés-Pizzini 2011).<br>- Impact of hurricanes and climate change (Valdés-Pizzini 2011).<br>- Overfishing or irresponsible fishing practices as related to the depletion of fishery reousrces (Valdés-Pizzini 2011; personal communication with fishermen at Council meetings). |

**Table 3.7.2.** Fishermen's and Stakeholder's concerns about socio-economic factors.

| Socio-Economic |
|---|
| - Risks associated with the profession regarding safety at sea (e.g. divers, weather related, etc.) (Personal communication with fishermen; testimony at Council meetings and informational metings). |

| |
|---|
| - Fishing business is not enough to support fisher's families; need other opportunities to diversify employment so that they can improve their socio-economic well-being (Personal communication with south coast fishermen).<br>- Fear that the fishery is aging out as younger generations are selecting other types of income generating activities.<br>- Displacement of coastal fishing communities due to coastal construction projects and developments.<br>- Potential loss of access to launching and landing sites, and further displacement of commercial fishing and fishing-related activities from coastal communities.<br>- Concern about conservation efforts affecting subsistence and commercial fishermen.<br>- Concern about "global movement" against fishing that would affect subsistence and commercial fishermen (Valdes-Pizzini 2011).<br>- Need to understand the fishing impact on adjacent fishng communities and the social and economic role of fishing. |

**Table 3.7.3.** Fishermen's and Stakeholder's concerns about management and operational aspects of fisheries.

| Management and Operations |
|---|
| - Effects and implications of the high number of closures and species listed as threatened on the fishermen (Valdés-Pizzini 2011; testimony at Council meetings, informational meetings and others; personal communications with fishermen).<br>- Inadequate/inaccurate collection of information on real impact of recreational-sport sector catches; concern that recreational sector catches may be more substantial than the commercial catches. Concern about incorrect or inaccurate number count of recreational fishermen, and lack of knowledge about if illegal sales of fish products from this sector are occurring (Valdés-Pizzini 2011; testimony at Council meetings).<br>- Poor, insufficient, and inaccurate data and fishing statistics that prevent appropriate management of fishery resources. For example, some fishermen catalogue the Puerto Rico Fisheries Law as being "too harsh"[51] (Valdés-Pizzini 2011; testimony at Council meetings, informational meetings and others; personal communications with fishermen).<br>- Concern about decreases in catches and management agencies misidentifying the reasons for the decline. For example, a reduced number of catch could be due to a decrease in the number of fishermen or a decline in stocks of some species (Valdes-Pizzini 2011), also due to misreporting, and/or underreporting (Valdés-Pizzini 2011; testimony at Council meetings; personal communications with fishermen). |

[51] In response to the implementation of the Puerto Rico Fishing Law, the reaction has been not to provide fishing statistics, which further exacerbates the data poverty situation.

| |
|---|
| - Lack of monitoring of longlining fishing activities in federal waters. Longliners are perceived as having an unfair access to resources that otherwise would be accessible to Puerto Rico fishermen once these fishery resources reach waters closer to their fishing grounds (Testimony at Council meetings, informational meetings, and other venues).<br>- Inadequate effort to incorporate the following parameters in the management of fisheries resources: destruction of ecosystems, decline in stocks, invasion of exotic species, displacement of traditional communities, competition with recreational and sport fishermen, increased conservation efforts, climate change effects (Valdes-Pizzini 2011).<br>- Concern that fishermen are not being involved in the fishery management process or the scientific data collection process. Concern that the scientific community does not understand why fishermen do not provide data (Valdés-Pizzini 2011; also similar comments made during testimony from fishermen at Council meetings, informational meeting, or other informal venues).<br>- Concern about which individuals constutute part-time and full-time fishermen, issues with allocations of species permits (Valdés-Pizzini 2011; testimony at Council meetings, informational meetings and others; personal communications with fishermen).<br>- Management measures sometimes do not include or do not have clear objectives of how they will be evaluated once implemented. Work plans need to be created beforehand so they can be put into action when the objectives of the management measure are reached (M. Hanke, fisherman, pers. comm., 2018).<br>- Management regime should be tailored to the reality of the islands and should not try to mimic management in the U.S. mainland.<br>- Concerned that efforts should be made to explore cost effective methods of data collection (e.g., to monitor fisher's efforts; use of different technologies) and to create a more efficient system to adjust management measures. |

With respect to the inadequate or inaccurate fishing statistics, Valdés-Pizzini (2011) notes that better statistics and commercial and recreational landings are needed so that managers, fishermen and scientists have a clearer vision of the effort, fishing mortality, and the the ability of the resource to reproduce and the capacity to sustain a fishing effort of a certain magnitude.

**Table 3.7.4.** Fishermen's and Stakeholder's concerns about resource access and resource competition.

| Resource access and Competition |
|---|
| - Commercial fishermen are concerned with competition with recreational fishermen for the same resources, potential loss of access to launching and landing sites, and |

| |
|---|
| further displacement of commercial fishing and fishing-related activities from coastal communities.<br>- Competition for the same species (e.g., mahi, snappers, groupers, mackerels, tunas) and fishing space with recreational and sport fishermen (Valdés-Pizzini 2011). |

**Table 3.7.5.** Fishermen's and Stakeholder's concerns about their education.

| Education |
|---|
| - Lack of resources for education to fishermen<br>- Many fishermen do not understand the scientific and socio-economic importance of fisheries statistics (Valdes-Pizzini 2011)<br>- Lack of conservation ethic in persons new to the fishing profession; additional environmental education is needed particularly for this group (Personal commumication fishermen south coast of Puerto Rico)<br>- Lack of public education and awareness that species that are not currently targetef could be usef for consumption (Fuete y Veguilla, Vol 8. Nov 2014). Also, lack of education programs aimed at teaching fishermen how to strategize for the future by fishing for other species and diversifying business activities (M. Hanke, pers. comm. 2018). |

# Chapter 4. Environmental Consequences

## 4.1 Action 1: Transitioning from a Species-Based FMP to an Island-Based FMP- Environmental Consequences

### 4.1.1 Direct and Indirect Effects on the Physical Environment

**Alternative 1** (no action) is an administrative action that would leave in place the existing species-based approach to federal fishery management in the U.S. Caribbean exclusive economic zone (EEZ). Because it would not change the status quo, it would not have any direct effects on the physical environment. The National Marine Fisheries Service (NMFS) and the Council already prohibit the use of destructive fishing gear types and methods such as explosives, chemicals, power assisted tools, powerheads, gill nets, and trammel nets among others (50 CFR part 622). By prohibiting destructive fishing methods and ensuring that activities do not adversely affect essential fish habitat (EFH) and habitat areas of particular concern, the Council and NMFS would ensure that negative impacts on the physical environment from authorized fishing activities are negligible.

Establishing an island-based FMP for the Puerto Rico EEZ in **Preferred Alternative 2** also does directly affect the physical environment. Under **Preferred Alternative 2**, regulations would be reorganized from a Caribbean-wide EEZ domain to a Puerto Rico EEZ domain, but the regulations would remain the same in most respects. As mentioned above, there are management measures already in place that prohibit the use of destructive fishing gears and methods and ensure that activities do not adversely affect EFH and other habitat areas. These measures would be migrated to the new plan under **Preferred Alternative 2**. In addition, as discussed in the 2014 EA (NMFS 2014), tailoring management measures to Puerto Rico could in the long-term make fisheries management more effective therefore eventually minimizing adverse direct or indirect effects from fishing activities to the physical environment.

### 4.1.2 Direct and Indirect Effects on the Biological/Ecological Environment

**Alternative 1** would leave in place the existing species-based approach to federal management; thus little change would be expected in the biological/ecological environment

Under **Preferred Alternative 2** regulations would be reorganized from a Caribbean-wide EEZ domain to a Puerto Rico EEZ domain, but the regulations would remain the same in most respects. Short-term effects to the biological/ecological environment would be the same as for **Alternative 1** because, based solely on the outcome from Action 1, the applied regulatory environment would not change. In the long term, the island-based approach proposed by **Preferred Alternative 2** could potentially minimize impacts to the biological environment from

fishing activities by enhancing fisheries management. However, the ultimate outcome from implementing **Preferred Alternative 2**, coupled with implementation of any combination of proposed management actions (except the no action alternatives) presented and discussed in Actions 2-7, likely would be positive. Long-term effects to the biological/ecological environment would be expected to be positive as discussed in Section 1.4 of the 2014 EA.

No direct or indirect effects to Endangered Species Act (ESA)-listed species are expected from this action, as it would not change how the fisheries within each management area operate (*i.e.*, gear used or effort expended).

### 4.1.3 Direct and Indirect Effects on the Economic Environment

To ascertain whether the net benefits associated with the preferred alternative (**Alternative 2**) exceed those under the no action alternative (**Alternative 1**), one would ideally look at the change in economic surplus (i.e., producer and consumer surplus), which would be forthcoming in moving to the preferred alternative. If positive, the alternative state (i.e., moving from the status quo to the preferred alternative) would be justifiable from the perspective of economic efficiency. Estimating the change in surplus, however, requires a significant amount of information/analyses including (a) costs associated with the commercial harvest of seafood and change in producer surplus associated with movement from the status quo, (b) consumer surplus derived from the consumption of commercially harvested product and its change associated with movement from the no action alternative , (c) benefits derived from recreational activities and the change in these benefits in conjunction with movement to the preferred alternative, and (d) benefits derived from non-consumptive activities and related changes in the transition from a species-based to an island-based management approach. None of this information/analyses exists, however, which makes evaluating the change in surplus infeasible.

While the change in surplus associated with moving from the no-action alternative (**Alternative 1**) to the preferred alternative (**Alternative 2**) cannot be estimated, there are a number of aspects associated with the economic environment that can help establish the expected direction (if any) of the change. First, because transition from a species-based to an island-based management approach is not expected to influence current harvest and resource use, one can surmise that changes in direct economic benefits would be minimal. However, there are likely to be indirect benefits associated with transitioning to an island-based management approach and the prospect of not ‘capturing’ these indirect benefits would hamper the realization of long-term maximum benefits derived from the fishery. Possibly the largest effect is the loss in indirect benefits that may be forthcoming from enhanced compliance. Specifically, it is widely recognized that the ability to adequately monitor and enforce existing regulations is limited due to limited resources. Furthermore, it is the fishermen who have requested an island-based approach to management in lieu of the current species-based approach. More involvement by the fishermen in the development and implementation of the management process could potentially culminate in

enhanced compliance. This enhanced compliance may range from the provision of higher quality fishery-dependent data to a voluntary reduction in fishing activities that are in violation of regulations. Such increased compliance may, over time, culminate in more efficient management practices that more adequately protect stocks and stock complexes; thereby, increasing indirect benefits.

Finally, transitioning from species-based management approach (**Alternative 1**) to an island-based management approach in the Puerto Rico EEZ (**Preferred Alternative 2**) would, over time, allow for the tailoring of management measures more in line with the specific needs of the island; including economic nuances, social nuances, and fishing practices specific to the island. There are likely to be substantial indirect economic benefits in doing so.

### 4.1.4 Direct and Indirect Effects on the Social Environment

The no action **Alternative 1** would not result in changes or direct effects to the social environment, however, there may be indirect effects if the no action alternative is chosen as the preferred. There has been considerable discussion at the Council level with regard to island specific management with public input strongly in favor of this style of management. In some cases, displeasure has been expressed toward the lack of understanding of local needs and concerns. This may still be a factor, however, the more recent assessment has suggested island level management may accommodate some of these concerns and moving toward island management may afford a more streamlined and successful management of Caribbean fisheries. Under **Alternative 1**, fishermen may become dissatisfied and perceptions of the efficacy of management may erode. Such an erosion of perception can lead to lesser compliance and affect participation in management. Cooperation and participation in management have been shown to improve compliance with fishery regulations and can contribute to the overall well-being of fishermen and other stakeholders including the well-being of the resource. Developing a new Puerto Rico FMP under **Preferred Alternative 2** would consider the unique attributes of the island group taking into account the specific cultural, social, economic, physical, geological, and biological environment of Puerto Rico. **Preferred Alternative 2** would create an individual plan for Puerto Rico and would addresses the concerns that have been expressed by the public regarding island management.

The different histories of the islands have had a unique effect on the development of the fishing economy on each. Based upon different governance, dissimilar colonization and development of plantations and slavery, the islands have today developed their own unique culture and social environments. These differences are evident as one examines the ethnic and cultural makeup of the stakeholders within each island fishery. While all share common experiences and historical provenance, over the decades, significant differences have evolved. Present day economies differ on each island as affected by unique histories and the new trends of tourism and global economies have helped transform the older more traditional coastal way of life. Fishing is one of

those historical activities that has remained an important part of island culture, yet each of the social and economic environments differ and have dictated unique trajectories for the development of all three sectors of fishing. By allowing for more island centric management, each locale may be able to take advantage of the historical trends that have created each unique social and cultural environment that may offer more streamlined and effective management. This may bring about more participation as stakeholders see management more responsive to their local needs. The increased cooperation may lead to more compliance which should benefit the biological, economic, and social environments.

### 4.1.5 Direct and Indirect Effects on the Administrative Environment

Choosing to take no action in **Alternative 1** would not require additional rulemaking and would therefore have no additional effects on the administrative environment. Although, when compared to **Preferred Alternative 2** (establishing a new Puerto Rico FMP), **Alternative 1** might prove beneficial to the administrative environment in the short-term because maintaining the status quo would not require administrative adjustments as opposed to the extensive rulemaking needed to implement a new Puerto Rico FMP. However, long-term effects would be negative as prior federal management addressed stocks over which the Council now has little or no influence. Expending resources to manage stocks over which there is little federal control, for example, by expending resources to monitor ACLs and implement AMs, could prove costly in terms of the actual expense of implementing measures that will be difficult to enforce. In addition, this process could take away resources from developing and implementing management measures for stocks over which the Council has more influence.

Under **Preferred Alternative 2** regulations would be reorganized from a Caribbean-wide EEZ domain to a Puerto Rico EEZ domain, but the regulations would remain the same in most respects. Short-term effects on the administrative environment would be negative but minor as the new regulations are established. However, long-term effects would be positive and possibly substantial as federal management was properly directed to stocks for which the Council actually has management influence while avoiding application of administrative effort to those stocks for which the Council has no management control.

## 4.2 Action 2: Identify Stocks in Need of Federal Conservation and Management - Environmental Consequences

### 4.2.1 Direct and Indirect Effects on the Physical Environment

Action 2 (species selection) is primarily an administrative action because adding or removing species for management does not directly affect how the fisheries operate (i.e., gear types used)

and is not expected to have direct effects on the physical environment. Indirect effects may apply depending on the species selected for management.

**Alternative 1** (No Action) would bring all species previously managed in the Reef Fish (including 81 species of finfish), Queen Conch, Spiny Lobster, and Corals FMPs into the new Puerto Rico FMP. Under **Alternative 1**, 81 species of reef fish, 58 species of aquarium trade fish, spiny lobster (one species), queen conch (one species), 94 species or species groups of corals, and 63 species or genera of aquarium trade invertebrates would continue to be managed under the Puerto Rico FMP. **Alternative 1** is not expected to have direct effects on the physical environment, nor any indirect affects that were not previously considered in the 2010 and 2011 Caribbean ACL Amendments as current fishing practices are not expected to change.

Applying the stepwise process under **Preferred Alternative 2** would result in 63 species of finfish, queen conch (one species), spiny lobster (one species), and all species of coral, sea cucumbers, and sea urchins included for management in the Puerto Rico FMP. Removing species infrequently caught in federal waters is not expected to impact the physical environment due to the small amount of effort involved in catching these non-targeted species

Adding species previously not managed would potentially have indirect effects on the physical environment if it resulted in new gear types, fishing areas, or fishing effort not previously analyzed, but these routes are not expected for any of the species added in **Preferred Alternative 2**. For example, including sea urchins and sea cucumber species in the Puerto Rico FMP could have indirect physical effects by placing all species included in these two groups into the management regime, thereby ensuring that harvest levels and methods are commensurate with the important role these two groups play as ecosystem engineers within the coral reef ecosystem. Healthy populations of sea cucumbers and sea urchins help to ensure their contributions to sediment bioturbation and biofouling reduction are maintained at appropriate levels. However, considering that harvest of both groups is presently prohibited in Puerto Rico commonwealth waters, and that harvest from the Puerto Rico EEZ is unknown but likely near zero, such physical effects would be expected to be minimal when compared to outcomes expected from **Alternative 1**. Regarding managed pelagic species such as dolphin and wahoo, these species are already legally harvested from the Puerto Rico EEZ by both commercial and recreational fishermen, generally using ubiquitous hook-and-line methods. Adding pelagic species to management would therefore be expected to have no direct or indirect physical effects on the environment beyond those already being experienced. However, future Council actions could affect the physical environment. For example, the Council could take action to reduce harvest of these species or change allowable harvest methods in a manner than changes effects to the physical environment. Only for corals, sea urchins, and sea cucumbers would indirect physical effects to the environment be anticipated to change, as a complete inclusion of all species from those groups to the Puerto Rico FMP will ensure that all species are managed.

Assuming the Council's past approach to managing these foundational components of the ecosystem, that being to prohibit harvest of all managed coral species, is carried forward into the new Puerto Rico FMPs (addressed in Action 3), the physical environment could benefit from the elimination of any mechanisms used to harvest non-managed corals as well as sea urchins and sea cucumbers. Compared to **Alternative 1**, **Preferred Alternative 2** would have fewer fish species included for management, which would most likely result in fewer indirect effects to the physical environment.

**Alternative 3** would allow the Council to select, in no certain order, the species to be included for management. Depending on the criteria and order selected, indirect impacts to the physical environment from the list of species selected for management could include range from no effects (if only prohibited species were included); no new effects (if the same species composition as in the current FMPs was selected), the same as **Alternative 1;** minimal effects (if some species were added while others removed, assuming those fishing-related effects to the physical environment would balance out) similar to **Preferred Alternative 2;** and maximum effects (if all species landed in Puerto Rico were selected, increasing effort and including new gears). The Council and expert panel used the best data and information available to develop the species selection criteria used in both **Preferred Alternative 2** and **Alternative 3** to best manage the federal fisheries of Puerto Rico. However, that process depended largely on the order that the criteria are applied, and because **Alternative 3** decreases the effectiveness of that process by allowing for some criteria to be excluded, or for a different order to be applied, **Preferred Alternative 2** may be a better choice for determining which species to manage.

### 4.2.2 Direct and Indirect Effects on the Biological/Ecological Environment

**Alternative 1** would retain the same indirect effects to the biological/ecological environment as those previously analyzed and described in the 2010 and 2011 Caribbean ACL Amendments (CFMC 2011a, b), but it would not allow for the inclusion of new species for management. Since those amendments were published, other species have been identified as playing an important role in Puerto Rico's fisheries and/or the coral reef ecosystem supporting those fisheries and may be in need of protection. **Alternative 1** would not allow new species to be added to the Puerto Rico FMP, thus would be expected to have indirect biological/ecological effects as it would not extend management to other species in need of conservation and management based on the criteria established in the Magnuson-Stevens Act. The Council would not set management reference points or other conservation measures for those species, or otherwise ensure those species are managed in a manner that prevents overfishing while achieving, on a continuing basis, the OY from the fishery. In addition, the Reef Fish, Queen Conch, Spiny Lobster, and Coral FMPs are Caribbean-wide, and **Alternative 1** would retain species that might not be as applicable for the Puerto Rico FMP due to the geography and location of management zones.

Finally, in response to changing environmental (e.g., habitat availability or health) or anthropogenic (e.g., fishing practices) factors, the species to be managed need to be reevaluated periodically to maximize biological as well as socioeconomic benefits. Under **Alternative 1**, that opportunity is lost, as the Council would take no action to reevaluate and revise (as appropriate) the species to be included for federal management.

Sixty-three species of finfish, queen conch, spiny lobster, and all species of coral, sea cucumbers, and sea urchins would be managed in the Puerto Rico FMP under **Preferred Alternative 2**. Chapter 2 includes a description of the affected corals. Like **Alternative 1**, **Preferred Alternative 2** would continue to manage species considered to be classified as overfished in U.S. Caribbean federal waters (queen conch, Nassau grouper and goliath grouper), or for which harvest is prohibited due to their ecological importance (rainbow, blue and midnight parrotfish), or for species that have seasonal closures or size limits (queen conch, spiny lobster and select snappers and groupers). These species are susceptible to excess fishing pressure and/or vulnerable to environmental conditions. Unlike **Alternative 1, Preferred Alternative 2** has the flexibility to include species that that were not included in the previous FMPs, but are currently considered to be biologically vulnerable or ecologically important. This would include species such as the giant manta ray, which was listed in January 2018 as threatened under the Endangered Species Act (ESA). Similarly, under **Preferred Alternative 2**, the Council would choose to include all species of sea urchins and sea cucumbers found in U.S. Caribbean waters off Puerto Rico, increasing the protection of these benthic species and their habitat, as harvesting techniques for these species could be destructive to coral reef resources. **Preferred Alternative 2** would also benefit the biological/ecological environment indirectly by establishing catch limits for highly targeted stocks that are currently without management measures, like dolphin and wahoo. Establishing harvest limits for these pelagic stocks would provide a more comprehensive management of the Puerto Rico coral reef ecosystem.

Conversely, NMFS' NS guidelines state that the principle implicit in NS7 is that not every fishery needs regulation. As such, not all species that are landed in Puerto Rico or that were included in the Reef Fish FMP list of managed species are appropriate for management in federal waters off Puerto Rico. During the stepwise process of **Preferred Alternative 2**, expert analysis guided by available data identified species that were either infrequently caught in federal waters or primarily caught in territorial waters, which were then excluded from federal management. Removal of species preliminarily caught in territorial waters or those with low or infrequent catch levels in federal waters would allow management efforts to be concentrated on the more heavily targeted and exploited stocks that are in need of management, thus providing increased benefits to the biological/ecological environment. Some of those species with low or infrequent landings may provide a valuable service to the ecosystem, and would potentially require management measures. Contrary to **Alternative 1**, revising federal fishery management in the Puerto Rico EEZ in **Preferred Alternative 2** provides the opportunity to reevaluate managed

species in response to changing environmental (e.g., habitat availability or health) or anthropogenic (e.g., fishing practices) factors to maximize biological as well as socioeconomic benefits.

With respect to ESA listed species, **Preferred Alternative 2** would include for management all corals, sea cucumbers, and sea urchins, which could reduce direct (habitat) and indirect (grazers) effects to ESA coral critical habitat. Species new to management proposed under this alternative would not be expected to increase impacts to ESA-listed species, as the gear types used in the harvest of these species were previously considered and analyzed under the 2011 Biological Opinion of the Reef Fish FMP (F/SER/2010/06680).

Unlike **Preferred Alternative 2**, which follows a regimented process including an integrated attributes analysis, **Alternative 3** does not require that the Council use all of the determined selection criteria, or apply them in a logical, stepwise process. This added flexibility could have greater negative indirect effects on the biological/ecological environment than either **Alternative 1** or **Preferred Alternative 2**, depending on the outcomes of those selections. For example, if Criterion A was not applied, then the species that are overfished or undergoing overfishing and most in need of conservation and management would not be included, indirectly increasing adverse effects to the biological/ecological environment. Or, if Criterion B was not applied, then species that are harvested primarily in territorial waters or infrequently in federal waters could be included in the FMP. In theory, including species in the FMP, establishing management measures, and constraining fisheries to ACLs would provide biological and ecological benefits; however, for some species, the landings data that would be used to define the ACLs would be generally insufficient to provide meaningful management benchmarks because they are landed in such small quantities. Also, because a small portion of the overall fishing activity for those species occurs in federal waters, any conservation and management measures applied to federal waters are not expected to have a noticeable effect on their populations.

In summary, relative to **Alternative 1** and **Alternative 3**, **Preferred Alternative 2** would be more beneficial to the biological/ecological environment because it would (1) direct resources to the management and protection of species that are truly in need of conservation and management; (2) allow inclusion of species that have not been previously subject to conservation and management; and (3) remove current management measures in place for species that are not targeted in federal waters. That rearrangement of species to be managed would increase the likelihood of sustainable harvest, as a means both to enhance food security for the island of Puerto Rico and to rebuild and sustain the natural ecological balance of the coral reef ecosystem within the context of sustainable harvest.

### 4.2.3 Direct and Indirect Effects on the Economic Environment

Management alternatives considered under this action are largely administrative in nature and therefore would have no direct economic effects. **Alternative 1** (no action) maintains the status quo with species subject to management remaining unchanged. While largely administrative in nature, there may be some indirect economic effects associated with maintaining the status quo. First, there may be species not included under the no action alternative which are in need of management for the realization of long-term maximum benefits derived therefrom. Specifically, some species commonly found in federal waters but not included in the no action alternative may be vulnerable to overfishing. Exclusion of these species from the Puerto Rico FMP translates to an inability to properly manage these species to ensure a stock level above that associated with an overfished condition. Second, enforcement is limited in the U.S. Caribbean and the current inclusion of species in the existing FMPs (i.e., queen conch, spiny lobster, reef fish, and coral) not in need of management may detract from enforcement activities for those species in greater need of monitoring and enforcement.[52]

Like **Alternative 1**, **Preferred Alternative 2** is largely administrative in nature though selection of **Preferred Alternative 2** would likely entail numerous economic effects. From an economic perspective, species included under Criterion A as a result of being in an overfished status (as defined by NMFS) would, in the long run, allow for the rebuilding of respective stocks under proper management. Rebuilding of the respective stocks would, after sufficient recovery (i.e., no longer being declared as overfished), potentially allow for commercial and/or recreational harvests of these species (i.e., Nassau grouper, goliath grouper, and queen conch) and presumably the associated economic benefits.[53] Similarly, protection of species and corals due to their ecological importance (as habitat in the case of corals or habitat engineers in the case of midnight, blue, and rainbow parrotfish) would allow for a more 'healthy' ecosystem upon which other species rely upon. A healthier ecosystem implies a larger carrying capacity for other species dependent upon that ecosystem which maps into larger stocks (controlling for other factors) and greater fishing opportunities by the commercial and recreational sectors. Finally species for which seasonal closures or size limits apply are also included in the Puerto Rico FMP under Criterion A. Presumably, these regulations were initiated out of concern that the respective species were susceptible to overfishing in the absence of regulation and/or that benefits derived from commercial and recreational activities could be enhanced via regulation.

[52] The outcome of this, of course, depends upon what species are added and what species are deleted in the Puerto Rico FMP in relation to the no action alternative (**Alternative 1**). This is discussed in greater detail in association with the other alternatives under this Action.

[53] A qualification needs to be given here. Most commercial fisheries in Puerto Rico are not restricted in terms of access. Being largely 'open access', these fisheries likely generate little producer surplus. While the rebuilding of stocks and increased harvests may allow for the generation of some short-run producer surplus (profit), this will likely be dissipated over time.

Including these species in the Puerto Rico FMP would help to ensure that benefits would not be reduced as might be the case should the species not be included.

Criterion B, as noted, would exclude from federal management those species that have been determined to infrequently occur in federal waters based on expert analysis guided by available data. Given rare occurrence, implying that these species contribute little to commercial or recreational catches, one would anticipate no direct economic effects associated with exclusion of these species from the Puerto Rico FMP.[54] Given limited enforcement capabilities in the region, furthermore, exclusion of these infrequently harvested species may also allow for enhanced enforcement activities associated with those species of greater economic relevance.

These species include some snappers, groupers, parrotfish, surgeonfish, triggerfish, wrasses, angelfish, barracudas, tripletail, manta ray, spotted eagle ray, and southern sting ray. Commercial as well as recreational landings of some of these species tend to be relatively limited and targeting of any of these species is likely very limited. Rather, catches would likely be incidental; often in conjunction with catch of a targeted species. Inclusion of these species is largely administrative in nature though indirect economic losses associated with not managing these species could be forthcoming if the rate of fishing (*i.e.*, fishing pressure) is large relative to their ability to reproduce, thereby resulting in declining harvests.

Among the remaining species after completing the first three steps in the sequential stepwise process (i.e., Criteria A through C), the fourth step (Criterion D) is to include those species possessing economic importance to the national or regional economy based on a threshold of landings or value separately determined for each of the recreational, commercial, and aquarium trade sectors as appropriate and those representing an important component of bycatch, as established by expert analysis. This step would add an additional 14 species to the Puerto Rico FMP. Addition of these species would be largely administrative in nature but there could be some indirect economic impacts. Furthermore, historical landings associated with some of the species which would be added under Criterion D are relatively large and are migratory in nature (e.g., dolphin fish, blackfin tunny, little tunny, wahoo, cero, and king mackerel). The migratory nature of these species calls into question the benefits of including them in the Puerto Rico FMP. While inclusion of these species is largely administrative in nature, the relatively large landings of some of these species imply that subsequent regulations can have substantial economic impacts. Until such regulations are specified, however, one cannot determine with the economic impacts to the commercial and recreational sectors are positive for both sectors, negative for both sectors, or mixed (*i.e.*, positive for one of the sectors but negative to the other sector).[55] Finally,

[54] This assertion is, of course, conditioned on Criteria A and C (inclusion of species that, even if rarely harvested, have essential ecological value).
[55] Given that there are no permit requirements associated with the commercial harvesting of these species, any producer surplus generated as a result of regulation would likely be transitory in nature.

to fully consider economic impacts that may, in the long run, be attributable to including many of the species listed under Criterion D in the Puerto Rico FMP, one must consider how limited enforcement reacts to regulation associated with these species. This may be an important consideration given the large landings and, hence, possible large enforcement activities that would detract from other enforcement activities.

Criterion is administrative and (i) given the very limited landings of those species that might be included and (ii) given that species in need of conservation and management would be already protected (see Criterion A), no economic impacts would be expected from Criterion E.

Unlike **Preferred Alternative 2**, which follows a regimented process including an integrated attributes analysis, **Alternative 3** does not require that the Council use all of the determined selection criteria, or apply them in a logical, stepwise process. This added flexibility could have lesser or greater indirect effects on the economic environment than either **Alternative 1** or **Preferred Alternative 2**, depending on the outcomes of those selections. Because so many options are available under **Alternative 3**, it is not possible at the present time to fully evaluate the direct and indirect effects of choosing **Alternative 3**. A more thorough analysis of direct and indirect effects associated with **Alternative 3** can be developed only with additional guidance as to the criteria to be included and the order of application of those criteria. However, the Council when considering this alternative decided to eliminate it from further study.

### 4.2.4 Direct and Indirect Effects on the Social Environment

The social effects from adding species to the list of stocks to be managed are indirect benefits that help fulfill the goals of the FMP and protect stocks that are important both economically and socially to Puerto Rico stakeholders. Under **Alternative 1** (No Action) those species that are currently managed under the old FMPs are included in the stock/stock complexes but does not add new species nor are species excluded that are not relevant. Not tailoring the list of stocks to be managed to those species of interest to Puerto Rico, would be contrary to the purpose of developing an Island-based FMP. With **Preferred Alternative 2**, a stepwise process using the identified criteria allows for a more methodical approach that takes into consideration biological, socioeconomic, and ecological considerations for Puerto Rico fisheries that should have indirect beneficial social effects. The process under **Preferred Alternative 2** uses an expert panel and other management panels to apply the criteria that give a broad interpretation of social, economic, and ecological importance which should benefit the stocks included and the fishery and more meaningfully meet the intent of creating an Island-based FMP. Including specific species in the management unit that are relevant to Puerto Rico fishermen and stakeholders would facilitate monitoring and assessment which is critical to ensuring stock status remains above critical thresholds of overfishing and overfished status. It also provides monitoring of fishing activity that can provide important information in determining whether actions may need to be undertaken to meet social and economic objectives within the Puerto Rico FMP. The

criteria included in **Preferred Alternative 2** serve different purposes as discussed in Section 2.2.2. All of these criteria offer an opportunity to consider social, economic, and ecological benchmarks by which to include species that are important to Puerto Rico into the FMP and should have positive social effects although indirect.

Similar to what was discussed above for economic effects, the flexibility provided by **Alternative 3** could have lesser or greater indirect effects on the social environment than either **Alternative 1** or **Preferred Alternative 2**, depending on the outcomes of those selections. Because so many options are available under **Alternative 3**, it is not possible at the present time to fully evaluate the direct and indirect effects of choosing **Alternative 3**.

### 4.2.5 Direct and Indirect Effects on the Administrative Environment

**Alternative 1** would not result in increased administrative effects associated with selecting stocks to be included for management because the Reef Fish, Spiny Lobster, Queen Conch and Coral FMPs already have the list of species in place. However, there would be some administrative costs associated with retaining the current management measures in place for those stocks if the current management measures continually result in the need to apply AMs. For example, recent analysis of spiny lobster carapace length data indicates a healthy population, yet in 2016 and 2017, AMs were applied to the Puerto Rico spiny lobster season in response to an exceedance of the ACL. Although the costs associated with implementing AMs are not well known, retaining outdated management measures would certainly add to the administrative workload. Also, continuing to monitor stocks that may not be landed primarily in federal waters would increase administrative effects, especially if that monitoring required additional administrative action.

**Preferred Alternative 2** would in the future result in increased administrative impacts associated with establishing ACLs and AMs for stocks new to management, but would also have decreased costs associated with the stocks that were removed from the previous FMPs. Under Criterion B, 26 individual species of fish and all finfish and invertebrates included in the aquarium trade categories in the Reef Fish and Coral FMPs, would be excluded from the Puerto Rico FMP. The decreased administrative costs for those removed stocks would be expected to outweigh the costs associated with adding the 18 new fish stocks and new invertebrate groups included for management under this alternative. Even though all species of corals, sea urchins, and sea cucumbers would be included in the Puerto Rico FMP, which would potentially include hundreds of species, they would be managed at either the Class (sea urchins and sea cucumbers) or Order (corals) level, requiring management measures for only three complexes.

Administrative effects related to **Alternative 3** are harder to anticipate, as it is unknown at this time which of the species selection criteria may be applied, or in what order. In general, the

administrative costs would be expected to increase if species are included for management, as they would require management measures be established and harvest levels be monitored annually. There is a greater risk under **Alternative 3** of including stocks not appropriate for federal management (i.e., primarily caught in territorial waters, or low of infrequent landings from federal waters), thereby increasing the burden on the administrative environment.

## 4.3 Action 3: Compose Stock Complexes and Identify Indicator Stocks as Appropriate - Environmental Consequences

### 4.3.1 Direct and Indirect Effects on the Physical Environment

Action 3 (revision of stocks) is primarily an administrative action because grouping species into stock complexes and selecting indicators stocks does not directly affect how the fisheries operate (*i.e.*, gear types used) and is not expected to have direct effects on the physical environment. Indirect effects may apply depending if stock complexes or indicator stocks were selected for management.

**Alternative 1** (No Action) would bring all stocks and stock complexes as they are currently managed in the Reef Fish, Queen Conch, Spiny Lobster, and Coral FMPs into the new Puerto Rico FMP. **Alternative 1** would continue to manage 139 reef fish species in 23 stock complexes, including the finfish and aquarium trade stock complexes, as well as the spiny lobster, queen conch, and corals stocks/stock complexes. Indirect effects to the physical environment could continue to occur based on interactions of the fisheries with the sea floor, but the effects would not be expected to be greater that those previously discussed in the 2010 and 2011 Caribbean ACL Amendments (CFMC 2011a, b) as the way the species are grouped or not grouped is not expected to impact the amount of effort or gear types used.

**Alternative 2** would not establish stock complexes, but rather would manage all species as individual stocks, resulting in one spiny lobster, one queen conch, 63 individual reef fish stocks and an unknown number of coral, sea urchin and sea cucumber stocks. Even though the species would be managed as individual stocks under this alternative, fishing practices would not be expected to change, so any direct or indirect effects to the physical environment would be expected to be the same as in **Alternative 1**.

Under **Preferred Alternative 3,** the species or species groups selected for management in Action 1 would be managed as 18 individual stocks and 19 stock complexes. These stocks and stock complexes would be grouped based on the similar characteristics of the current Puerto Rico fisheries, like gear type used and depth and/or habitat targeted. Updating the stocks/stock complexes using recent data and information pertaining to the current fisheries would be

expected to increase the overall effectiveness of established management measures, when compared to historical stocks/stock complexes, and decrease the potential for negative impacts to the physical environment.

**Alternative 4** determines whether to assign indicator species to a stock complex (**Preferred Sub-alternative 4a**) or to not assign indicator species (**Preferred Sub-Alternative 4b**), neither of which would be expected to change fishing practices or have additional direct or indirect effects on the physical environment relative to the status quo.

### 4.3.2 Direct and Indirect Effects on the Biological/Ecological Environment

Action 2 is primarily an administrative action because grouping species into stock complexes and selecting indicators stocks does not directly affect how the fisheries operate (*i.e.*, amount of fish caught) and is not expected to have direct effects on the biological/ecological environment. Indirect effects may apply depending if stock complexes or indicator stocks were selected for management.

**Alternative 1** (no action) is not expected to have direct impacts to the biological/ecological environment because it is not changing the amount of allowable harvest, it would be expected to have indirect effects due to the stocks/stock complexes that would be managed. At the time the 2010 and 2011 Caribbean ACL Amendments were developed, the stocks/stock complexes that were established were based on the best available information at that time, but that information is not necessarily applicable to the way the fishery operates at this time. Additionally, those stocks/stock complexes were established for the entire U.S. Caribbean and might not be suitable to an island-based FMP for Puerto Rico. Since no stock complexes were previously established for the species that were selected as new to management in Action 1, they would be managed as individual stocks.

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**Alternative 2** would not group species into stock complexes and would result in management measures being established for each individual stock, even if life history information or landings data are not available for that species. Magnuson-Stevens Act NS3 states that interrelated stocks of fish shall be managed as a unit or in close coordination and guidance from the recently amended NS1 defines a stock complex as a group of stocks that are sufficiently similar in geographic distribution, life history, and vulnerabilities to the fishery such that the impact of management actions on the stocks is similar (74 FR 3178). Thus, by not allowing for species to be grouped into stock complexes, **Alternative 2** would be expected to result in ineffective management measures and additional burdens to the biological/ecological environment.

Stock complexes established under **Preferred Alternative 3** would be more likely to be based on the most recent information available and therefore more representative of the current fisheries. Currently, stock assessments are not available for the majority of U.S. Caribbean

species, and so grouping unassessed stocks into complexes may help to avoid implementing AMs for species whose landings fluctuate due to rarity or species identification issues. National Standard guidelines state that stocks may be grouped into complexes if: (1) they cannot be targeted independently of one another in a multispecies fishery; (2) data are insufficient to measure their status relative to established status determination criteria; or (3) when it is feasible for fishermen to distinguish individual stocks among their catch (50 CFR 600.310 (b) (8) in 74 FR 3178). Those criteria are applicable to several species that were selected for management under the Puerto Rico FMP, and were considered by the Council and expert panel when the stock complexes were assigned. This alternative would be expected to result in more careful and responsive management of the fisheries, and provide increased benefits, albeit indirect ones, to the biological/ecological environment.

**Alternative 4** could be applied to each stock complex as necessary, depending on the desire to select (**Preferred Sub-alternative 4a**) or not select (**Preferred Sub-alternative 4b**) indicator species for the complex. While this alternative is administrative, **Preferred Sub-alternative 4a** increases the potential benefits to the biological/ecological environment as the selected indicator stock can be used to help manage and evaluate more poorly known stocks within a stock complex. If an indicator stock is selected, it would represent the typical vulnerability of the stocks within the complex, with special regard to interactions with the fishery. Indicator species minimize the risk associated with the probability of overfishing, as all species in the stock complex are managed under the measures created for the indicator species. Conversely, having the option to not select an indicator stock, as in **Preferred Sub-alternative 4b,** would provide flexibility in creating management measures for stock complexes for which an appropriate indicator cannot be identified. In those instances, the management measures would be based on the complex as a whole, thus providing increased biological/ecological benefits to the species within the complex. For each stock complex established in **Preferred Alternative 3**, the Council's SSC determined whether or not an indicator species would provide additional biological benefits.

With respect to ESA listed species, no direct effects are expected from this action, as it re-organizes how stocks are grouped, or not grouped, which would not be expected to alter fishing practices in the Puerto Rico EEZ management area. Indirect effects to ESA-listed species may occur through the improved management of stocks (e.g., restructuring stock complexes to more accurately reflect current fishing practices may reduce the amount of regulatory discards and/or bycatch) that were updated under this action using applicable scientific analysis and expert opinion from the scientific and fishing communities.

### 4.3.3 Direct and Indirect Effects on the Economic Environment

Overall, the arrangement (or change in arrangement) of species into stocks and stock complexes, as proposed under Action 3, would not result in direct economic effects. This is because it is not expected to influence current harvest or use of the resource and direct effects are manifested via management actions that influence current harvest and resource use. **Alternative 2** would constitute the simplest of the proposed alternatives since it does not organize species into stock complexes. As noted in section 2.3, however, all species may not benefit from being managed as individual stocks due to issues associated with identification of some individual species and unreliability of landings associated with the 'more' infrequently caught species. Both of these factors would likely result in establishment of reference points in instances where little is known about the 'true' stock status. Furthermore, the 'more' infrequently landed species are not targeted by commercial and recreational fishermen but are instead caught in conjunction with other species (*i.e.*, they are a part of a multi-species fishery). Thus, efforts to protect the stock status of these infrequently caught species via ACL's, are likely to be relatively ineffective (assuming a high discard mortality which would likely be the case for, at least the reef fish species, given the depth of federal waters) unless catch of the other targeted species are also simultaneously curtailed. Furthermore, ACL's associated with each individual species within the Puerto Rico FMP would most likely result in a significant increase in administrative burden as AM's would need to be imposed when the ACL's are reached. These frequent AM's can be disruptive to the fishing communities.[56]

Like **Alternative 2**, **Alternative 1** is not expected to influence current harvest or use of the resource and thus has no direct economic effects. Given that many of the fisheries in Puerto Rico are multi-species in nature, however, management of fishery complexes as in **Alternative 1**, via regulation, can result in different economic outcomes than managing at the individual stock level (**Alternative 2**). Specifically, managing at the individual stock level is likely to result in more regulatory discards than that which would occur under **Alternative 1**. Hence, benefits associated with **Alternative 2** are less than those of **Alternative 1**.

.[57] **Preferred Alternative 3**, like **Alternative 1**, would use the concept of stocks and stock complexes to manage species (the selection of which is derived from the outcome of Action 2). However, the designation of stocks and stock complexes would differ from those designated in **Alternative 1** (see Tables 5.8.1 and 5.8.2 for **Alternative 1** and 5.8.3 for **Preferred Alternative 3**). A comparison of **Alternative 1** with **Preferred Alternative 3** indicates that much (though not all) of the differences in the arrangement of stocks (stock complexes) represents inclusion of species managed individually in **Alternative 2** into various stocks and stock complexes in

[56] The disruption is not as much a result of needing to curtail/change fishing practices but, rather, staying informed of the numerous AM's that might be forthcoming. Given the low landings of these 'infrequently' caught species, short-term producer surplus will likely not be reduced significantly with even numerous AMs specific to the infrequently caught species.

[57] See Section 2.3 for detail regarding types of scientific analysis which would be considered in development of the stocks and stock complexes.

**Preferred Alternative 3** (e.g., yellowmouth grouper would be managed under GU4 in **Preferred Alternative 3** rather than as an individual species in **Alternatives 1** and **2**). Other changes in stocks and stock complexes represent additional scientific information that allowed for a 'better' (in terms of scientific justification) specification of the stocks and stock complexes. Many of the species being added to a stock or stock complex in **Preferred Alternative 3** which would be managed at the species level in **Alternative 2** (as well as removing a species under one stock or stock complex in **Alternative 2** and putting it into a different stock or stock complex in **Preferred Alternative 3**), represent 'minor' species in that annual landings are relatively limited.

Like **Alternative 1** and **Alternative 2**, **Preferred Alternative 3** is not expected to directly affect the economic environment because it does not directly change the current harvest or use of the resource. Subsequent regulations, such as implementation of AMs, could trigger a change in the economic environment. Given the language in the previous paragraph regarding primary differences between **Alternative 2** and **Preferred Alternative 3**, furthermore, changes in the economic related to **Alternative 2** are compared to changes related to **Preferred Alternative 3**. While differences between **Alternative 2** and **Preferred Alternative 3** are relatively minor (in terms of changes in the economic environment that may be forthcoming with regulation), better and more recent scientific information is used in **Alternative 3** to create stock complexes than is the case with **Alternative 2**. As such, there is likely a better chance of setting ACLs that would provide adequate protection of the stock with **Preferred Alternative 3** than with **Alternative 2** which, overtime, would provide greater indirect economic benefits.

**Preferred Alternative 4**, **Preferred Sub-alternative 4a** or **Preferred Sub-alternative 4b** would not be expected to directly affect the economic environment because they not directly change the current harvest or use of the resource.

Assuming subsequent regulation (the outcome of **Preferred Alternative 3**), however, the economic outcome of assigning one or more indicator stocks for stock complexes could have important implications relative to not assigning indicator stocks. This would depend upon two factors: (a) the indicator stock selected and (b) the 'jointness in catch' among the individual stock in the complex.[58] Presumably, the indicator species selected would reflect those species which provide the most informative catch data.[59] If this is the situation and if catch in the multispecies fishery is highly joint in nature, use of indicator stock can help manage and evaluate the conditions for some of those species for which catch and other relevant data that can be used in the management process are less informative. Thus, use of one or more indicator stocks could be used to better assure that catches of more infrequently caught species (which have less

[58] Jointness in catch reflects the inability of the fishermen to change fishing practices in a manner that will change species composition in the multispecies fishery.
[59] See Section 5.2 for the set of criteria that may be used to select one or more indicator species.

informative data) would not be overfished, which would then detract from any long-term benefits from harvesting these species. If true jointness does not exist in the harvesting (production) process, however, any economic benefits that might be derived from the use of indicator stocks may also be diminished.[60]

### 4.3.4 Direct and Indirect Effects on the Social Environment

The social effects from establishing stock complexes are likely to be indirect as many of the impacts would come from the thresholds for ACLs and other reference points that are determined for each stock complex as a result. This solution helps resolve the problem of placing reference points on each individual stock, especially those that do not have stock assessments, which can place unnecessary burdens on different fishing sectors according to their fishing practices for a particular species. **Alternative 1** would organize stocks and stock complexes as they are currently under the existing FMPs, which could induce a slightly cumbersome management regime for new single species that are added to the FMU and are not included in other stock complexes. Those species that are not in complexes would need to have reference points established individually, such as ACLs, MSY and others which may prove difficult if data are not available. Without reliable and consistent data, the reference points that are established and AMs that could follow may create closures and other problems that disrupt current fishing patterns.

By grouping species according to the methodology in **Alternative 2**, the burden of placing reference points on individual stocks would create an even more difficult management regime that would stem from the lack of consistent and reliable data on certain stocks. Without consistent and reliable data for some stocks, as mentioned previously, establishing reference points with little or no data could trigger unnecessary and onerous management that could have complex negative social effects.

With **Preferred Alternative 3** the selection of stock complexes or single stocks would entail a process that includes analysis and review by expert and experience based panels that provide extensive input into the process of creating stock complexes and single stocks groupings. Such a process garners both scientific and public support and can provide a more consistent approach that is in line with the purpose of creating FMPs that are tailored for each island or island group.

**Alternative 4** would allow the Council to choose indicator stocks that have measurable SDC that would be used to set criteria for a particular complex, which should have beneficial indirect social benefits as it would allow for monitoring of those species with little or no information and

[60] As noted, entry into most of the fisheries in the Federal waters off of the Puerto Rico coast is not limited which would tend to suggest relatively limited producer surplus. This fact and the fact that the landings of the more infrequently harvested species are more limited suggest that economic benefits associated with the use of one or more indicator stocks will be limited.

facilitate setting status determination criteria. Under **Alternative 4, Sub-alternative 4a** criteria are used to select indicator stocks along with expert and experiential input which should add more confidence the selection of future status determination criteria for the complexes. With **Alternative 4, Sub-alternative 4b** those stocks or complexes for which the criteria do not apply no indicator species would be chosen and AMs would be established for the group based upon the aggregate ACL. It is anticipated that the preferred alternatives would have positive social benefits through practical grouping that is less cumbersome than single species ACLs and the selection of indicator species where possible would provide some oversight, albeit a proxy. However, the formation of ACLs for grouped stocks and the use of indicator stocks may induce some changes in fishing behavior if unanticipated closures occur as a result of these thresholds being exceeded. However, in the long term, if these measures provide sufficient protection for stocks there should be positive social effects.

### 4.3.5 Direct and Indirect Effects on the Administrative Environment

**Alternative 1** would result in increased administrative impacts associated with establishing stocks and stock complexes for the species new to management, but not for those previously managed in the Reef Fish, Spiny Lobster, Queen Conch and Coral FMPs, as these groupings are already in place. Indirect administrative effects could also occur if the stock complexes in those FMPs are now considered to be outdated, resulting in additional administrative actions from the continuation of management for those stock complexes.

**Alternative 2** would result in the greatest administrative burden, as it would require that management measures be established for 68 individual stocks. Some of these species are misidentified or misreported or have extreme fluctuations in landings through time due to rarity, or lack of targeted fishing effort. Thus, specifying individual management measures for these stocks might result in periodic overages that would require AM implementation, creating additional burdens on science and enforcement in the future.

**Preferred Alternative 3** would increase the number of stock/stock complexes, generally increasing the effects to the administrative environment. However, the long-term effects of this alternative would be expected to be reduced through better management of the stocks in the Puerto Rico FMP, as the stocks and stock complexes were selected using the best information available. Thus, it would be expected that the number of administrative actions related to these stocks/stock complexes would be fewer and less frequent than the status quo.

Both **Preferred Sub-alternative 4a** and **Preferred Sub-alternative 4b** would be expected to have no direct effect on the administrative environment. However, depending on the determination of an indicator stock for the complex, the process for establishing management measures would be slightly different and could have differing administrative effects. For those stock complexes where an indicator stock was selected (**Preferred Sub-alternative 4a**), the

process for establishing management measures would be similar to single species stocks, which is a simpler process. For those stock complexes where an indicator was not selected (**Preferred Sub-alternative 4b**), establishing management measures would require an extra step to combine the data for the stocks within that complex. Similarly, monitoring the multi-species complexes without an indicator would require that additional step before determining if the ACL was exceeded. Overall, the expected effects of selecting or not selecting an indicator species would be expected to be minimal, as those determinations were based on the best available information at the time and would provide managers with increased flexibility in the monitoring and management of stock complexes.

## 4.4 Action 4: Establish Status Determination Criteria and Management Reference Points: Environmental Consequences

### 4.4.1 Direct and Indirect Effects on the Physical Environment

**Alternative 1**, the no action alternative, would result in the continuation of SDC and management reference points established in the 2010 and 2011 Caribbean ACL Amendments and the Caribbean SFA Amendment. **Alternative 1** simply carries over the existing reference points and SDC. **Alternative 1** does not respond to and incorporate additional data, and does not adapt to a changing suite of managed stocks. In particular, stocks newly added to the Puerto Rico FMP would not be accounted for in **Alternative 1**, and would not meet the requirements of the Magnuson-Stevens Act. Adoption of **Alternative 1** could create potential short- and long-term negative effects on the physical environment because harvest levels and associated fishing activities would not be specified, monitored, or managed for newly added stocks. This could result in higher levels of gear deployment, potentially including those presently employed gear types that may negatively impact the physical environment.

Under **Preferred Alternative 2**, continuing the pattern of sector-based fishing existing during the reference landings period upon which each sector's reference points were based would not cause changes to the physical environment. Although each sector employs different gear types and practices to pursue a particular stock, resulting in differential impacts to the physical environment from the pursuit of that stock, those impacts would be expected to follow the reference period pattern of impacts.

**Preferred Alternative 3** would define a *three-step process* to specify new reference points for all stocks and stock complexes (as appropriate) proposed for management in the Puerto Rico FMP. Applying the best scientific information available to ensure federally managed stocks are harvested sustainably over the long-term ensures those finfish and invertebrate populations supporting harvest are exploited to the greatest practicable extent while protecting reproductive

capacity and maintaining effective ecological contributions. Establishing appropriate harvest reference points, taking into account both the biological needs and the ecological contributions of the stock as would be prescribed by **Preferred Alternative 3**, provides positive short- and long-term benefits to the physical environment both directly by managing fishing effort and associated gear impacts and indirectly by managing the ecological integrity of the coral reef ecosystem.

**Alternative 4** would follow the SDC and reference point setting methodologies developed in the 2010 and 2011 Caribbean ACL Amendments. However, unlike **Preferred Alternative 3**, **Alternative 4** would not apply the best scientific information available and would not be based on the recommendations of the Council's SSC or the SEFSC. Those same methodologies were used to establish the SDC and reference points that would be applied under **Alternative 1**. The final step in **Alternative 4** is to set the ACL by applying a reduction buffer to the ABC to account for uncertainty in the management process. The specific effects would depend on the choice of sub-alternative and cannot be fully analyzed prior to that Council decision. Suffice to say that, in general, the benefits to the physical environment would be enhanced with a larger buffer between ABC and ACL.

Effects to the physical environment resulting from implementation of **Alternative 4** would be expected to be more beneficial than those that would be realized from implementation of **Alternative 1** but less beneficial than those that would be realized from implementation of **Preferred Alternative 3**. For data poor situations, **Preferred Alternative 3** is a tiered control rule that allows for and anticipates updates with additional information, but **Alternative 4** sets a specific process regardless of information. Thus, providing a mechanism for developing reference points for all managed species, as called for in **Alternative 4**, could result in positive effects, but the extent of those positive effects would be limited by an inability to consider and apply the best scientific information available and to update management as those data expand and improve.

### 4.4.2 Direct and Indirect Effects on the Biological/Ecological Environment

Direct and indirect effects would result from the revision (stocks presently managed in U.S. Caribbean EEZ waters) or establishment (stocks newly added to the Puerto Rico FMP) of management reference points. Reference points directly affect how the fisheries operate (i.e., amount of fish caught) and are therefore expected to have direct effects on the biological/ecological environment. In addition, indirect effects such as effects on other species (e.g., trophic interactions) may be experienced. Those direct and indirect effects would differ depending upon the alternative chosen by the Council for establishing management reference points, and are discussed below.

Under the no action **Alternative 1**, management reference points and in particular ACLs would be carried over from the presently established Reef Fish, Spiny Lobster, Queen Conch, and Coral

FMPs. Those reference points resulted from a lengthy process of data evaluation and analysis led by the Council's SSC, as described in the 2010 and 2011 Caribbean ACL Amendments (CFMC 2011a, b), and remain valid within the context of that process. However, that context is founded upon commercial and recreational landings data obtained during those years for which the landings data were available and were considered valid at the time. While the validity of the reference year data has changed little (with the exception of 2005), the years during which landings are available has changed. For those stocks (snapper, grouper, parrotfish, queen conch) addressed in the 2010 Caribbean ACL Amendment, the most recent reference year was 2005, whereas for the remaining stocks under federal management, the most recent reference year was 2009. As reference points are reevaluated for application in the Puerto Rico FMP, additional years of data are available extending through 2016.

If **Alternative 1** is chosen as the reference setting approach, those more recent years of landings data would not be considered. Much has changed with commercial and recreational fisheries in Puerto Rico EEZ waters since 2009, and even more so since 2005. In particular, implementation of the 2005 SFA Amendment (CFMC 2005) along with the 2010 and 2011 Caribbean ACL Amendments altered many facets of the regulatory environment in Puerto Rico EEZ waters, for example by establishing area and season closures, altering the composition of the managed fisheries, and implementing ACLs and AMs. In some instances it may be appropriate to use only reference years preceding some or all of those events, as landings during those years may best represent a sustainable harvest level. But for other components of Puerto Rico EEZ commercial and recreational fisheries, accounting for those changes best represents modern fishing practices as well as fishing activity into the future. These recent events would not be considered by the Council under **Alternative 1**. This could result in potentially direct negative effects by not ensuring each stock in the Puerto Rico FMP is managed at OY. **Alternative 1** also may result in negative indirect effects by not allowing the Council to properly address ecological functionality such as those associated with trophic interactions (including grazing capacity) to the extent those interactions can be influenced by fishery management.

Of equal or greater effect, reference points for those species newly added to management would not be specified under **Alternative 1**, including for such economically important species as the dolphinfish complex and such ecologically important stocks as sea urchins. That outcome could result in direct negative biological effects by preventing achievement for OY, as required by the Magnuson-Stevens Act, and indirect negative ecological effects by failing to ensure the provision of essential ecosystem services such as grazing capacity.

**Preferred Alternative 2** would establish that management reference points for a stock/stock complex in the Puerto Rico FMP be allocated by sector (e.g., commercial and recreational), when the data allow. This is an administrative action with minimal direct or indirect biological/ecological impacts. Because sector-specific reference points are included in the

presently existing management reference points applicable to the Puerto Rico EEZ, there would be no difference in outcome between **Alternative 1** and **Preferred Alternative 2** for those species presently managed in the Puerto Rico EEZ that would be carried over into the new Puerto Rico FMP. In contrast, for those species new to management in the Puerto Rico EEZ, there would be a difference in outcome between **Alternative 1** and **Preferred Alternative 2**. However, that difference would be inconsequential with respect to the biological/ecological environment because the total allowable harvest would remain the same (= total ACL) regardless of whether that ACL was subdivided among the commercial and recreational sectors or not. Only to the extent that the total ACL is more frequently obtained by not establishing sector-specific management, and thereby allowing either sector to harvest as much of the ACL as possible, would any direct or indirect effects to the biological/ecological environment be obtained. Those effects would likely be minor, resulting from the amount of harvest taken by one sector, beyond what would be their own (sector-specific) ACL, which would otherwise have been allocated to the other sector but would not have been harvested by that other sector.

**Preferred Alternative 3** would be expected to have positive short- and long-term effects on the biological/ecological environment associated with the Puerto Rico EEZ. Applying the best scientific information available would ensure federally managed stocks are harvested sustainably while protecting reproductive capacity and maintaining effective ecological contributions. The Council and their SSC applied considerable expertise and effort to the process of developing their ABC CR, establishing the process and protocols for implementing that ABC CR, and identifying the best available scientific data and expertise to be used in the ABC CR analytical process. That effort would ensure, to the greatest practicable extent, the most appropriate quantitative estimates of SYL and ABC to ensure sustainability of a stock or stock complex. The Council carefully considered the process applied by the SSC, along with the environment within which management would be applied, when assigning an appropriate buffer to derive the ACL from the ABC established by the SSC. These outcomes provide positive short- and long-term benefits to the biological/ecological environment by reducing the likelihood of stock depletion and by providing guideposts on (SYL) and limits to (ACL) indicative of potential negative trends in reproductive capacity and ecological function. Management measures implemented to achieve the harvest objectives set by the $F_{MSY}$ proxy would directly impact the biological environment in the form of controlling fishing effort. The choice of the $F_{MSY}$ proxy depends on the life history of a species and how much risk the Council is willing to take. **Sub-Alternative 3b**, which uses $F_{40\%SPR}$ as a proxy for $F_{MSY}$ is more conservative and would provide greater assurance overfishing would not occur than the $F_{MSY}$ proxies specified under **Sub-Alternatives 3a** and **3c** (**Preferred**). Therefore, the biological benefits of **Sub-Alternative 3b** would be greater than **Sub-Alternatives 3a** and **3c** (**Preferred**).

Effects to the biological/ecological environment resulting from implementation of any combination of sub-alternatives under **Alternative 4** would be expected to be more beneficial

than those that would be realized from implementation of **Alternative 1** but less beneficial than those that would be realized from implementation of **Preferred Alternative 3**. Providing a mechanism for developing reference points for all managed species, as called for in **Alternative 4**, would result in positive effects, but the extent of those positive effects would be limited by an inability to consider and apply the best scientific information available and to update management as those data expand and improve. Those relative effects would be exacerbated by establishment of a scientifically indefensible and therefore implausible OFL.

With respect to ESA listed species, direct effects could be expected from this action, even though gear types and fishing effort are not expected to substantially differ from those previously analyzed, as it updates ACLs for several stocks previously managed and establishes ACLs for stocks new to management. Additionally, this action would prohibit harvest for all species of corals, sea urchins, and sea cucumbers, and for the recently-listed giant manta ray. However, it is uncertain how fishing under those new ACLs would impact ESA-listed species, since some stock/stock complex-specific ACLs increased while others decreased. These would be considered in the accompanying biological opinion for the Puerto Rico FMP.

### 4.4.3 Direct and Indirect Effects on the Economic Environment

Alternatives under Action 4 outline different approaches for specifying management reference points and SDC. There are four alternatives (along with sub-alternatives) in this section. Management reference points (SDC) are specified to protect stocks (or complexes) from being overfished, while achieving, on a continual basis, optimum yield. Ideally, these alternatives would be analyzed by examining the changes in producer and consumer surplus under each of the alternatives. Given no information on costs in the commercial sector, no information regarding consumer surplus is derived from the commercial harvest, no information on the benefits derived from recreational fishing activities, and no information on the benefits from non-consumptive activities prohibits any in-depth analysis of the changes in producer surplus. Hence, a more general analysis will be presented here relying more on expected changes in catch.

**Alternative 1** maintains the status quo. As such, reference points as specified in the 2010 and 2011 Caribbean ACL Amendments would remain in effect. There are no direct economic impacts associated with maintaining the status quo but there may be indirect effects if the reference points as specified in the 2010 and 2011 Caribbean ACL Amendments are not based on the best available data or, for other reasons, are incorrectly specified.[61] If the status quo ACLs are specified in such a manner that they do not adequately protect stocks/stock complexes,

[61] As indicated in Section 2.4, the timeframe used in calculating management reference points ended in 2005 and recreational data used in the calculations covered only the 2000-2005 timeframe.

there would be indirect economic effects from taking no action to change the ACLs (i.e., assuming sufficient effort, stocks may become overfished). On the other hand, if the no action management reference points are overly restrictive, AMs may be triggered in instances where such action is not warranted (i.e., overfishing on the stocks is not occurring and they are not in an overfished status). These AMs triggered based on incorrect management reference points would result in indirect economic losses.

**Preferred Alternative 2** is an administrative action with no indirect economic impact until such time that subsequent regulations are imposed. Reference points for stocks/stock complexes - MSY, OFL, ABC, OY, and total ACL - are invariant regardless as to whether the stock/stock complex is managed by sector or in total (*i.e.*, combined commercial and recreational). Thus, at least in theory, it makes no difference in terms of protection of the stock/stock complex whether or not management reference points are specified by sector. The economic effects associated with sector reference points, however, would differ from the case where management reference points are specified only for combined recreational and commercial landings (assuming that the reference points are binding; *i.e.*, that landings exceed the ACL). Specifically, without sector management reference points, both sectors would be penalized (via triggering of AMs) if the total ACL (i.e., a combined commercial plus recreational) is met or exceeded. By comparison, with sector management reference points, only that sector that met or exceeded its ACL would be penalized by triggering the AM specific to that sector. If the total ACL was met or exceeded and an AM triggered that resulted in catch restrictions, a loss in producer and consumer surplus in the commercial sector, a loss of consumer surplus in the private recreational sector, and a loss in both producer and consumer surplus in the recreational for-hire sector would be expected. With sector management reference points, exceeding a sector ACL and the total ACL would only reduce surplus on that sector subject an overage. For example, if sector ACLs are specified for yellowtail snapper and the recreational sector meets or exceeds its ACL, while also meeting or exceeding the total ACL, an AM would be triggered. The resultant constraint on harvest would result in a reduction in consumer surplus in the private recreational sector and a reduction in both consumer and producer surplus in the recreational for-hire sector, but no change in the surplus associated with the commercial sector.[62] With a combined ACL, however, AMs would also result in a reduction in surplus emanating from the commercial sector. In other words, costs to society are shifted depending upon whether or not sector specific management reference points are established (again, this discussion is predicated on the assumption that the ACLs are binding and adequately enforced). Not only would there be a shift in costs, but there is no certainty that total costs would be the same. Benefits, on the other hand, are tied to the protection of the stock/stock complexes. These benefits would be the same whether management reference points are specified at the sector level or the combined sectors (again, assuming adequate enforcement). Without considerably more research, however, it cannot be determined

[62]This, of course, presumes adequate enforcement of the recreational sector (including the sale of recreationally harvested dolphinfish in commercial-based establishments).

which scenario would result in higher societal costs. Thus, it cannot be determined with any certainty that the economic net benefits of sector management reference points exceed combined management reference points. However, the Council was asked to consider the use of sector ACLs and managing in this manner may yield greater compliance in the respective sectors.

**Preferred Alternative 3** would use a three step process to specify the SYL, ABC, OY, and ACL for each stock/stock complex. The first step would be the adoption of an ABC CR (Table 2.4.1). Adoption of the ABC CR is entirely administrative in nature and is expected to have no direct or indirect effects on the economic environment.

Upon adoption of the ABC CR, the second step is to determine fishing mortality rate associated with fishing at MSY, which will inform qualitative approximations of MSY and MFMT when $F_{MSY}$ cannot otherwise be determined, based on three Sub-alternatives. The third step is to determine OY and ACL based on six sub-alternatives. In all six of these sub-alternatives, OY is set equal to ACL, with ACL being some fraction of ABC (ranging from 0 to 1). The total ABC (i.e., combined commercial and recreational), for each stock/stock complex resulting from the Preferred Alternatives in Actions 2 and 3, are provided in Table 6.3.3 for each of the sub-alternatives.

As noted, there are no cost data by which to estimate the differences in producer surplus to the commercial sector that might be forthcoming (at least in the short run[63]) under the different Sub-alternatives nor is there information that would allow for estimation in the change in benefits that would occur in the recreational sector (either private or for-hire). One could look at change in dockside revenues to the commercial sector in conjunction with the ex-vessel price data but there is little to be gained from this exercise because the fractions associated with each of the Sub-alternatives would provide the proportionate change in ex-vessel value that would be forthcoming under each Sub-alternative if it is binding.[64]

Given the lack of information, discussion of each of the sub-alternatives is also limited. Certainly, moving from **Sub-alternative 3d** to **Sub-alternative 3i** harvests that would be allowed before AMs are triggered would be reduced. This would provide enhanced protection of the stocks/stock complexes listed in Table 5.2.5 but this protection may be unwarranted (such as under **Sub-Alternative 3i** except in the rare instance where a species is heavily overfished). The reduction in catches as one moves from **Sub-alternative 3a** to **Sub-alternative 3f** would, at least

[63] It is important to specify short-run at this point because the purpose of setting an ACL to protect a stock/stock complex from being overfished, while achieving OY in a continuing basis. There would be no need to specify alternative ACLs for a given stock/stock complex if there were no uncertainty as to the scientific 'appropriate' ACL. Unfortunately, this is not the case and selection of a fraction that is too high, say 0.95, may result in insufficient protection of the stock/stock complex. Conversely, selection of a fraction that is too low may result the triggering of AMs that are not warranted for protection of the stock/stock complex.
[64] The assumption is being made that dockside price does not change in response to changes in binding ACLs.

in the short run, reduce producer surplus to the commercial sector (assuming the response in price is relatively limited) and benefits to the recreational sector. If warranted, however, it would provide the necessary biological protection to the stock/stock complex. If reduction in harvest is not warranted (i.e., selection of a Sub-alternative which dictates a lower harvest than that which is necessary to adequately protect the stock/stock complex), then selection of that Sub-alternative would unnecessarily result in a reduction in surplus with no long-run benefits. Thus, there is an obvious tradeoff. Moving from **Sub-alternative 3d** to **Sub-alternative 3i** reduces surplus that society gains from fishing activities but provides greater stock protection. There is no way of determining though what level of protection yields the highest net benefits.[65]

**Alternative 4** is similar to **Preferred Alternative 3** in that its purpose is to provide a procedure for calculating an ACL and OY for each stock/stock complex. Possible changes in the economic environment that might be forthcoming from the selection of any sub-alternative in Step 3 of **Preferred Alternative 3** would be similar to any of the sub-alternatives selected in Step 4 of **Alternative 4**. Specifically, it cannot be stated with any certainty which sub-alternative would yield the greatest net benefits. As such, it is also not possible to compare changes in the economic environment in the two alternatives.

### 4.4.4 Direct and Indirect Effects on the Social Environment

Setting management reference points can impose indirect social effects as the impacts are often recognized once stock assessments are completed. However, because Caribbean species have not been assessed, the thresholds chosen may be more immediate in their effects as they are often landing limits set as a result of deliberation by expert panels and the Council. The social effects of retaining reference points for stocks or stock complexes under **Alternative 1** may be negative because those reference points were established by species and not by island. In applying **Preferred Alternative 2**, the Council would specify management reference points for specific sectors when data are available. This alternative would likely have positive social benefits as the ensuing reference points would be more specific to each sector and its fishing patterns and behaviors. **Preferred Alternative 3** has social benefits as the stepped process allows for more and specific information to be considered in choosing reference points for those stocks or complexes that have assessments or those with more data (Tiers 1-3) and helps assess the risk of overfishing. It also provides a process recommended by the Council's SSC for specifying SDC for those species that do not have assessments (Tiers 4a and 4b); thereby incorporating the best available science. With the series of sub-alternatives included in **Alternative 3** Step 2, progressing from **Sub-alternative 3d** to **Sub-alternative 3i**, each sub-alternative progressively identified a more restrictive OY and ACL. The most restrictive is **Sub-alternative 3i**, which

[65] From a technical point of view, the question comes down to how much risk society is willing to take that a stock/stock complex will not be overfished versus the costs associated with a reduction in the ACLs.

allows for no catch. As the sub-alternatives progress to a larger buffer and lower ACL and OY, the social effects would become increasingly negative in the short-term as catch limits would be increasingly lower. The long-term effects would likely be positive if the OY and ACLs provide protection for the stocks and ensure the sustainability of stocks and stock complexes.

As in Tier 4 of the control rule in **Alternative 3**, **Alternative 4** would also use a series of steps to choose various reference points. For many alternatives, it may be difficult to know the social effects as they would depend upon each sequential step to understand the effect of the combined steps. The social effects of setting time series reference points for stocks or stock complexes under **Alternative 4** (Step 1) may be different as different time series can encompass an entirely different set of actors and fishing behaviors depending upon the bounds of the time series. Shorter time series that are closer to the present would reflect recent changes and fishing behavior and current participation; whereas, longer time series provide a more historical perspective on the particular fishery for a stock or stock complex and include past fishermen as well as fishermen who have been involved in the long term. In either case, there can be both negative and positive indirect social effects. With **Sub-alternative 4a**, by using the longest time series available the historic fishery and participation should be accounted for, however, it may reflect a much different fishery than existed previously and may not resemble the type of fishery that exists today in participation or behaviorally. Using the time series under **Sub-alternative 4b** would be consistent with what had been used in previous amendments but may not reflect the best time series for Puerto Rico. Using the most recent data in **Sub-alternative 4c** would be more indicative of the current fishery but does not offer the long term perspective. The time series under **Sub-alternative 4d** could have more positive social effects if the Council's SSC were able to take into consideration more current factors that may be missed with other sub-alternatives, such as recent weather events that may have altered the fisheries and their makeup.

**Alternative 4** (Step 2) would set MSY proxies through a series of sub-alternatives. The social effects from any of these sub-alternatives are dependent upon selection from the previous step and subsequent choices of the succeeding steps. Overall, the effects are likely to be more positive with increased information, but again, it would depend upon the time series chosen for a particular sub-alternative as to whether the choice was reflective more of the historic fishery or the current one. In any case, selection based upon Puerto Rico's historic fisheries should be more positive than previously selected reference points that were more broadly based on a Caribbean-wide fishery.

Setting of the biological parameters for harvest thresholds has few direct social effects as the impacts are more indirect from the SSC/s recommendation of the ABC and any subsequent reduction through ACLs and AMs. **Alternative 4** (Step 3) identified an ABC through the choice of a series of sub-alternatives. Those choices range from an ad hoc approach recommended by the SSC for each stock/stock complex in **Sub-alternative 4h** through a series of progressively

lower ABCs from **Sub-alternative 4i** (where it is equal to OFL) to **Sub-Alternative 4l** (75% of OFL). With each subsequent sub-alternative as before, from **Sub-alternative 4i** to **Sub-alternative 4l**, the ABC is lower with each sequential sub-alternative, as would be the consequent reference points such as the ACL. As discussed earlier, the lower ACLs that would result from each sub-alternative would have negative short-term social impacts, but could also have long-term benefits if it were to help maintain stocks at sustainable levels.

**Alternative 4** (Step 4) specifies an OY through the choice of a series of sub-alternatives. Optimum yield is a reference point that takes into consideration social, economic and ecosystem factors to provide net benefits to the nation. In choosing a percentage of ABC, there is an assumption that the buffer provided would have positive social benefits. It is an implicit assumption that the buffer provides insurance that the stock would be healthier and thus positive social benefits should accrue as there should be continuous fish to harvest. However, this assumption is not based upon actual social, economic, or ecological factors which are often lacking in these analyses due to the paucity of this type of data being collected on a continuing basis. Optimum yield is a management target and setting it at levels that are equal to ACLs without knowing what social, economic or ecological factors may have negative short term social impacts if it is set too low. Although, it could also have long term benefits if it were to help maintain stocks over a long period of time and allow businesses to continue to operate within communities.

### 4.4.5 Direct and Indirect Effects on the Administrative Environment

Administrative effects from **Alternative 1** are expected to be neutral because no additional action needs to be taken.

Under **Preferred Alternative 2**, effects on the administrative environment would be minimal as administration of a sector-based management scheme would continue. To the extent species are added or removed from management according to Action 2, or to the extent complexes are rearranged or indicator species are established for those complexes according to Action 3, some administrative adjustments would be required resulting in minor short-term effects on the administrative environment.

**Preferred Alternative 3** would be expected to result in minor negative short-term administrative effects as effort is expended to modernize landings tracking protocols to account for establishment of new reference points and inclusion of new species. With respect to setting an $F_{MSY}$ proxy, greater positive effects on the administrative environment could be expected from **Preferred Sub-alternative 3c** of Step 2 because it would constrain harvest to the least extent relative to **Sub-alternatives 3a** or **3b**, and therefore could require less frequent management responses if ACLs are met compared to greater harvest constraints.

Under **Alternative 4**, administrative short-term effects would be negative but minor, due to the additional administrative effort to update regulations and public awareness documents. Long-term administrative effects likely would be minor and positive, due to the expected stabilization of management and enforcement.

## 4.5 Accountability Measures for Stocks and Stock Complexes - Environmental Consequences

### 4.5.1 Direct and Indirect Effects on the Physical Environment

Effects to the physical environment resulting from establishment of AMs for stocks/stock complexes included in the Puerto Rico FMP are expected to be indirect, minimal and generally neutral or positive. In general, benefits to the physical environment would be expected from the application of either **Alternatives 1**, **2 (Preferred), 4,** or **5 (Preferred)**, and this is the case regardless of the sub-alternative(s) chosen in **Alternative 2**. Indirect physical effects from the application of AMs reflect the reduction in fishing effort resulting from a reduction in the length of the fishing season (**Alternatives 1, 2 (Preferred),** and **4**) or a complete prohibition on harvest (**Preferred Alternative 5**). Physical effects to the environment from fishing activities primarily result from gear interactions with physical structures such as seagrass beds for coral reefs. Those physical impacts may result from interactions with fishing gear or from vessel and especially anchor impacts. With regard to gear impacts, the extent of those impacts would reflect fishing effort. Reducing fishing effort reduces the opportunity for negative physical impacts from non-trap fishing gear and anchors with the sea bottom, including structural habitat such as coral. Within the constraints of ACLs, more intensive deployment of gear may result in greater physical impacts, but would also likely result in increased harvest rates that would achieve the ACL sooner within the year. As a result, the intensity of gear interactions would increase but the duration of those effects would be shorter. That trade-off between intensity of the effect and duration of the effect would likely result in a neutral overall effect. Beneficial physical effects also may be realized for those fisheries using trap gear, although the extent of that effect would depend on the extent to which traps are hauled and redeployed less frequently (traps generally are not removed from the water even during fishing closures). These effects would not be expected from **Preferred Alternative 3** because triggering an AM does not result in a fishery closure as in the other alternatives.

Effects from anchoring may be reduced as a result of applying an AM. That AM would reduce the length of the fishing season, thereby reducing the number of anchoring events. In this case, fishing effort may increase within the shortened season, though this would only be the case with a post-season AM, when fishers know the season will be shortened and may adjust their

behavior. This increased fishing effort would not necessarily result in an increase in the number of anchoring events because more effort can be expended within a single such event. Overall effects would depend on the extent to which other fishing opportunities, including effort shifts to stocks that remain available for harvest, alter overall fishing effort. For example, if an AM was applied to the spiny lobster stock harvested by hand, and fishermen responded by shifting effort to hook-and line harvest of a finfish stock, the overall effect could be detrimental resulting from increased interactions of the fishing gear with physical structures such as coral. But, this would be tempered by the limit imposed by the ACL and potential application of an AM to the finfish stock, such that the overall effect would again be neutral.

### 4.5.2 Direct and Indirect Effects on the Biological/Ecological Environment

Biological/ecological effects resulting from AM application would be indirect and positive, and in some cases could be substantial in nature. **Preferred Alternative 5** provides the greatest overall benefit to the biological/ecological environment, but only for those stocks to which it applies (i.e., stocks for which harvest is prohibited). For those stock available for harvest, **Alternative 4** provides the greatest biological/ecological benefit because that approach ensures that harvest is constrained to a pre-determined, biologically sustainable level as the landings data is available. There is a lag in application of the AM to constrain harvest in the post-season AMs contemplated in **Alternatives 1 and 2**. However, application of **Alternative 4** depends on the timely availability of landings data, and at present those in-season data are not available. As in-season landings data become available for one or more stocks, **Alternative 4** would be available to provide the most biological and ecologically beneficial option. In the meantime, **Preferred Alternative 2** would result in the most biologically/ecologically beneficial effects to the environment. Those effects are immediately achievable. **Preferred Alternative 2** simply continues and extends (to those stocks newly added to management) the beneficial effects realized from the original implementation of the 2010 and 2011 Caribbean ACL Amendments and fully discussed in those amendments (CFMC 2011a, b). **Alternative 1** would provide biological and ecological benefits similar to those presented for **Preferred Alternative 2**, but fails to provide such benefits to those stocks newly added to management. Finally, **Preferred Alternative 3** addresses a special case of pelagic stocks newly added to management. Those stocks have not been previously managed in Puerto Rico EEZ waters, are broadly migratory, are relatively short-lived, and as a result tend to experience substantial year-class variability. Because of that, reducing the length of the fishing season in response to an ACL overage may provide little positive biological/ecological benefit. While short-term effects of convening the Council to determine, based on advice from the SEFSC, whether corrective action is needed following an ACT exceedance are likely neutral, long-term beneficial biological/ecological effects would be anticipated. Consulting with the SEFSC to appropriate action to take to respond to ACT exceedances based on the most up-to-date biological and fishery information would provide an opportunity to better understand stock function relative to fishing pressure while providing guidance as to additional data and management needs.

No direct effects to ESA-listed species are expected from this action, as it established how and when an AM would be applied. Indirect effects to ESA-listed species may occur if and when those AMs are applied, although it is difficult to ascertain at this time the timing and duration of those closures or the stocks/stock complexes to which they would apply. Following from Action 4, several stocks/stock complexes would experience increases in their applicable ACLs, and so it would be expected that fewer AMs would be triggered and applied. Again, however, it is difficult to predict which fisheries would experience fishing season reductions.

### 4.5.3 Direct and Indirect Effects on the Economic Environment

Assuming stocks/stock complexes newly added to the Puerto Rico FMP are subject to overfishing or being overfished, **Alternative 1** would not provide the mechanism needed to adequately protect these stocks/stock complexes. This could result in long-term economic losses to the users of the resource via reduction in stock/stock complex levels due to excessive harvests that fails to achieve OY. Finally, as noted in Section 6.9, the no action alternative (**Alternative 1**) would fail to comply with the requirements of the Magnuson-Stevens Act, which requires that mechanisms of accountability be established for all federally managed stocks.

In determining the economic consequences associated with the implementation of any of the sub-alternatives associated with **Preferred Alternative 2**, it is important to realize that landings data for Puerto Rico are merely estimates (based on an extrapolation from reported landings) and that estimated landings in any given year may be highly imprecise (with estimated landings being overestimated in some years and underestimated in other years). In addition, there is likely to be significant natural annual variation in the abundance of the stock/stock complex; particularly for stocks/stock complexes comprised of short-lived species. Large annual variation in stock/stock complex abundance can result in significant annual variation in 'true' landings as well as estimated landings. These two factors would suggest that a longer sequence of years (up to some point) may be preferable to a shorter sequence in a comparison against the ACL. Given this to be the case, **Sub-Alternative 2a** would likely lead to the triggering of an AM in many instances where such a triggering is could be based on imprecise landings data for any given year. This situation, which is caused by 'artificial' annual perturbations in the landings data, can result in significant disruption to fishing communities and a loss of economic benefits derived from fishing activities. No real benefits associated with protection of the stock/stock complex may be realized because of the high estimated landings are merely an artifact of error in the extrapolation process. Regulatory discards resulting from bycatch of species caught during an AM closure represents another potential economic cost in terms of lost benefits to the harvesting sector; particularly if the AM closure is the result of estimated landings over a short period (say, one or two years) exceeding 'true' landings. Finally, administrative burden associated with frequent AM closures is likely to be significant. While **Sub-Alternative 2b** uses an average of the two

most recent years of complete landings to be compared against the applicable ACL (after the first year), the use of only two years of landings data may not be sufficient to 'smooth out' errors in the landings data. Thus, from an economic perspective, **Sub-Alternative 2c** would appear to adequately protect the stocks/stock complexes while imposing the least economic costs on the fishing communities as well as imposing the least amount of administrative burden when compared to either **Sub-Alternative 2a** or **Sub-Alternative 2b**. Finally, the economic costs associated with **Preferred Sub-Alternative 2d** would be of a similar magnitude of those under **Alternative 2c** with the only difference being those which are entailed during the first few years of FMP operation. However, **Alternative 2c** is likely to have marginally lower economic costs because a longer sequence of years is used after the first year of FMP operation, not after the second as with **Preferred Alternative 2d**. Finally, since **Preferred Alternative 2** provides protection for those species newly added to the Puerto Rico FMP whereas **Alternative 1** does not, economic benefits from protection of the stocks/stock complexes under the sub-alternatives listed in **Preferred Alternative 2** likely exceed the benefits associated with **Alternative 1**. The difference in benefits is likely to be particularly pronounced in a comparison of **Sub-Alternative 2c** with **Alternative 1**.

**Preferred Alternative 3**, as noted, applies only to pelagic stocks new to management in the Puerto Rico EEZ. These pelagic stocks, as discussed in Section 6.9, are largely migratory in nature and the benefits to management of these stocks/stock complexes was called into question. Specifically, the long-run impact on the population of any of these stocks/stock complexes from harvest in the Puerto Rico EEZ is likely insignificant given the migratory nature of these species and the wide geographic area over which harvesting occurs. Based on these assumptions, and considering all the possible combinations of sub-alternatives, **Preferred Sub-Alternative 3a** (i.e., ACT would be 90% of ACL) in conjunction with **Sub-Alternative 3f** (i.e., a single year of total landings, beginning with the most recent available complete year of landings, then a two-year average of total landings from that single year and the subsequent year, then a three-year running average of total landings from those two years and the subsequent year, and thereafter a progressive running three-year average) would impose the least costs on fishing communities and would also entail the least amount of administrative burden.[66] The rationale for **Preferred Sub-Alternative 3a** is that it gives the highest ACT relative to ACL. The rationale for **Sub-Alternative 3f** follows the line of reasoning used in the selection of **Sub-Alternative 2c** in the economic analysis of **Preferred Alternative 2**. Conversely, the greatest costs to fishing communities (and high administrative burden) with little benefits given to protection of the stocks/stock complexes (given the migratory nature of the stocks/stock complexes in conjunction

[66] It is worth noting that triggering of the AM would not automatically necessitate any mitigation in overages. Instead, it would call for the Council to consult with the SEFSC to review available data and evaluate what factors led to the exceedance and whether corrective action is warranted (such as revision of the ACL). Comparison of the combination of sub-alternatives presented herein is premised on corrective action being taken (i.e., a restriction on future harvests due to exceeding the current limit). The only costs to consider if no action is taken to curtail future harvests can be represented by convening with the SEFSC.

with the overall insignificant harvest taken from Puerto Rico waters) would be the combination of **Sub-Alternative 3c** in conjunction with **Sub-Alternative 3d**. Costs associated with all other combinations would fall somewhere in between these two extremes.[67]

In-season landings data for stocks proposed for inclusion in the Puerto Rico FMP are unavailable which implies that in-season management (i.e., **Alternative 4**) is currently infeasible. As such, an economic assessment of the benefits and costs of in-season management cannot be presented until (a) such time that the data become available to allow for such management and (b) greater detail is provided as to how in-season management would proceed.

Potential benefits relative to costs associated with **Preferred Alternative 5** are expected to be relatively large. This is based on the consideration that ABC for these species is set to zero due to the overfished nature of some stocks (i.e., queen conch, Nassau grouper, goliath grouper) and the ecological importance of other stocks (blue parrotfish, midnight parrotfish, rainbow parrotfish, manta ray, spotted eagle ray, southern stingray, sea cucumbers, sea urchins, and corals). Hence, enhanced protection of these stocks is warranted with the enhanced protection.

### 4.5.4 Direct and Indirect Effects on the Social Environment

Accountability measures assist managers in maintaining an ACL within its bounds and can prevent overages from occurring or would account for overages in some manner. In **Alternative 1** there would be no revision for determining the trigger for an AM or specifying an AM for the new stocks/stock complexes in the Puerto Rico FMP. The AMs applicable to the old stocks/stock complexes would continue to apply which could have negative social effects, as management would not reflect the new Island-based management. .

In **Preferred Alternative 2** an AM is triggered if total landings exceeds the total ACL for a stock/indicator stock/stock complex in the Puerto Rico FMP, and may be more aligned with stakeholder desires, benefitting the social environment. Under several sub-alternatives, the AM may be implemented in a variety of ways. Under **Sub-Alternative 2a** a single year of the most recent year of landings is used as the determinant. This alternative is more reactive to immediate circumstances but may not be the best predictor of future fishing practices. It assumes that fishing effort is constant and unchanged by other factors. Using the most recent year of landings then a progressive 2 year average starting with the initial year and subsequent year **Sub-alternative 2b** may account for trends that may be better predictors of future fishing behavior. The **Sub-alternative 2c** is similar to **2b** but uses a longer three year average. The final **Preferred Sub-Alternative 2d** uses a stepwise approach that once a three year average is attained it moves forward by one year into the future. Which of these sub-alternatives would have the least negative social effects is difficult to determine. The alternative that best reflects

[67] Benefits in all cases would likely be very low for reasons already cited.

fishing trends and prevents overages from occurring is the more desirable. Those that incorporate running averages may be more in tune with fishing practices at the time considered and what may occur in the future.

Under **Preferred Alternative 3** a two step process is considered to establish an ACT and then an AM through several sub-alternatives for pelagic stocks/indicator stock/stock complex. An ACT of 90% of the ACL would be established under **Preferred Sub-Alternative 3a** with an ACT of 80% of ACL under **Sub-Alternative 3b** and an ACT of 70% of ACL under **Sub-Alternative 3c**. Moving from **Sub-Alternative 3a (Preferred)** to **3c**, the social effects are likely less negative to more negative respectively. That is if there are no negative effects to the stock, in which case a more conservative approach may have more positive social effects in the long term. The step 2 in **Preferred Alternative 3** would trigger the AM with the same suite of sub-alternatives from **Preferred Alternative 2**. Again, it is difficult to determine which sub-alternative would have the least negative social effects, but those that best reflect fishing trends into the future and prevent overages are more desirable.

By establishing an in-season AM in **Alternative 4** fishing would be prohibited for the remainder of the year once the total ACL is reached. This alternative would pertain to those stocks for which data are available to make such a determination, therefore would be limited in its scope as for most stocks included in the stock or stock complexes in season data are not available. Therefore, the inability to implement an in-season AM would have negative social effects.

For those stocks with an ABC of zero, **Preferred Alternative 5** would establish the harvest prohibition as the required AM. There would be few if any social effects from choosing this alternative.

### 4.5.5 Direct and Indirect Effects on the Administrative Environment

**Alternative 1** would not produce administrative effects in the short-term as it would not change the status quo, but by not complying with Magnuson-Stevens Act requirements by not establishing AMs for stocks/stock complexes new to management, it may trigger some type of legal action for not doing so. **Preferred Alternatives 2** and **3**, **Alternative 4**, and **Preferred Alternative 5** would all have direct minor administrative effects because they all require rulemaking to establish AMs for managed stocks. In **Preferred Alternative 2**, sub-alternatives that could result in more frequent AM closures (i.e., **Sub-alternative 2a**) would increase significantly the administrative burden. Although, **Alternative 4** effects would be larger because of additional administrative cost and time burdens associated with tracking landings in-season, however at this time, in-season tracking of landings is not feasible.

## 4.6 Describe and Identify EFH for Stocks not Previously Managed in the Puerto Rico EEZ - Environmental Consequences

### 4.6.1 Direct and Indirect Effects on the Physical Environment

**Alternative 1** would not comply with the Magnuson-Stevens Act which requires that EFH be designated for all managed species, therefore would not be viable. However, if the alternative was viable, protection of fish habitat in the Puerto Rico EEZ would still occur under existing and possible future regulatory actions. Many Federal and state laws and regulations require evaluation of the consequences of projects proposed for the marine (and other) environments. NMFS already has the ability to recommend, through Fish and Wildlife Consultation Act consultations, mitigation, or minimization of adverse impacts on those habitats important to fisheries resources. The Council and NMFS have a wide range of management authority, which includes the ability to manage fishing activities and protect fish habitats to ensure healthy stocks and sustainable fisheries. The Council and NMFS have taken a variety of measures in past management plan amendments that protect fish habitat. In some cases, the habitat protection occurred as direct action for habitat (e.g., anchoring prohibitions on sensitive areas, designation of marine protected areas, restrictions on certain fishing gear), while in other cases the habitat protection occurred as a benefit of management measures directed for other purposes (e.g., gear modifications, harvest limits, time/areal restrictions).

EFH designation indirectly benefit the physical environment (future regulatory action, and EFH consultations). The indirect effects stemming from the decision not to designate EFH for the proposed species is that the Council would not designate new areas, and thus would not be able to take action to protect these areas from fishing or to consult on effects to these areas. We would not realize potential benefits, but of course those potential benefits depend on new areas of EFH being identified (or there being something different about how the species use the EFH that results in additional protections from any consults).

Immediate direct and indirect effects on the physical environment are expected to be non-significant for **Alternatives 2 (Preferred)** and **3**.

Under **Preferred Alternative 2,** the Council would describe and identify EFH for species new to management following the same procedure used in the 2004 EFH-FEIS (CFMC 2004) for those species already under management. **Preferred Alternative 2** would designate EFH by specifying functional relationships for life stages and habitat types that might be regarded as meriting special attention for their importance to managed species based on the limited information available through literature review, fishery-dependent and independent data and expert opinion (Section 2.6, Appendix H).

**Alternative 3** proposes other method(s) to describe and identify EFH for species new to federal management. The alternative lists five different levels of data that were explored in the 2004 EFH-FEIS for describing and identifying EFH that could be used depending on data availability. The limiting factor is the lack of species -specific data (density, abundance, etc.) and the lack of geographical boundaries for the marine habitats used by the species new to management.

Designation of EFH has no direct impact on the physical environment, but may have indirect impacts due to two other provisions of the Magnuson-Stevens Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to section 303(a)(7) of the Magnuson-Stevens Act. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or recommendations under sections 305(b)(2)-(4) of the Magnuson-Stevens Act.

From a geological point of view, EFH alternatives would have no direct impacts on the physical environment. None of the alternatives considered would change the general bathymetry, geological configuration, or water quality of the Caribbean.

However, fishing gear could have impacts on the biogenic structure and biota living on the bottom,. The fishing gears used in harvesting these 18 new species are similar to fishing gears used for species already managed. The Council considered the effect these gears would have on the physical environment in the EFH EIS, and the Reef Fish FMP, and has taken action to protect areas currently designated as EFH from these gears. If the Council designates additional areas as EFH, it would similarly need to take action to minimize the adverse effects to these areas from fishing.

Non-fishing activities can adversely affect some geological features through digging, scraping, drilling, modifying deposition, or dumping. These actions could homogenize the seabed surface, cause sedimentation to cover surface features, cause subsidence through removal of oil or gas, or form barriers to river-transported sediments. Consultation by responsible Federal agencies with NOAA Fisheries (and the Council) would have indirect impacts to the degree that consultations mitigate the effects of proposed non-fishing activities.

Non-fishing activities, such as coastal development, dredging, sand and mineral mining, oil and gas exploration, pipelines, and contaminants can affect water quality, dissolved oxygen, or turbidity. In many cases, the indirect impacts of non-fishing activities on EFH occur in areas removed from the area where the activity takes place. For example, rivers may transport high levels of suspended sediments that travel long distances in the marine environment. A broad definition of EFH may, therefore, have benefits in terms of ensuring the consultative process associated with non-fishing activities includes as many potentially damaging activities as possible.

### 4.6.2 Direct and Indirect Effects on the Biological/Ecological Environment

Designation of EFH in US waters has no direct impact on the biological environment, but is likely to result in indirect impacts due to two other provisions of the Magnuson-Stevens Act. First, every FMP must minimize to the extent practicable adverse effects of fishing on EFH, pursuant to section 303(a)(7) of the Act. Second, Federal agency actions that may adversely affect EFH trigger consultation and/or recommendations under sections 305(b)(2)-(4) of the Act.

Adverse impacts have occurred on habitats used by many fishes. Many large and small, possibly insignificant, actions have accumulated to the current significant habitat losses. Describing and identifying EFH would not by itself restore degraded habitat, but any resulting Council action to minimize effects to EFH and EFH consultations may help to arrest the current degradation and prevent future adverse impacts due to fishing and non-fishing activities. This may allow the habitat to begin a recovery from past impacts, if it has not been replaced or destroyed. Measures that improve habitat conditions would have regional and local benefits to the biological environment. Local habitat improvements resulting from protective measures and/or recommendations arising out of EFH consultations would offer an opportunity for increased productivity that would likely have spillover effects to surrounding areas as fish move on and off with daily and seasonal movements. Uncertainty of the role that habitat plays in fish production limits the conclusions one may draw on the effects of designating EFH, however, we conservatively estimate that habitat improvements and protections for certain habitats, especially spawning habitats, could have a beneficial effect on the biological/ecological environment. **Preferred Alternative 2** designates EFH for newly proposed species for federal management but does not add additional designations other than those previously done in the species-specific FMPs. **Alternative 3** would allow the Council to more finely designate EFH and promulgate additional protection if needed.

The Council and NMFS can currently regulate fishing activities that have potential to adversely impact EFH, but designation of EFH would help to focus additional consultation in this area. The Council and NMFS can also provide input into decisions regarding non-fishing activities, through consultation with other Federal agencies that have responsibility for non-fishing activities. Councils are required to comment on Federal or State activities that are likely to substantially affect habitat, including essential fish habitat, of anadromous fishery resources (MSA § 305(b)(3)(B)), and may comment on Federal or State activities that may affect habitat, including essential fish habitat. The effectiveness of consultations on mitigating potential adverse impacts would likely depend on the level at which a managed fish species depends on the habitats at risk, and on the ability to justify that dependence. The available information with which to document fish dependence on habitat is incomplete.

**Alternative 1** (No Action) and **Alternatives 2 (Preferred)** and **3** would have no direct impact on the biological/ecological environments unless actions were to be taken to regulate impacts to the EFH designations. The indirect effect of **Alternatives 2 (Preferred)** and **3** would ultimately depend on the management actions taken. The Council may not need to take additional action if the same areas area designated as EFH for the species new to management as the existing EFH designations. **Preferred Alternative 2** does not result in designation of new EFH areas, or any new information on the habitat use, thus these designations may not lead to additional protective measures from fishing gears (as the gears have not changed, and the Council has already taken action to protect these same areas from gears) or additional protections in consultations. **Alternative3** results in no EFH designations at present but in the future it might provide better information to inform management or consultations, for example.

No direct or indirect effects to ESA-listed species are expected from this action, as it just defines and then describes EFH for species new to management. The protective measures the Council puts in place to protect EFH however could limit fishing in an area, and that could benefit ESA listed species in those areas. It is acknowledging the limits of our ability to predict indirect effects to ESA listed species

### 4.6.3 Direct and Indirect Effects on the Economic Environment

[68] While identifying or not identifying EFH is merely an administrative action that would have no direct economic effects, not identifying as proposed in **Alternative 1** it may have economic effects if the gears and/or fishing practices used by fishermen to harvest these new species impact the surrounding physical environment and regulations to protect the environment are not an outcome of specifying EFH for these species. This, through time, may result in a loss of carrying capacity of the environment and, hence, long-run yield of species to be added to the Puerto Rico FMP as well as species currently managed in Federal waters. The reduction in long-run yields may translate into a loss of revenues for commercial fishermen and catch rates for recreational fishermen.[69]

In addition, degradation of EFH may impact the enjoyment associated with non-consumptive activities (e.g. scuba diving) which, in turn, could reduce consumer surplus to this component. Benefits associated with protection of habitat through regulation of gears/practices that impact the habitat must, of course, be weighed in conjunction with the costs imposed on the various sectors from the regulations. Specifically, regulations implemented to protect EFH impose a direct cost on those sectors upon whom regulation is imposed. Until such regulations are

[68] This appears to be the case with triggerfish, for example. As stated in Section 2.3, the three species of triggerfish included in the Puerto Rico FMP prefer different habitats.
[69] Whether revenues decline in reaction to any reduction in catch depends on the price response to the change in landings. Given that there are few entry restrictions associated with fishing in federal waters, however, reduction producer surplus associated with a reduction in harvest may be limited

outlined, however, one cannot determine whether direct and indirect economic effects would be positive or negative. If gear types and/or fishing practices do not impact the habitat, one would expect no indirect benefits from specifying EFH for the added species.

**Preferred Alternative 2** and **Alternative 3** both call for describing and identifying EFH for species not previously managed in federal waters of Puerto Rico but use different techniques for doing so. **Preferred Alternative 2** would describe and identify EFH according to functional relationships between life history stages for those species not previously managed in federal waters of Puerto Rico based on available information from the literature, expert opinion and usable data while **Alternative 3** would use other methods and levels of data not available to date but explored in the 2004 EFH-FEIS, and outlined herein in 7.3. As with **Alternative 1**, these are merely administrative in nature and would result in no direct economic impacts. Whether any indirect economic benefits (or costs) would be forthcoming from either of these two alternatives depends upon a number of factors. The first, of course, is whether the gear and/or fishing activities impact EFH. If there is no impact, there would be no indirect benefits or costs associated with describing and identifying EFH for species not managed in federal waters of Puerto Rico under either **Preferred Alternative 2** or **Alternative 3**. In general, if there are impacts to EFH from gear and/or activities and regulations are implemented to protect EFH, there would be benefits to the habitat and species, and associated economic impacts (as previously discussed). However, these benefits must be compared to costs (e.g., gear restrictions that are costly financially or result in a reduction in catch) to determine whether the net benefits that society receives from regulations imposed to protect EFH would be positive or negative. Both **Preferred Alternative 2** and **Alternative 3** are warranted from an economic perspective (that of efficiency) if protection of EFH via regulation generates positive net benefits. **Preferred Alternative 2** does not result in new or different designations and therefore the actions already taken action to protect these same areas from gears or additional protections in consultations result in direct positive benefits.

### 4.6.4 Direct and Indirect Effects on the Social Environment

Designating EFH has limited direct social impacts, although by designating and possibly protecting habitat from measures to minimize effects from fishing or through taking actions in EFH consultations, it can have positive indirect social effects. Social impacts include for example the knowledge that marine habitats are being protected, the expectation that by protecting these habitats fishery resources could be positively impacted (e.g., fish population growth) and the expectations that these habitats would be available for non-consumptive uses (e.g., snorkeling). In **Alternative 1** EFH is not designated for new species included in the FMP and could therefore have negative indirect social effects. However, the Magnuson-Stevens Act requires that EFH be established for species under management, so **Preferred Alternative 2** and **Alternative 3** would meet that mandate although by using different methods to identify EFH.

**Preferred Alternative 2** would be the use available presence/absence information to describe and identify EFH, whereas **Alternative 3** would allow the Council to select among different sources of information to determine EFH. The social effects of either alternative would be hard to determine given the indirect links to other management alternatives that may or may not have some impacts. Of course, any protection to fishery habitat that is afforded by any alternative should have beneficial social impacts if it provides protection for stocks throughout their life history which in turn ensures healthy stocks that can be harvested at levels that provide optimum yield.

### 4.6.5 Direct and Indirect Effects on the Administrative Environment

**Alternative 1** (No Action) would have a direct negative impact on the administrative environment since the description and identification of EFH is a required provision for the FMPs as stated in the Magnuson-Stevens Act. This could potentially result in lawsuits for non-compliance which, which would require resources to address..

**Preferred Alternative 2** complies with the requirements of the law and applies available information to describe and identify EFH. This is the method that the Council previously used to identify EFH for the species under management in the species-based plans.

**Alternative 3** would allow the Council to select among a variety of methods to determine essential fish habitat. Given that the data are not available to provide a useful description of EFH, this is not a viable alternative. Selecting this alternative would not result in EFH being designated, with the same effects as **Alternative 1**, at least with respect to the newly managed species, above. If the information were to become available, the benefits of using one or more of the methods put forth in **Alternative 3** could be higher than using **Preferred Alternative 2**. The direct impact on the administrative environment supposes a more defined identification of EFH perhaps resulting in the promulgation of additional or new management measures.

Under section 305(b)(2) of the Magnuson-Stevens Act, each Federal agency must consult with NMFS regarding any action authorized, funded, or undertaken by the agency that may adversely affect EFH. The EFH regulations require that Federal agencies prepare EFH Assessments as part of the consultation process (50 CFR 600.920(e)). Under section 305(b)(4)(A) of the Act, NMFS must provide EFH conservation recommendations to federal and state agencies regarding any action that would adversely affect EFH. Under section 305(b)(3) of the Act, Councils may comment on and make recommendations to Federal and state agencies regarding any action that may affect the habitat, including EFH, of a fishery resource under Council authority.

Federal agencies would incur costs as a result of conducting EFH consultations, since time and resources would be required to develop EFH Assessments, exchange correspondence, and

engage in other coordination activities required for effective interagency consultation. In some cases, Federal agencies might also request information from applicants for permits, licenses, or funding to assist the agency in completing EFH consultation. However, the EFH regulations encourage agencies to combine EFH consultations with existing environmental review procedures to promote efficiency and avoid duplication of effort. Agreements to streamline the EFH consultation process have been developed for key Federal agencies having responsibility in the US Caribbean. State agencies and other non-federal entities are not required to consult with NMFS regarding the effects of their actions on EFH. At a general level, **Alternative 1** doesn't have new EFH designations, and thus does create new areas for which the action agencies would need to consult. **Preferred Alternative 2** and **Alternative 3** could both result in new designations and new consultations, with the burdens described.

Comparing to the baseline, though, requires us to know if we are going to have new areas designated under **Preferred Alternative 2**. There is no indication of new areas being designated under the **Preferred Alternative 2,** the same areas currently identified are EFH for the species new to management, and then these burdens already apply; consultations are already required on effects to these areas. **Alternative 3** does not result in an EFH designation, and would not result in these burdens.

## 4.7 Action 7: Framework Procedures for the Puerto Rico FMP - Environmental Consequences

### 4.7.1 Direct and Indirect Effects on the Physical Environment

Modifying the framework procedure is not expected to have direct effects on the physical environment; however, if the level of fishing effort or the use of certain gear types is affected by the management strategies modified by the framework, this could affect the physical environment by changing the interactions between gears and the habitat.

**Alternative 1** would not modify the framework procedures established in the Council's Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs and thus would have no additional effects to the physical environment from the baseline. Indirect effects to the physical environment would be expected from those measures included in the framework that result in a faster protection to the habitat from gear/habitat interactions than if the measures were approved through a regular amendment, which may take more time to develop and implement. Examples of these measures include the specification or modification of gear restrictions including those that minimize the interaction of fishing gear with endangered species, such as listed habitat-forming corals (e.g., *Orbicella annularis*, *Orbicella franski*) and those actions that close/open areas to fishing, adjust harvest, and regulate fishing effort (e.g., adjustment of trip limits, bag limits, size limits, ACLs),

among others. **Alternative 1** would not result in any additional indirect effects—the same measures could be adjusted via framework as under the species-based plans.

**Preferred Alternative 2** would allow the Council to change management measures more expeditiously than via a regular amendment in response to changes in resource abundance and new scientific information. This is expected to indirectly affect the physical environment similar to that described above for **Alternative 1**. The abbreviated framework option available in **Preferred Alternative 2** but not available in the other alternatives proposed, is not expected to provide additional indirect benefits to the physical environment as changes that can be made through the abbreviated framework would be insignificant.

**Alternatives 3** and **4** would also alter the existing framework in a broader or narrower procedure, respectively. These alternatives may result in indirect physical impacts as a result of the timeliness of implementing the change to the management measures. Similar to **Alternatives 1** and **2 (Preferred)**, this is expected to indirectly benefit the physical environment if a speedier application of measures protecting the biological integrity of managed resources and the modification of gear restrictions result in quicker protection to the physical environment from gear/habitat interactions. The potential indirect benefits from **Alternative 3** are slightly larger than those from **Alternatives 1**, **2 (Preferred)**, and **4**, given that **Alternative 3** allows for a broader spectrum of measures that can be rapidly implemented through framework when compared to the other alternatives proposed. **Alternative 4** would be the least beneficial to the physical environment because the range of actions that can be taken more expeditiously through framework is more limited than the other alternatives.

### 4.7.2 Direct and Indirect Effects on the Biological/Ecological Environment

Modifying the framework procedure in the Puerto Rico FMP is primarily an administrative action that provides a more expeditious way for implementing management changes. The managed stocks in the Puerto Rico FMP could benefit from the modification of framework procedures in Action 7 as a speedier implementation of management measures could yield biological benefits in the future by protecting the biological integrity of the managed resources and preventing overfishing.

**Alternative 1** would not modify the framework established in the Council's Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs; therefore, it would not have any effects on the biological/ecological environment outside the baseline.

**Preferred Alternative 2** would allow the Council to make more expeditious regulation changes to a list of management actions in response to changes in resource abundance and new scientific information, therefore protecting the biological integrity of the managed resources and decreasing the risk of overfishing those resources. For example, under **Preferred Alternative 2**,

changes to ABCs and ACLs would be implemented quicker than if such changes proceeded via a full FMP amendment, which could help to prevent overfishing of the resources.

Both **Alternatives 3** and **4** would modify the existing framework in a broader (**Alternative 3**) or narrower (**Alternative 4**) procedure compared to **Preferred Alternative 2**. These alternatives may result in indirect biological/ecological impacts as a result of the timeliness of implementing the measure. Although all of these alternatives allow for a speedier adjustment of management measures than implementing measures via FMP amendments, **Alternative 3** provides the advantage that the framework actions may be implemented at any time in response to any additional information or changed circumstances. This is beneficial to the biological/ecological environment as changes would be implemented quicker, helping to prevent overfishing of the stocks.

**Alternative 4** is more restrictive than **Alternatives 1**, **2 (Preferred)**, and **3** with respect to the circumstances where a framework can be applied, thus benefits to the biological environment would be more limited than in those alternatives. In addition, the list of actions that can be done through a framework is also very narrow, thus positive effects from a faster adjustment of measures would be limited to those measures on the list, contrasting with the benefits from the more extensive list of measures that can be rapidly adjusted in **Alternatives 1**, **2 (Preferred)**, and **3** in response to biological changes to the managed resources.

No direct or indirect effects to ESA-listed species are expected from this action, as it just outlines management measures that could be amended through the selected framework procedure.

### 4.7.3 Direct and Indirect Effects on the Economic Environment

The purpose of including Action 7 in the Puerto Rico FMP is given in Section 8.1. It consists of four alternatives including the status quo (i.e., retain the framework procedures presently included under the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs (see Table 8.2.1) which is listed as **Alternative 1**. **Preferred Alternative 2** (Table 8.2.2) proposes a new set of framework procedures; **Alternative 3** (Table 8.2.3) widens the range of management measures that can be implemented without a full plan amendment, while **Alternative 4** provides a narrower range (Table 8.2.4).

None of the four alternatives listed in Action 7 are expected to have any direct effects on the economic environment since they represent administrative actions. However, framework procedures can reduce the amount of time needed to change a management measure and this reduction in time could provide benefits in the nature of stock/stock complex protection or rebuilding. In addition, regulations that may be forthcoming in response to a change in framework procedures could indirectly result in a change in the economic environment via a change in effort and/or fishing techniques.

Relative to **Alternative 1**, **Preferred Alternative 2** expands the range of management measures that can be implemented by the Council without going through a full plan amendment process. Therefore, **Preferred Alternative 2** should allow for a wider suite of measures that can more rapidly be implemented (compared to the time to develop an FMP amendment) that would be beneficial to the stocks, thereby yielding biological benefits in the future. This will, in turn, yield future economic benefits to the fishing sectors. Anticipated indirect benefits are dependent upon the relative speed at which regulatory changes can be made.

Given that **Alternative 3** (Table 8.2.3) provides a broader suite of options that can be implemented under the framework procedure than either **Alternative 1** or **Preferred Alternative 2**, one would expect indirect economic benefits associated with implementation of **Alternative 3** to exceed those of either **Alternative 1** or **Preferred Alternative 2**.

Conversely, since **Alternative 4** provides a narrower set of options that can be implemented under framework than either **Preferred Alternative 2** or **Alternative 3**, economic benefits derived from implementation of **Alternative 4** are likely to be less than those associated with either **Preferred Alternative 2** or **Alternative 3**.

### 4.7.4 Direct and Indirect Effects on the Social Environment

The development of a revised framework procedure would have beneficial impacts on the social environment as management can react in a timelier manner to changes in the fishery or stock status. Yet, framework actions that are done in an expedited process may have restricted public input and comment at the time the action is undertaken for analysis that is recent. The alternatives below offer several ways to address the benefits of timely action while balancing adequate public comment. **Alternative 1** retains the framework procedures from the species-based FMPs and would not allow for the addition of framework procedures that may be more tailored to specific fisheries within Puerto Rico FMP. Over time, if a specific procedure that was needed to address a particular Puerto Rico fishery was not included in the framework, it may have negative indirect social effects not allowing these measures to be updated via the speedier framework process. The actions under **Alternative 1** are also outdated and do not reflect current management. **Preferred Alternative 2** would be a framework that incorporates the most options with an abbreviated and standard framework that includes either open or closed framework options. This would provide the most flexibility to the Council by offering expedited processes when needed and still allow for more extended public input when appropriate. **Preferred Alternative 2** does not require convening the Council's Advisory Panel (AP) or Scientific and Statistical Committee (SSC), but may do so if deemed appropriate. **Alternative 3** provides options for implementing a framework procedure through open or closed frameworks but is broader because any new information can be used to initiate the framework action. It provides for limited public input with discussion required at only one council meeting and does not

require the AP or SSC to review the action, but the Council may do so if deemed appropriate. **Alternative 4** is the narrowest interpretation as it is only adopted when a new stock assessment has been accomplished and requires discussion during at least three Council meetings. This alternative also requires review by the SSC and AP.

As mentioned earlier, timing and public input become the parameters that are constrained or alleviated by these various alternatives. While public input and participation by advisory panels are beneficial and needed in some instances, that participation, if required, can extend the management process whereby regulations may not be implemented in a well-timed manner to address a particular issue. A more timely application of framework actions can respond to needed changes that may be applied quickly and alleviate short term negative impacts that may impose hardships if extended by more cumbersome frameworks. On the other hand expedited action by the Council may also overlook important input by either the public or advisory panels. Therefore by combining a variety of processes to address both issues within the framework procedure, the Council can provide enough flexibility to ensure the proper input occurs and regulations are implemented in a timely manner.

### 4.7.5 Direct and Indirect Effects on the Administrative Environment

No additional administrative effects are expected from **Alternative 1**, no action.

**Preferred Alternative 2** allows the use of both abbreviated and standard frameworks and includes a comprehensive list of actions. Of all alternatives proposed, **Preferred Alternative 2** provides the best balance between the actions allowed to be implemented under the framework and the procedure required to take these actions. Also when compared to **Alternatives 1**, **3**, and **4**, **Preferred Alternative 2** provides the opportunity for sufficient public review and involvement in the process, while still accommodating the ability for more streamlined implementation.

**Alternative 3** allows for a broader range of actions to be taken through framework rather than by the regular FMP amendment process and requires less discussion at Council meetings and, similar to **Preferred Alternative 2**, does not specifically require SSC and AP input, thus would minimize the administrative burden of implementing regulations and planning/funding public and advisory meetings.

**Alternative 4** would be the least beneficial to the administrative environment because the range of actions that can be taken more expeditiously through framework is more limited than the other alternatives, making **Alternative 4** more administratively burdensome as many actions that could be rapidly taken through framework would need to be taken through the lengthier regular amendment process. In addition, **Alternative 4** requires additional public, SSC, and AP input which requires more administrative resources and efforts than the other alternatives proposed.

## 4.8. Cumulative Effects Analysis

The National Environmental Policy Act (NEPA) requires federal agencies preparing an environmental assessment (EA) to consider not only the direct and indirect effects associated with regulatory actions, but also the cumulative effects resulting from those actions. NEPA defines a cumulative effect as the effect on the environment which results from the incremental effect of an action when added to other past, present, and reasonably foreseeable future actions, regardless of which agency (federal or non-federal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions that take place over a period of time (40 CFR 1508.7), and can be either additive or synergistic. A synergistic effect results when the combined effects are greater than the sum of the individual effects. The five-step cumulative effects analysis presented below addresses the effects of the Council's preferred alternatives for all seven actions identified in Chapter 2.

### 1. The area in which the effects of the proposed action will occur

If the Puerto Rico FMP is implemented, the geographic scope of the area directly affected would include waters of the Puerto Rico EEZ. Those waters extend from nine nautical miles (nm) off the coast of Puerto Rico to 200 nm off that coast, or to a point equidistant between the coast of Puerto Rico and the coast of any neighboring island-state (including the islands of the USVI) with an abutting EEZ, or to an otherwise negotiated boundary between conjoining international EEZs. Additionally, because implementation of the Puerto Rico FMP requires transitioning Caribbean-wide management included in each of the Spiny Lobster, Queen Conch, Reef Fish, and Corals FMPs to island-based management inherent in the Puerto Rico FMP, the geographic scope of the action includes those EEZ waters surrounding the islands of the USVI. Those waters extend from three nautical miles off the coast of each island constituting the USVI to 200 nm off that coast, or to a point equidistant between the USVI coast and the coast of any neighboring island-state (including Puerto Rico) with an abutting EEZ, or to an otherwise negotiated boundary between conjoining international EEZs. In combination, these areas of the U.S. EEZ constitute the Council's area of jurisdiction. This area is described in detail in Section 3.1 of this document (see Figure 1.5.1), and represents the entire area in which fishing activities for Council-managed species could be affected by the alternatives analyzed in this EA. Information about the affected area in the USVI EEZ can be found in Section 3.1 of each of the corresponding St. Thomas/St. John FMP/EA and St. Croix FMP/EA. The most measurable and substantial effects of the Puerto Rico FMP would be limited to the area encompassed by the Puerto Rico EEZ.

### 2. The impacts that are expected in that area from the proposed action

Transitioning from Caribbean-wide, species-based FMPs to an island-based FMP for the Puerto Rico EEZ (Action 1 in this EA) only rearranges past Council actions, without affecting those actions or any other past or present actions taken by federal or non-federal entities. Modifying the stocks managed under the Puerto Rico FMP (Action 2) would include altering the composition of the stocks and their arrangement within complexes (Action 3), and would for the first time identify indicator stocks for some of those stock complexes. Associated with this modification to the list of managed stocks would be revision (in the case of stocks previously managed by the Council) or establishment (in the case of stocks newly added to management) of harvest reference points (Action 4) and associated AMs (Action 5). The impacts of these changes would be minimal as discussed in Chapter 4. Based on application of guidance provided in NS 1 of the Magnuson-Stevens Act regarding identification of stocks in need of federal conservation and management, 38 reef fish, and a host of smaller fish and invertebrates harvested for the aquarium trade, were removed from federal management. In most cases, the decision to remove was based on their infrequent occurrence in federal waters. Applying the same Magnuson-Stevens Act criteria, other reef fish species were identified as being in need of federal conservation and management, but inclusion of those species did not substantially alter the basic character of the reef fish stock complex arrangement previously established for Puerto Rico EEZ waters. Harvest reference points would be revised (Action 4), based upon the application of the best available data, but that is an ongoing obligation of effective fishery management. The manta ray, eagle ray, and sting ray, which are not considered to be reef fish, would be added to management because of their biological vulnerability, but landings data indicate these species are rarely caught and that is reflected in their designation as prohibited species. Because of their biological vulnerability or their importance to the regional or national economy, several pelagic species (dolphinfish, wahoo, tripletail, cero mackerel, king mackerel, little tunny, and blackfin tuna) were added to the Puerto Rico FMP. Although these species are not reef dependent and therefore constitute an essentially new ‘group’ of (pelagic) stocks, all have been and continue to be targeted by both commercial and recreational fishers, so the impacts from inclusion in the Puerto Rico FMP would be minimal. Moreover, establishment of an ACT for these pelagic species as the AM provides a mechanism for the Council in consultation with NMFS’ SEFSC to evaluate the factors contributing to an exceedance of the ACT and to determine whether corrective action is needed. Identifying indicator species (included in Action 3) increases management efficiency but would have no impacts in the area of interest.

Identifying EFH for species new to management (Action 6) addresses a required provision from the Magnuson-Stevens Act. All species new to management co –occur in the same habitats as those already managed, but there are a number of species that have a much more extensive distribution and are only seasonally present in the Puerto Rico EEZ (e.g., dolphinfish). Any impacts from identifying and designating EFH for these new species would be administrative due to consultation requirements, to the extent that new areas are designated. Finally, modifying

framework procedures (Action 7) is an administrative action with no direct impacts to the biological/ecological or socio-economic environments. Minor indirect impacts on these environments would be expected from those actions that modify fishing effort and/or fishing techniques to protect the biological integrity of the managed resources or decrease the risk of overfishing those resources.

### 3. Other Past, Present and Reasonably Foreseeable Future Actions that have or are expected to have impacts in the area and the impacts or expected impacts of these actions:

Listed are past, present, and reasonably foreseeable actions affecting the fisheries in the Puerto Rico EEZ. A list of regulations applicable to stocks managed by the Council in the Puerto Rico EEZ that would be migrated into the Puerto Rico FMP/EA is found in Chapter 5.

*Other Fishery-related actions*

**Past Actions**

The reader is referred to Appendix A (History of Management) for past fishery management actions affecting all stocks managed under the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs. The most relevant past actions are summarized below.

*2010 and 2011 Caribbean Annual Catch Limit (ACL) Amendments (CFMC 2011a, b) and associated EIS*

The CEAs included in each of the Environmental Impact Statements (EISs) for the 2010 and 2011 Caribbean ACL Amendments (CFMC 2011a, b) analyzed cumulative effects from the Reef Fish FMP related to management of reef fish in the U.S. Caribbean EEZ. The 2010 Caribbean ACL Amendment (CFMC 2011a) CEA analyzed cumulative effects to reef fish and queen conch, whereas the CEA included in the 2011 Caribbean ACL Amendment (CFMC 2011b) analyzed cumulative effects to reef fish, spiny lobster, and coral reef resources, in the U.S. Caribbean EEZ. Both of those CEAs also described baseline economic and social conditions for fishing communities in Puerto Rico. The CEAs described the effects of the implementation of ACLs, AMs, and the selection of revised management reference points for Council-managed species, and how those actions would serve to restore and stabilize natural trophic and competitive relationships, rebuild species abundances, re-establish natural sex ratios, contribute to the long-term health of the ecosystem, and reinvigorate sustainable fisheries while minimizing to the extent practicable negative socio-economic impacts. These CEAs are still considered accurate and useful at the present time and are incorporated herein by reference. Both CEAs discussed that, although ACLs and AMs are intended to prevent or greatly reduce the risk of overfishing and are expected to have positive biological benefits, they may also impose more restrictive catch levels on fisheries resulting in negative social and economic impacts over the

short-term. However, to the extent that ACLs and AMs prevent overfishing and assist in rebuilding overfished stocks, they should have positive long-term benefits to both the biological and socio-economic environments.

*Comprehensive Amendment to the U.S. Caribbean FMPs: Application of AMs (AM Application Amendment*) and EA (CFMC 2016)

This amendment modified AM-applicability language in the four Council FMPs to correct an inconsistency with the implementing regulations. Although this action directly affected AMs, the action did not result in regulatory changes and did not change the way AMs are currently implemented in the EEZ. The action in the AM Application amendment is not expected to contribute to the effects expected from the actions considered in the Puerto Rico FMP, and vice-versa. The CEA included in the AM Application Amendment analyzed cumulative effects to the spiny lobster, queen conch, reef fish, and coral resources in the U.S. Caribbean EEZ and revealed no significant, cumulative adverse effects on the human environment. The CEA in the AM Application Amendment also considered the analyses of cumulative effects listed in each of the 2010 and 2011 Caribbean ACL Amendments/EISs, mentioned above. These analyses are still considered accurate and useful at the present time and are incorporated herein by reference.

*Amendments to the Reef Fish, Spiny Lobster, and Corals and Reef Associated Plants and Invertebrates FMPs: Timing of AM-Based Closures and EA (CFMC 2017a)*

The CEA included in this document discussed the implications of changing the end date for AM-based closures from December 31st to September 30th each year, with the closure period extending backward toward the beginning of the year for the number of days necessary to achieve the required reduction in landings. The CEA revealed no significant beneficial or adverse cumulative effects on the physical or biological/ecological environments but identified positive non-significant effects on the social and economic environments by minimizing adverse socio-economic effects from the application of AMs. The CEA also considered the analyses of cumulative effects listed in each of the 2010 and 2011 Caribbean ACL Amendments/EISs, mentioned above. The CEA of this amendment is still considered to be accurate and useful at the present time.

*Regulatory Amendment 6 to the Reef Fish FMP: Triggering AMs (CFMC 2017b)*

Regulatory Amendment 6 affected only Council-managed reef fish that are managed with sector-specific ACLs, currently only applicable in the Puerto Rico EEZ. The action triggered an AM for a stock/complex when the total ACL, rather than the sector-specific ACL, is exceeded, and was expected to minimize the potential adverse socio-economic effects of AM-based fishery closures and increase the likelihood that OY is achieved on a continuing basis. Although the socio-economic environment was expected to experience short-term adverse effects from an applied AM, the long-term social and economic effects would be expected to be positive through

healthier fish stocks. The action was not expected to have significant beneficial or adverse cumulative effects on the physical or biological/ecological environments, as harvest would continue to be constrained to the total ACL, which is set at a harvest level that is sustainable for a stock or stock complex. The CEA concluded that the action would not contribute any cumulative effects that were not previously considered when AMs were established and implemented, and no significant, cumulative adverse effects on the biological/ecological and socio-economic environments were expected from the proposed action. The CEA of this amendment is still considered accurate and useful at the present time.

**Present and Reasonably Foreseeable Future Actions**

The overarching goal of the present action, establishing a Puerto Rico FMP, is to ensure the continued health of fishery resources occurring in the EEZ surrounding Puerto Rico within the context of the unique biological, ecological, economic, and cultural characteristics of those resources and the communities dependent upon them. To achieve this fundamental goal, the Puerto Rico FMP establishes a place-based framework designed to provide the foundation for conserving and managing the fisheries of Puerto Rico within an integrative, ecosystem-based approach. Essential to this ecosystem-based fishery management (EBFM) approach is enhanced stewardship among fishermen, residents and others who value the fishery resources and marine and coastal environment of Puerto Rico and the U.S. (reference or link to the NMFS EBFM policy and the Caribbean EBFM RIP).

The Council, in partnership with NMFS and other regional constituencies, is in the process of moving towards full implementation of EBFM in the region. EBFM enables a more holistic approach to decision-making by considering trade-offs among fisheries, aquaculture, protected species, biodiversity, habitats, and the human community, within the context of climate, habitat, ecological, and other environmental change.

*Consideration of Climate Change and Other Non-Fishery Related Issues*

Stresses affecting fishery resources and protected resources as well as the human communities that depend on those resources include, but are not limited to, natural events, habitat quality, human population growth, and anthropogenic threats (e.g., habitat loss and degradation, sedimentation, pollution, water quality, overharvest, climate change). Some managed species may be more sensitive to the quality of their environment than are others. For example, any changes in benthic conditions resulting from land-based increases in sedimentation or turbidity will adversely affect the available productive habitat for queen conch (Appeldoorn et al. 2011) and corals. Consideration of these stressors, and the changing nature of stressors within the context of climate variability and change, is an important component of the EBFM approach.

Emerging information sheds light on how global climate change will affect, and is already affecting, fishery resources and the habitats upon which they depend. Climate change can affect marine ecosystems through altered patterns of thermal stratification, changes to upwelling patterns, sea level rise, increases in wave height and frequency, loss of sea ice, changes to storm frequency and intensity, and increased risk of diseases in marine biota, among other things. Potential vulnerabilities for coastal zones include increased shoreline erosion leading to alteration of the coastline, loss of coastal wetlands, and changes in the profiles of fish and other marine life populations (Lorde et al. 2013). Changes in ocean temperatures have been linked to shifting fish stock distribution and productivity in many marine ecosystems, and these impacts are expected to increase in the future (NMFS 2014). Any of these could affect the local or regional seafood output and thus the local economy (Carter et al. 2014). In the U.S. Caribbean region and throughout the southeastern U.S., the major climate induced ecosystem concerns include: 1) Threats to coral reef ecosystems - coral bleaching, disease, and ocean acidification; 2) Threats to habitat from sea level rise – loss of essential fish habitat; and 3) Climate induced changes to species phenology and distribution (Osgood 2008).

Climate variability is also a factor that needs to be considered when addressing climate effects, and in the reasonably foreseeable future, it may be far more influential than unidirectional climate change. For example, inter-annual (e.g., El Niño/La Niña) changes in the ocean environment may result in altered patterns of fish distribution, productivity, reproduction, and recruitment (NOAA PFL Climate Variability and Marine Fisheries, accessed November 2018). Additionally, cyclical water temperature variability may result in relatively short-term (decadal) changes in water temperature that substantially exceed (cyclical temperature maximum) the evident long-term pattern of temperature increase, or that act in opposition (cyclical temperature minimum) to that long-term pattern. Such decadal-scale events may be far more influential with respect to fishery management regulations such as those included in the Puerto Rico FMP than are long-term climate change events, because these decadal-scale events operate on the time frame of the fishery management action and effect the ecosystem in the short-term.

Many types of "pollution" may adversely affect the coral reef ecosystem, but increasing atmospheric carbon dioxide concentration is having substantial and clearly documented negative effects. Excess carbon dioxide ($CO_2$) dissolves into the ocean and is converted to corrosive carbonic acid, resulting in the phenomenon known as "ocean acidification" (Madin 2010). At the same time, the $CO_2$ also supplies carbon that combines with calcium already dissolved in seawater to provide the main ingredient for shells and coral skeletons, calcium carbonate ($CaCO_3$) (Madin 2010). The net responses of organisms to rising $CO_2$ concentration will vary depending on often opposing sensitivities to decreased seawater pH, carbonate concentration, and carbonate saturation state, and to elevated oceanic total inorganic carbon and gaseous $CO_2$ (Cooley and Doney 2009). Increased ocean acidity caused by elevated $CO_2$ could directly damage organisms by partially dissolving their skeletal structure (Madin 2010) or by decreasing

skeletal growth rate. Other species with more protective coverings on their shells and skeletons, such as crustaceans, temperate urchins, mussels, and coralline red algae, may be less vulnerable to decreasing seawater pH (Madin 2010). Projections based on the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (SRES) estimate a reduction in average global surface ocean pH of between 0.14 and 0.35 units during the 21st century (Climate Change 2007). Although the extent and direction of effects on species and ecosystems resulting from ocean acidification are not fully understood, deleterious impacts have been unequivocally documented and the need for effective management is clear.

Although the full range of effects resulting from climate change, climate variation, and ocean acidification cannot be quantified at this time, nor is the exact timeframe known in which these impacts will occur, the need for proactive management is evident. Both globally and throughout the Caribbean basin, coral bleaching events are occurring more frequently and with greater severity. Other coral diseases also contribute to coral reef degradation. Few of the management actions proposed in this FMP/EA are expected to increase or decrease the potential impacts of climate change and ocean acidification on fishery resources and other protected resources. However, prohibitions on and reductions in allowable catch of grazing species, including parrotfish and surgeonfish, are designed to ensure adequate grazing capacity and thereby strengthen the resilience of corals to environmental impacts resulting from climate variability and change. Unfortunately, other anthropogenic impacts to Council-managed resources in the affected area may be more pressing than climate change or even decadal-scale climate variability. Those anthropogenic impacts may include, but are not limited to, nitrification, sedimentation, and other symptoms of an ever-increasing human population. Nonetheless, continued monitoring of the effects of climate change, climate variability, and ocean acidification should be a priority of national and local programs. For more information about climate impacts in U.S. marine living resources concerning NMFS, see Osgood (2008). For additional information about climate change in the Caribbean and Southeast region, please see Chapter 17 of the Third National Climate Assessment: *Climate Change Impacts in the United States* (Carter et al. 2014).

Tropical storms constitute past, present and certainly foreseeable future events with significant effects on Puerto Rico fishery resources, the habitats upon which those resources depend, and the human communities dependent upon that fishery ecosystem. Historically, such tropical events substantially impact the ecosystem. Although those impacts may be relatively short-lived, they can be severe and tragic. In 2017, Hurricanes Maria and Irma affected all of the islands constituting the U.S. Caribbean region, with resultant loss of life and property from which the region has not yet recovered. Stresses caused by the impact of those recent hurricanes on Puerto Rico fisheries and to the socio-economy of Puerto Rico, and the resulting recovery, are discussed in detail in Sections 3.4 and 3.5.11. Within the fishery ecosystem, target and non-target resources were redistributed with both beneficial and detrimental effects. Habitat, and

specifically coral reefs, were severely damaged although rapidly developing restoration and recovery strategies are reducing the extent and duration of these impacts. Socially and economically, impacts to gear and infrastructure were substantial and prevented fishing in the short-term and to this day continue to constrain fishing, although the magnitude of that constraint varies as fishers have modified their fishing techniques, gears, or target species to adapt to new environmental conditions after the hurricanes' impact. Those fishing constraints result not just from the fishermen's loss of their trade tools, but also from loss of markets due to residents leaving the island and tourists staying away. Tropical storm events are a future certainty, and the prediction is for climate change to increase the frequency and severity of tropical storm events.

Other issues directly affecting human communities include high fuel costs, increased seafood imports, restricted access to traditional fishing grounds, and regional economies. Additional information on these topics as they pertain to the Puerto Rico FMP can be found in Sections 3.4, 3.5, and 3.7.

### 4. *The overall impact that can be expected if the individual impacts are allowed to accumulate:*

Cumulative effects resulting from creation of a Puerto Rico FMP in combination with other past, present, and reasonably foreseeable future actions would be expected to be minimal. Some minor short-term negative effects would result from revision of regulatory text and other descriptive documents, and some positive socioeconomic effects may result from increased compliance and cooperation from affected constituents. But transitioning from Caribbean-wide, species-based FMPs to an island-based FMP for the Puerto Rico EEZ only rearranges past Council actions, without affecting those actions or any other past or present actions taken by federal or non-federal entities.

No significant overall impacts to the biological/ecological environment, to protected species occurring within that environment, to the habitats constituting and supporting that environment, or to the dependent socioeconomic environment are expected to result from the cumulative past, present, or reasonably foreseeable future impacts of the actions that comprise this transition to a Puerto Rico FMP. As discussed earlier, the impacts from recent hurricanes on the fishery ecosystem were both positive (e.g., increase in abundance of some species in some areas) and negative (e.g., physical damage to coral reefs). But restoration activities, either current or planned for the immediate future, are expected to reduce the extent and duration of these impacts. Similarly, no cumulative effects would be expected to result from reasonably foreseeable future actions that may be taken, by other federal or non-federal agencies, which would otherwise not occur if the management transition did not take place.

### 5. *Summary:*

The transition to a Puerto Rico FMP from the Council species-based FMPs is not expected to have individually significant effects to the biological/ecological, physical, or socio-economic environment or to combine with the effects of other past, present, or reasonably foreseeable future actions in such a way that could have a potentially significant, cumulative effect.

# Chapter 5. Conservation and Management Measures - Action Plan

## 5.1 Introduction

In order to conserve, maintain, and sustain the fisheries and related environment and habitats in the U.S. Caribbean, the goal of the Caribbean Fishery Management Council (Council) is to develop and establish effective conservation and management measures that maintain a healthy fishery that meets the needs of fishermen and the general public. These conservation and management measures are based on (1) determining the status of the fisheries stocks and overall biological productivity and capacity to maintain vital fishery resources for the near- and long-term, (2) considering the economic, social and cultural aspects of the fisheries, and (3) determining effective fishing practices, rules, and regulations to ensure sustainable harvest of fishery resources within the context of optimum yield (OY). The federal guidelines regarding these conservation and management measures are fully described in National Standard (NS) 1 of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) and are discussed in Appendix F of this document.

Chapter 5 describes the Council's conservation and management measures included in the Puerto Rico FMP to achieve the Council's management objectives in the Puerto Rico exclusive economic zone (EEZ). Chapter 5 also discusses the criteria used to assess the status of Council-managed stocks and the management measures that the Council has developed as a means to prevent overfishing and avoid an overfished resource. As discussed in Chapter 2 (Action 1: Transition Fisheries Management in the Puerto Rico EEZ from a Species-Based Approach to an Island-Based Approach), although the Puerto Rico FMP would replace the Council's Reef Fish, Spiny Lobster, Queen Conch, and Corals and Reef Associated Plants and Invertebrates FMPs[70], the new FMP carries forward most of the management measures from those four species-based FMPs. Importantly, the Puerto Rico FMP introduces some new management measures as well as new reference points and status determination criteria (SDC) evaluated and ultimately selected by the Council in the draft environmental assessment included in this document. For additional information on the management measures migrated from the Council's previous FMPs (Reef Fish, Spiny Lobster, Queen Conch, and Coral), please see the Council's FMPs and amendments as those documents contain comprehensive discussions of the need and analysis of each of the measures transitioned into this plan at the time they were created. All management measures in the Puerto Rico FMP have been developed and analyzed in accordance with Magnuson-Stevens Act requirements and National Environmental Policy Act, and other applicable law. The

[70] Action 1 of the DEIS (1) established a new island-based FMP for Puerto Rico EEZ waters, repealed the existing species-based FMPs and replaced them with the island-based FMP for Puerto Rico EEZ waters.

Council continues to believe that the measures that the Council is retaining from the species-based plans are necessary and appropriate to manage the fishery under the Puerto Rico FMP, as they remain important to ensure that the Council is managing the resources in a manner that is consistent with the Magnuson-Stevens Act, including National Standard 1, that is, preventing overfishing while achieving OY, and other applicable law.

Management measures listed in this chapter include harvest guidelines, minimum size limits, gear restrictions and identification, seasonal and areal closures, and harvest limits (among others) for all stocks managed by the Council in the Puerto Rico EEZ. The following sections list all provisions and regulations applicable to the fishery resources managed in the Puerto Rico EEZ by fishery group (finfish [reef fish, pelagic fish, other non-reef fish], spiny lobster, queen conch, coral reef resources).

## 5.2 Prohibited Species and Harvest Restrictions

Harvest prohibitions/restrictions for species described below apply to both the commercial and recreational sectors of those fishing within the Puerto Rico EEZ.

### 5.2.1 Fish (Shallow-water Reef Fish, Deep-water Reef Fish, Coastal Pelagics)

This provision applies to the following stocks/stock complexes:
Groupers: Grouper complex 1 (Nassau [*Epinephelus striatus]* and Grouper complex 2 goliath [*E. itajara*]
Giant Manta Ray (*Manta birostris*)
Spotted Eagle Ray (*Aetobatus narinari*)
Sting Ray (*Dasyatis americana*)
Parrotfish Complex 1: blue (*Scarus coeruleus*); midnight (*Scarus coelestinus*); rainbow (*Scarus guacamaia*)

No person may fish for or possess goliath grouper, Nassau grouper, blue parrotfish, midnight parrotfish, rainbow parrotfish, giant manta ray, spotted eagle ray, or sting ray in or from the Puerto Rico EEZ. Such fish caught in the Puerto Rico EEZ must be released immediately with a minimum of harm.

This provision applies to all managed finfish. Landing fish intact.

- Finfish in or from the Puerto Rico EEZ must be maintained with head and fins intact, with the following exceptions:
    - Bait is exempt from the requirement to be maintained with head and fins intact.
        - "Bait" means: (A) Packaged, headless fish fillets that have the skin attached and are frozen or refrigerated; (B) Headless fish fillets that have

the skin attached and are held in brine; or (C) Small pieces no larger than 3 $in^3$ (7.6 $cm^3$) or strips no larger than 3 inches by 9 inches (7.6 cm by 22.9 cm) that have the skin attached and are frozen, refrigerated, or held in brine.

    - Note a finfish or part thereof possessed in or landed from the Puerto Rico EEZ that is subsequently sold or purchased as a finfish species, rather than as bait, is not bait.

  - Legal-sized finfish possessed for consumption at sea on the harvesting vessel are exempt from the requirement to have head and fins intact, provided: (i) Such finfish do not exceed any applicable bag limit; (ii) Such finfish do not exceed 1.5 lbs. (680 g) of finfish parts per person aboard; and (iii) The vessel is equipped to cook such finfish on board.

- The operator of a vessel that fishes in the Puerto Rico EEZ is responsible for ensuring that fish possessed on the vessel while in the Puerto Rico EEZ are maintained intact and, if taken from the EEZ, are maintained intact through offloading ashore.

Gear restrictions and minimum size limits apply. See Sections 5.3 and 5.4 below.

### 5.2.2 Spiny Lobster

No species harvest prohibition. No harvest of egg bearing females (Figure 5.2.1). Egg-bearing spiny lobster in the Puerto Rico EEZ must be returned to the water unharmed. An egg-bearing spiny lobster may be retained in a trap, provided the trap is returned immediately to the water. An egg-bearing spiny lobster may not be stripped, scraped, shaved, clipped, or in any other manner molested, in order to remove eggs.

Landing spiny lobster intact. A Caribbean spiny lobster in or from the Puerto Rico EEZ must be maintained with head and carapace intact. The operator of a vessel that fishes in the EEZ is responsible for ensuring that spiny lobster on that vessel in the EEZ are maintained intact and, if taken from the EEZ, are maintained intact through offloading ashore.

Gear restrictions and minimum size limit apply. See Sections 5.3 and 5.4 below.

**Figure 5.2.1.** Berried spiny lobster.

### 5.2.3 Queen Conch

No person may fish for or possess queen conch in or from the Puerto Rico EEZ.

### 5.2.4 Coral Reef Resources

#### 5.2.4.1 Corals

No person may fish for or possess any species of coral (stony corals, octocorals, black corals) in or from the Puerto Rico EEZ. The taking of any corals in the Puerto Rico EEZ is not considered unlawful possession provided it is returned immediately to the sea in the general area of fishing.

#### 5.2.4.2 Sea Urchins and Sea Cucumbers

No person may fish for or possess any species of sea urchins or sea cucumbers in or from the Puerto Rico EEZ.

## 5.3 Gear and Methods

### 5.3.1 Prohibited Gear and Methods Applicable to all Stocks

***Explosives.*** An explosive (except an explosive in a powerhead where a powerhead is an allowable gear) may not be used to fish in the Puerto Rico EEZ. A vessel fishing in the Puerto Rico EEZ for a species managed under the Puerto Rico FMP, may not have on board any dynamite or similar explosive substance.

## 5.3.2 Gear and Methods for the Harvest of Finfish (Reef Fish, Pelagics, Others [rays])

### 5.3.2.1 Prohibited Gear and Methods for the Harvest of Reef Fish

A. Applicable to both the Commercial and Recreational Sectors of those Fishing for Reef Fish

Poisons

A poison, drug, or other chemical may not be used to fish for Caribbean reef fish in the Puerto Rico EEZ.

Powerheads

A powerhead may not be used in the Puerto Rico EEZ to harvest Caribbean reef fish. The possession of a mutilated Caribbean reef fish in or from the Puerto Rico EEZ and a powerhead is prima facie evidence that such fish was harvested by a powerhead.

Gillnets and trammel nets

A gillnet or trammel net may not be used in the Puerto Rico EEZ to fish for Caribbean reef fish. Possession of a gillnet or trammel net and any Caribbean reef fish in or from the Puerto Rico EEZ is prima facie evidence of violation of this paragraph. A gillnet or trammel net used in the Puerto Rico EEZ to fish for any other species must be tended at all times.

### 5.3.2.2 Allowed Gear and Methods for the Harvest of Reef Fish

**A. Reef Fish-- Applicable to the Commercial Sector**

*Gear Type Allowed by Fishery*

| Puerto Rico Reef Fish Fishery: | Gear Type |
|---|---|
| A. Commercial Longline/hook and line fishery | A. Longline, hook and line |
| B. Commercial Trap/pot fishery | B. Trap, pot |
| C. Other commercial fishery | D. Spear |

Specifications are provided only for the trap/pot gear, as follows:

I. *Fish Trap Identification*

- Fish Traps and Associated buoys

  A fish trap used or possessed in the Puerto Rico EEZ must display the official number specified for the vessel by Puerto Rico or the U.S. Virgin Islands so as to be easily identified. Fish traps used to target reef fish in the Puerto Rico EEZ that are fished individually, rather than tied together in a trap line, must have at least one buoy attached that floats on the surface. Fish traps used in the Puerto Rico EEZ that are tied together in a trap line must have at least one buoy that floats at the surface

attached at each end of the trap line. Each buoy must display the official number and color code assigned to the vessel by Puerto Rico or the U.S. Virgin Islands, whichever is applicable, so as to be easily distinguished, located, and identified.

- Presumption of ownership of fish traps
  A fish trap in the Puerto Rico EEZ will be presumed to be the property of the most recently documented owner. This presumption will not apply with respect to such traps that are lost or sold if the owner reports the loss or sale within 15 days to the Regional Administrator (RA).

- Disposition of unmarked fish traps or buoys
  An unmarked fish trap or a buoy deployed in the Puerto Rico EEZ where such trap or buoy is required to be marked is illegal and may be disposed of in any appropriate manner by the Assistant Administrator or an authorized officer.

II. *Fish Trap Construction Specifications and Tending Restrictions*

- Minimum Mesh Size
  - A bare wire fish trap used or possessed in the Puerto Rico EEZ that has hexagonal mesh openings must have a minimum mesh size of 1.5 inches (3.8 cm) in the smallest dimension measured between centers of opposite strands.

  - A bare wire fish trap used or possessed in the Puerto Rico EEZ that has other than hexagonal mesh openings or a fish trap of other than bare wire, such as coated wire or plastic, used or possessed in the Puerto Rico EEZ, must have a minimum mesh size of 2.0 inches (5.1 cm) in the smallest dimension measured between centers of opposite strands.

- Escape Mechanisms
  A fish trap used or possessed in the Puerto Rico EEZ must have a panel located on one side of the trap, excluding the top, bottom, and side containing the trap entrance. The opening covered by the panel must measure not less than 8 by 8 inches (20.3 by 20.3 cm). The mesh size of the panel may not be smaller than the mesh size of the trap. The panel must be attached to the trap with untreated jute twine with a diameter not exceeding 1/8 inches (3.2 mm). An access door may serve as the panel, provided it is on an appropriate side, it is hinged only at its bottom, its only other fastening is untreated jute twine with a diameter not exceeding 1/8 inches (3.2 mm), and such fastening is at the top of the door so that the door will fall open when such twine degrades. Jute twine used to secure a panel may not be wrapped or overlapped.

- Tending Restrictions
  A fish trap in the Puerto Rico EEZ may be pulled or tended only by a person (other than an authorized officer) aboard the fish trap owner's vessel, or aboard another vessel if such vessel has on board written consent of the trap owner, or if the trap owner is aboard and has documentation verifying his identification number and color code. An owner's written consent must specify the time period such consent is effective and the trap owner's gear identification number and color code.

B. Reef Fish-- Applicable to the Recreational Sector

*Gear Type Allowed*

| **Puerto Rico Recreational Reef Fish Fishery** | **Gear Type** |
|---|---|
| Recreational fishery | Dip net, handline, rod and reel, slurp gun, spear |

## 5.3.3. Gear and Methods for the Harvest of Caribbean Spiny Lobster

### 5.3.3.1 Prohibited Gear and Methods for the Harvest of Spiny Lobster

A. Applicable to both the Commercial and Recreational Sectors

Spears and hooks
A spear, hook, or similar device may not be used in the Puerto Rico EEZ to harvest a Caribbean spiny lobster. The possession of a speared, pierced, or punctured Caribbean spiny lobster in or from the Puerto Rico EEZ is prima facie evidence of violation of this section.

Gillnets and trammel nets
A gillnet or trammel net may not be used in the Puerto Rico EEZ to fish for Caribbean spiny lobster. Possession of a gillnet or trammel net and any Caribbean spiny lobster in or from the Puerto Rico EEZ is prima facie evidence of violation of this paragraph. A gillnet or trammel net used in the Puerto Rico EEZ to fish for any other species must be tended at all times.

### 5.3.3.2 Allowed Gear and Methods for the Harvest of Caribbean Spiny Lobster

A. Applicable to the Commercial Sector

*Gear Type Allowed*

| Caribbean Spiny Lobster Fishery | **Gear Type** |
|---|---|
| A. Trap/pot fishery | A. Trap/pot |
| B. Dip net fishery | B. Dip net |
| C. Hand harvest fishery | C. Hand harvest, snare |

Specifications are provided only for the trap/pot gear.

I. *Caribbean Spiny Lobster Trap Identification*

- Caribbean Spiny Lobster traps and associated buoys
  A Caribbean spiny lobster trap used or possessed in the Puerto Rico EEZ must display the official number specified for the vessel by Puerto Rico or the U.S. Virgin Islands so as to be easily identified. Caribbean spiny lobster traps used in the Puerto Rico EEZ that are fished individually, rather than tied together in a trap line, must have at least one buoy attached that floats on the surface. Caribbean spiny lobster traps used in the Puerto Rico spiny lobster fishery that are tied together in a trap line must have at least one buoy that floats at the surface attached at each end of the trap line. Each buoy must display the official number and color code assigned to the vessel by Puerto Rico or the U.S. Virgin Islands, whichever is applicable, so as to be easily distinguished, located, and identified.

- Presumption of ownership of Caribbean spiny lobster traps
  A Caribbean spiny lobster trap in the Puerto Rico EEZ will be presumed to be the property of the most recently documented owner. This presumption will not apply with respect to such traps that are lost or sold if the owner reports the loss or sale within 15 days to the RA.

- Disposition of unmarked Caribbean spiny lobster
  An unmarked Caribbean spiny lobster trap or a buoy deployed in the Puerto Rico EEZ where such trap or buoy is required to be marked is illegal and may be disposed of in any appropriate manner by the Assistant Administrator or an authorized officer.

II. *Caribbean Spiny Lobster Trap Construction Specifications and Tending Restrictions*

- Escape mechanisms
  A spiny lobster trap used or possessed in the Puerto Rico EEZ must contain on any vertical side or on the top a panel no smaller in diameter than the throat or entrance of the trap. The panel must be made of or attached to the trap by one of the following degradable materials:
  - Untreated fiber of biological origin with a diameter not exceeding 1/8 inches (3.2 mm). This includes, but is not limited to tyre palm, hemp, jute, cotton, wool, or silk.
  - Ungalvanized or uncoated iron wire with a diameter not exceeding 1/16 inches (1.6 mm), that is, 16 gauge wire.

- Tending restrictions

A Caribbean spiny lobster trap in the Puerto Rico EEZ may be pulled or tended only by a person (other than an authorized officer) aboard the fish trap owner's vessel, or aboard another vessel if such vessel has on board written consent of the trap owner, or if the trap owner is aboard and has documentation verifying his identification number and color code. An owner's written consent must specify the time period such consent is effective and the trap owner's gear identification number and color code.

B. Applicable to the Recreational Sector

*Gear Type Allowed*

| Caribbean Spiny Lobster Fishery | Gear Type |
|---|---|
| Recreational fishery | Dip net, hand harvest, snare |

## 5.4 Size Limits

Species that are not in compliance with the size limits, in or from the Puerto Rico EEZ, may not be possessed, sold, or purchased and must be released immediately with a minimum amount of harm. The operator of a vessel that fishes in the Puerto Rico EEZ is responsible for ensuring that the species on board the vessel are in compliance with the size limits specified below.

### 5.4.1 Applicable to Reef Fish

Yellowtail Snapper (*Ocyurus chrysurus*)
The minimum size limit is 12 inches (in) (30.48 cm) total length (TL). This size limit applies year-round.

### 5.4.2 Caribbean Spiny Lobster

The minimum size limit is 3.5 in or 8.9 cm carapace length (Figure 5.4.1). See Section 5.2.2 above for harvest restrictions applicable to the harvest of Caribbean spiny lobster, including the requirement that Caribbean spiny lobster must be maintained with head and carapace intact.

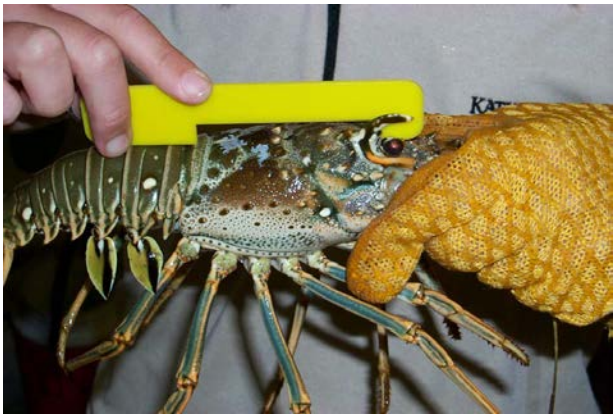

**Figure 5.4.1.** Measurement of a spiny lobster carapace.

## 5.5 Commercial Trip Limits

There are no commercial trip limits established for stocks or stock complexes managed under the Puerto Rico FMP.

## 5.6 Recreational Bag Limits

### 5.6.1 General Applicability of Bag and Possession limits for Certain Reef fish Species and Spiny lobster

The bag and possession limits apply to certain stocks or stock complexes in or from the Puerto Rico EEZ, as specified below. Unless specified otherwise, bag limits apply to a person on a daily basis, regardless of the number of trips in a day. Unless specified otherwise, a person is limited to a single bag limit for a trip lasting longer than one calendar day. Unless specified otherwise, possession limits apply to a person on a trip after the first 24 hours of that trip. The bag and possession limits apply to a person who fishes in the Puerto Rico EEZ in any manner, except a person who has a valid commercial fishing license issued by Puerto Rico or the U.S. Virgin Islands. A person who fishes in the Puerto Rico EEZ may not combine a bag limit specified for the Puerto Rico EEZ with a bag or possession limit applicable to territorial waters. A stock/stock complex subject to a bag limit specified below and taken in the Puerto Rico EEZ by a person subject to the bag limits may not be transferred at sea, regardless of where such transfer takes place, and such fish may not be transferred in the Puerto Rico EEZ. The operator of a vessel that fishes in the Puerto Rico EEZ is responsible for ensuring that the specified bag and possession limits are not exceeded.

### 5.6.2 Bag and Possession Limits for Reef Fish[71]

| Aggregate bag limit for: | Allowed quantity: |
|---|---|
| Snapper<br>grouper<br>parrotfish, combined | 5 fish per person/day, or if 3 or more persons are aboard, 15 fish total per vessel/day; but not to exceed: 2 parrotfish per person/day or 6 parrotfish per vessel/day. |
| angelfish, grunts, wrasses, jacks, triggerfish, surgeonfish, combined | 5 fish per person/day or, if 3 or more persons are aboard, 15 fish total per vessel/day, but not to exceed: 1 surgeonfish per person/day or 4 surgeonfish per vessel/day. |

### 5.6.3 Bag and Possession Limits for Caribbean Spiny Lobster

| Bag limit for: | Allowed quantity: |
|---|---|
| Spiny lobster | 3 spiny lobsters per person/day, not to exceed 10 spiny lobsters per vessel/day, whichever is less. |

## 5.7 Restrictions on Sale/Purchase

### 5.7.1 General

The Magnuson-Stevens Act defines recreational fishing as fishing for sport and pleasure.

### 5.7.2 Reef Fish

A live red hind or live mutton snapper in or from the Puerto Rico EEZ may not be sold or purchased and used in the marine aquarium trade.

### 5.7.3 Caribbean Spiny Lobster

No person may import a Caribbean spiny lobster with less than a 6-ounce (170-gram) tail weight **into Puerto Rico**. A 6-ounce (170-gram) tail weight is defined as a tail that weighs 5.9-6.4 ounces (167-181 grams). If the documentation accompanying an imported Caribbean spiny lobster (including but not limited to product packaging, customs entry forms, bills of lading, brokerage forms, or commercial invoices) indicates that the product does not satisfy the minimum tail weight, the person importing such Caribbean spiny lobster has the burden to prove

[71] The recreational bag limit only applies to reef fish. It does not apply to pelagic stocks, which are new to management in the Puerto Rico FMP such as dolphin, pompano dolphin, wahoo, little tunny, blackfin tuna, king mackerel, cero, wahoo, tripletail, and the great barracuda or to rays.

that such Caribbean spiny lobster actually does satisfy the minimum tail-weight requirement or that such Caribbean spiny lobster has a tail length of 6.2 inches (15.75 cm) or greater or that such Caribbean spiny lobster has or had a carapace length of 3.5 inches (8.89 cm) or greater. If the imported product itself does not satisfy the minimum tail-weight requirement, the person importing such Caribbean spiny lobster has the burden to prove that such Caribbean spiny lobster has a 302 tail length of 6.2 inches (15.75 cm) or greater or that such Caribbean spiny lobster has or had a carapace length of 3.5 inches (8.89 cm) or greater. If the burden is satisfied such Caribbean spiny lobster will be considered to be in compliance with the minimum 6-ounce (170-gram) tail-weight requirement.

No person may import a spiny lobster with less than a 5-ounce (142-gram) tail weight **into any place subject to the jurisdiction of the United States excluding Puerto Rico and the U.S. Virgin Islands**. A 5-ounce (142-gram) tail weight is defined as a tail that weighs 4.2-5.4 ounces (119-153 grams). If the documentation accompanying an imported spiny lobster (including but not limited to product packaging, customs entry forms, bills of lading, brokerage forms, or commercial invoices) indicates that the product does not satisfy the minimum tail-weight requirement, the person importing such spiny lobster has the burden to prove that such spiny lobster actually does satisfy the minimum tail-weight requirement or that such spiny lobster has a tail length of 5.5 inches (13.97 cm) or greater or that such spiny lobster has or had a carapace length of greater than 3.0 inches (7.62 cm). If the imported product itself does not satisfy the minimum tail-weight requirement, the person importing such spiny lobster has the burden to prove that such spiny lobster has a tail length of 5.5 inches (13.97 cm) or greater or that such spiny lobster has or had a carapace length of greater than 3.0 inches (7.62 cm). If the burden is satisfied, such spiny lobster will be considered to be in compliance with the minimum 5-ounce (142-gram) tail-weight requirement.

No person may import, into any place subject to the jurisdiction of the United States, Caribbean spiny lobster tail meat that is not in whole tail form with the exoskeleton attached.

No person may import, into any place subject to the jurisdiction of the United States, Caribbean spiny lobster with eggs attached or Caribbean spiny lobster from which eggs or pleopods (swimmerets) have been removed or stripped. Pleopods (swimmerets) are the first five pairs of abdominal appendages.

## 5.7.4 Coral Reef Resources

### 5.7.4.1 Corals

No person may sell or purchase a Caribbean coral harvested in the Puerto Rico EEZ.

A Caribbean coral that is sold in Puerto Rico will be presumed to have been harvested in the Puerto Rico EEZ, unless it is accompanied by documentation showing that it was harvested elsewhere. Such documentation must contain:

The information specified in subpart K of part 300 of 50 CFR for marking containers or packages of fish or wildlife that are imported, exported, or transported in interstate commerce; the name and home port of the vessel, or the name and address of the individual, harvesting the Caribbean coral; the port and date of landing the Caribbean coral; and a statement signed by the person selling the Caribbean coral attesting that, to the best of his or her knowledge, information, and belief, such Caribbean coral was harvested other than in the Puerto Rico EEZ or the waters of Puerto Rico.

#### 5.7.4.1 Sea Urchins and Sea Cucumbers

No person may sell or purchase a Caribbean sea urchin or a sea cucumber harvested in the Puerto Rico EEZ.

### 5.7.5 Queen Conch

No person may sell or purchase a Caribbean queen conch harvested in the Puerto Rico EEZ.

## 5.8 Anchoring Restrictions

### 5.8.1 General

<u>Specific areas in the Puerto Rico EEZ with anchoring restrictions</u>
Anchoring is prohibited year-round in the Bajo de Sico Spawning Aggregation Area west off Puerto Rico (See Figure 10.10.1 in Section 10.10 below for information on the Bajo de Sico Spawning Aggregation Area).

### 5.8.2 Reef Fish

The owner or operator of any fishing vessel, recreational or commercial that fishes for or possesses Caribbean reef fish in or from the Puerto Rico EEZ must ensure that the vessel uses only an anchor retrieval system that recovers the anchor by its crown, thereby preventing the anchor from dragging along the bottom during recovery. For a grapnel hook, this could include an incorporated anchor rode reversal bar that runs parallel along the shank, which allows the rode to reverse and slip back toward the crown. For a fluke or plow type anchor, a trip line consisting of a line from the crown of the anchor to a surface buoy would be required.

## 5.9 Seasonal Closures Applicable to Fishing for Certain Species

The seasonal closures applicable to fishing for the species listed below apply to all fishing activities.

### 5.9.1 Seasonal Species Closures Applicable to Reef Fish

**Table 5.9.1.** Species in the Puerto Rico EEZ with seasonal closures and dates when season is closed and open for fishing for these species.

No person may fish for or possess the following species in or from the Puerto Rico EEZ (unless another area is specified) during the closed time period. The prohibition on possession does not apply to the species harvested and landed ashore prior to the closure.

| **Species** | **Open** | **Closed** |
|---|---|---|
| **Snappers** | | |
| Silk | January 1 – September 30 | October 1 – December 31 |
| Black | | |
| Blackfin | | |
| Vermillion | | |
| Mutton | July 1 – March 31 | April 1 – June 30 |
| Lane | | |
| **Groupers** | | |
| Red hind (applies only west of 67º10' W longitude) | March 1 – November 30 | December 1 – Last day of February |
| Yellowfin | May 1 – January 31 | February 1 - April 30 |
| Red | | |
| Tiger | | |
| Black | | |
| Yellowedge | | |

## 5.10 Seasonal Area Closures Applicable to Reef Fish

**Table 5.10.1.** Areas in the Puerto Rico EEZ with seasonal area closures and dates when the area is closed and open for specific fishing activities.

| Area | **Open** | **Closed** |
|---|---|---|
| **Bajo de Sico Spawning Area[1]** | | |

| | | |
|---|---|---|
| - No fishing for or possession of any Council-managed reef fish species[2] during closure. The prohibition is limited to managed reef fish, and does not apply to Caribbean spiny lobster or other species that can be legally harvested from the Puerto Rico EEZ (e.g., HMS). The prohibition on possession does not apply to such Caribbean reef fish harvested and landed ashore prior to the closure. | April 1 – September 30 | October 1 – March 31 |
| - Fishing with pots, traps, bottom longlines, gill or trammel nets is prohibited year-round. | Year round | |
| - Anchoring, by fishing vessels, is prohibited year-round. | Year round | |
| **Tourmaline Bank[1] and Abrir La Sierra Spawning Areas** | **Open** | **Closed** |
| - All fishing is prohibited during the closure. | March 1 – November 30 | December 1 – until the last day of February |
| - Fishing with pots, traps, bottom longlines, gill or trammel nets is prohibited year-round. | Year round | |

[1]Closures applies only the portion of those areas in the Puerto Rico EEZ.

[2] Closures cover any newly managed reef fish in the Puerto Rico FMP

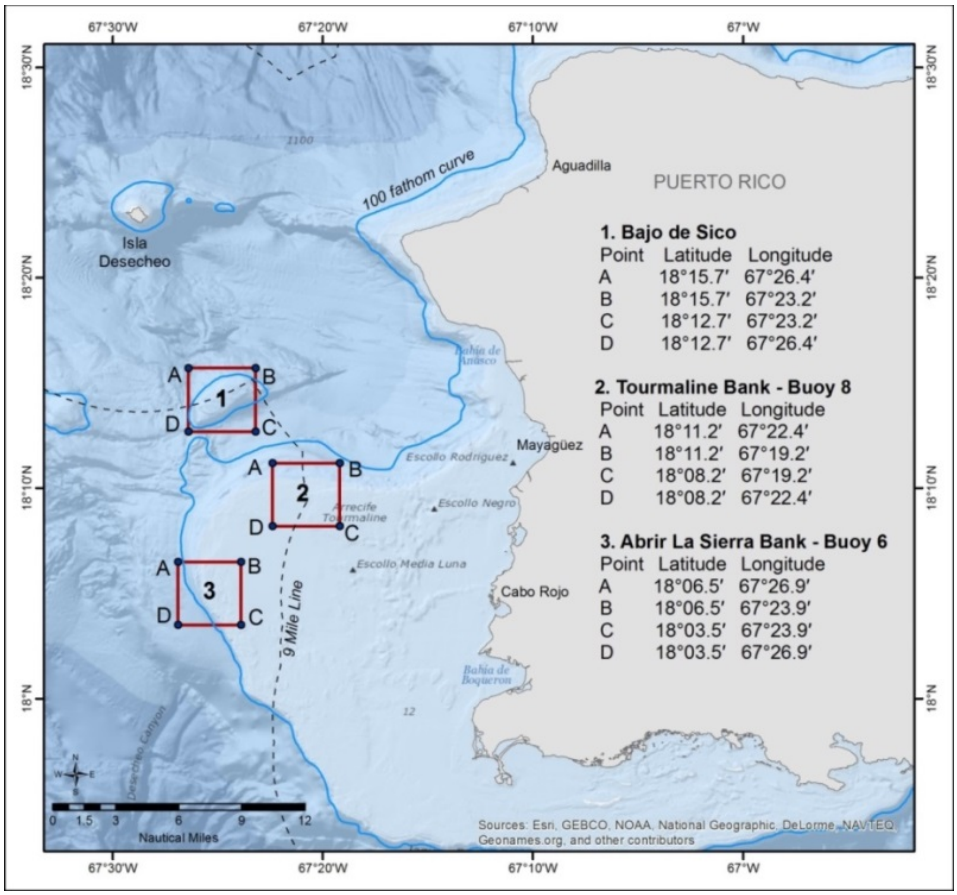


**Figure 5.10.1**. Map of the Bajo de Sico (#1), Tourmaline Bank (#2), and Abrir La Sierra (#3) closed areas off the west coast of Puerto Rico.

## 5.11 Permitting and Reporting

### 5.11.1 General

Federal permits are not needed for the harvest of Council-managed species.

## 5.12 Adjustment of Management Measures

The following table lists the framework procedure established in the Puerto Rico FMP and lists the situations when management measures can be adjusted through framework. The framework procedure was selected by the Council and analyzed in Section 2.7 of the EA within this document.

**Table 5.12.1.** Framework procedure in the Puerto Rico FMP.

| OPEN FRAMEWORK | |
|---|---|
| **1. Situations under which this open framework procedure can be used:**<br>**A. A new stock assessment or other information indicates changes should be made to: MSY, OFL, ABC, or other related management reference points and status determination criteria (SDC).** | |
| **B. New information or circumstances indicates management measures should be changed.**<br>- The Council will, as part of a proposed framework action, identify the new information and provide rationale as to why this new information indicates that management measures should be changed. | |
| **C. Changes are required to comply with applicable laws such as MSA, ESA, MMPA, or are required as a result of a court order.**<br>- In such instances, the RA will notify the Council in writing of the issue and the action that is required. If there is a legal deadline for taking action, the deadline will be included in the notification. | |
| **2. Types of Open Frameworks:** | |
| **Abbreviated Framework** | **Standard Framework** |
| Can be used for routine or insignificant changes | Changes that do not qualify as routine or insignificant. |
| Request is made with letter or memo from the Council to the RA with supporting analyses (biological, social, economic).<br>If RA concurs and approves action, it will be implemented through publication of FR Notice. | Requires a completed framework document with supporting analyses. |
| **Actions that can be taken under each Framework** | |
| **Abbreviated Framework** | **Standard Framework** |
| ix. Gear marking requirements<br>x. Vessel marking requirements<br>xi. Restrictions related to maintaining fish in a specific condition (whole condition, filleting, use as bait, etc.)<br>xii. Recreational bag and possession limit changes of not more than 1 fish per boat<br>xiii. Size limit changes of not more than one inch of the prior size limit for reef fish.<br>xiv. Commercial vessel trip limit changes of not more than 10% of the prior trip limit<br>xv. Changes to the length of an established closed season by no more than 1 day of the existing season.<br>xvi. Minor changes to gear modifications to address conservation issues including to respond to interactions with listed species. | In addition to making changes specified under Abbreviated Framework (left column) that exceed the established thresholds, the following actions can be completed via a standard framework:<br>xi. Re-specify ABC<br>xii. Re-specify MSY and OY, and SDC<br>xiii. Re-specify SYL<br>xiv. Re-specify ACLs<br>xv. Re-specify ACTs<br>xvi. Rebuilding plans and revisions to approved rebuilding plans<br>xvii. Revise accountability measures (e.g., change AM triggers and AM timing)<br>xviii. Modify reporting and monitoring requirements<br>xix. Modify seasonal or year-round closures and closure procedures<br>xx. Modify area closures and closure procedures |
| **7.** The Council will initiate the open framework process to inform the public of the issues and develop potential alternatives to address the issues. The framework process will include the development of documentation and public discussion during at least one council meeting. | |

| | |
|---|---|
| **8.** | Prior to taking final action on the proposed framework action, the Council may convene its Scientific and Statistical Committee (SSC) or applicable Advisory Panel (AP), as appropriate, to provide recommendations on the proposed actions. |
| **9.** | For all framework actions, the Council will provide the letter, memo, or the completed framework document along with proposed regulations to the Regional Administrator in a timely manner following final action by the Council. |
| **10.** | For all framework action requests, the Regional Administrator will review the Council's recommendations and supporting information and notify the Council of the determinations, in accordance with the MSA and other applicable law. |
| **CLOSED FRAMEWORK** | |
| Consistent with existing requirements in the FMP and implementing regulations, the RA is authorized to conduct the following closed framework actions through appropriate notification in the Federal Register:<br>d. Reopen any sector of the fishery that had been prematurely closed.<br>e. Implement AMs, either in-season or post-season. Implement an in-season AM for a sector that has reached or is projected to reach, or is approaching or is projected to approach its ACL according to the process established in the FMP, or implement a post-season AM for a sector that exceeded its ACL according to the process established in the FMP, or any other established AM. | |

## 5.13 Application of National Standard 1 and Management Reference Points

### 5.13.1 Stock Status Determination Process

National Standard 1 of the Magnuson-Stevens Act establishes maximum sustainable yield (MSY) is the basis for fishery management (16 U.S.C. 1851(a)(1)). When data are insufficient to estimate MSY directly, Councils should adopt other measures of reproductive potential that can serve as a reasonable proxy for MSY (§600.310(e)(1)(v)). In the Caribbean region, scientific assessments from which MSY and SDC (SDC = maximum fishing mortality threshold (MFMT), overfishing limit (OFL), and minimum stock size threshold (MSST) are derived are not available due to data limitations. As a result, the Council and their Scientific and Statistical Committee (SSC) has chosen to adopt the sustainable yield level (SYL) as their alternative measure of reproductive potential for stocks, stock complexes, and indicator stocks identified in Chapter 2 of this document.

### 5.13.2 Sustainable Yield Level

The SYL would serve the Council as a guidepost, alerting the Council there is a need to reconsider their approach to managing a stock or stock complex. As discussed in Section 2.4.2, the SYL is an equilibrium concept, in contrast to the non-equilibrium OFL. The SYL is considered to be a proxy for OFL and a minimum estimate of MSY (where MSY $\geq$ SYL). The

SYL is not intended as a metric for reporting stock status in terms of overfishing or overfished. Instead, the SYL is intended to ensure a stock or stock complex is maintained at a sustainable level, and serves to maintain the stock/stock complex at a sustainable level until the stock's status relative to MSY-relative reference points can be determined. In the present plan (Section 2.4), acquiring data adequate to move the stock from Tier 4 to Tier 3, 2, or 1 in the acceptable biological catch (ABC) control rule (CR) is a necessary precursor to establishing a scientifically defensible MSY and to deriving reference points from that MSY.

To evaluate the status of a stock or stock complex relative to the SYL, the commonplace approach would be to compare the most recent three years of adjusted landings. However, during the first few years following implementation of the Puerto Rico FMP, the landings data would be acquired from a stepped series of fishing years as described for the ACL approach in Section 2.4 of this FMP. In the initial year following FMP implementation, only the single most recently available year of landings would be compared against the SYL, and similarly for the second year following implementation. In the third year following implementation, the average of the two most recent years of available landings would be compared to the SYL. In the fourth year and for all subsequent years, the average of the most recent three years of available landings would be compared to the SYL. This approach maintains consistency with the approach used to evaluate fishery landings relative to the ACL, thereby ensuring management responses to fishing activity act in concert rather than in potential opposition.

In the event the appropriate landings benchmark exceeds the established SYL for a stock, stock complex, or indicator stock representing a stock complex, the Council would evaluate their management of that stock or stock complex, identify factors contributing to the SYL exceedance, and revise their management regime accordingly. Revisions to the Council's management regime could include (but are not limited to) reductions in the allowable catch, implementation of size or bag limits, or expansion or establishment of seasonal or areal closures.

### 5.13.3 Annual Catch Limits (ACLs) and Optimum Yield (OY)

The methods for setting ACLs for stocks/stock complexes in the Puerto Rico FMP are discussed in Section 2.4. Table 5.13.1 lists the ACLs (and OY) established for stocks and stock complexes in the Puerto Rico commercial and recreational sectors.

Evaluating landings relative to the ACL, and the status of a stock or stock complex relative to OY, follows the process described above for evaluating stock status relative to the SYL. During the first few years following implementation of the Puerto Rico FMP, the landings data would be acquired from a stepped series of fishing years as described in Section 2.4.2. In the initial year following FMP implementation, only the single most recently available year of landings would be compared against the ACL, and similarly for the second year following implementation. In

the third year following implementation, the average of the two most recent years of available landings would be compared to the ACL. In the fourth year and for all subsequent years, the average of the most recent three years of available landings would be compared to the ACL. As noted in the SYL description above, this approach maintains consistency between SYL and ACL with the approach used to evaluate fishery landings relative to the ACL, thereby ensuring management responses to fishing activity act in concert rather than in potential opposition.

#### 5.13.3.1 Annual Catch Limits for Finfish

In the EEZ management area surrounding Puerto Rico, both recreational and commercial harvest data are collected for Council-managed finfish. This allows for the establishment of separate ACLs and AMs for each federally managed finfish stock or stock complex for the commercial and recreational fishing sectors. With the exceptions of goliath grouper, Nassau grouper, midnight parrotfish, blue parrotfish, rainbow parrotfish, giant manta ray, spotted eagle ray, and sting ray, ACLs are based on the combined Caribbean EEZ and Puerto Rico territorial landings reported for Puerto Rico.

For all finfish stocks, OY would equate to the total (recreational + commercial) ACL (CFMC 2017) when data from both sectors are available. In the event applicable landings for one sector are not available for the averaging period, the sector would not be managed by a separate sector ACL. The ACL for the sector with available data would be the applicable ACL for the fishery. The total ACL was set equal to an annual value equal to OY (CFMC 2011b).

The ACLs for all Council-managed species are listed in Table 5.13.1.

#### 5.13.3.2 Annual Catch Limits for Caribbean Spiny Lobster

In Puerto Rico, only commercial harvest data are collected for spiny lobster (recreational landings are not available). However, the ACL and AM (discussed in Section 10.13.4 below) for spiny lobster governs all harvest of spiny lobster, whether commercial or recreational. The ACL is based on available landings information, whether reported as landed from federal or territorial waters (Table 5.13.1).

#### 5.13.3.3 Annual Catch Limits for Stocks with Harvest Prohibitions

Harvest for the following stocks/stock complexes would be prohibited in the Puerto Rico EEZ: queen conch, Nassau grouper, goliath grouper, midnight parrotfish, rainbow parrotfish, blue parrotfish, sea cucumbers, sea urchins, corals, southern stingray, giant manta ray, and spotted eagle ray. The ACL and the OY for each one of these stocks/stock complexes would be zero (Table 5.13.1).

**Table 5.13.1.** Annual catch limits (= Optimum yield) for the commercial sector, recreational sector, and combined total for each stock/stock complex selected for management in the Puerto Rico FMP. Values are in pounds (lbs) of whole weight (ww). Indicator stocks are marked in bold text.

| Stock/Stock Complex | Commercial ACL (lbs) | Recreational ACL (lbs) | Total ACL (lbs) |
|---|---|---|---|
| Spiny Lobster | 527,232 | NA | 527,232 |
| Queen conch | 0 | NA | 0 |
| Snapper 1 (black, blackfin, **silk**, vermilion, wenchman) | 424,009 | 111,943 | 535,951 |
| Snapper 2 (**queen**, cardinal) | 257,236 | 24,974 | 282,210 |
| Snapper 3 (lane) | 244,376 | 21,603 | 265,979 |
| Snapper 4 (**mutton**, dog, schoolmaster) | 116,434 | 76,625 | 193,059 |
| Snapper 5 (yellowtail) | 315,806 | 23,988 | 339,794 |
| Snapper 6 (cubera) | 119 | 6,448 | 6,567 |
| Grouper 1 (Nassau) | 0 | 0 | 0 |
| Grouper 2 (goliath) | 0 | 0 | 0 |
| Grouper 3 (**coney**, graysby) | 23,890 | 19,634 | 43,524 |
| Grouper 4 (black, red, tiger, yellowfin, yellowmouth) | 2,492 | 5,867 | 8,359 |
| Grouper 5 (misty, yellowedge) | 15,327 | 4,225 | 19,553 |
| Grouper 6 (**red hind**, rock hind) | 121,729 | 34,493 | 156,222 |
| Parrotfish 1 (blue, midnight, rainbow) | 0 | 0 | 0 |
| Parrotfish 2 (princess, queen, redtail, stoplight, redband, striped) | 147,774 | 17,052 | 164,826 |
| Surgeonfish (blue tang, ocean, doctorfish) | 147 | 860 | 1,007 |
| Triggerfish (**queen**, ocean, gray) | 83,099 | 7,453 | 90,552 |
| Wrasses 1 (hogfish) | 70,140 | 8,263 | 78,402 |
| Wrasses 2 (puddingwife, Spanish hogfish) | 20,126 | 5,372 | 25,499 |
| Angelfish (queen, gray, French) | 137 | 2,985 | 3,122 |
| Barracuda (great barracuda) | 495 | 167,693 | 168,188 |
| Tripletail | 270 | 39,005 | 39,275 |
| Grunts (white grunt) | 177,923 | 2,461 | 180,384 |
| Jacks 1 (crevalle jack) | 46 | 41,894 | 41,940 |
| Jacks 2 (African pompano) | 1,052 | 5,719 | 6,771 |
| Jacks 3 (rainbow runner) | 913 | 8,091 | 9,005 |
| Dolphinfish (**dolphin**, pompano dolphin) | 232,173 | 1,513,873 | 1,746,046 |
| Tuna (little tuny, blackfin tuna) | 82,779 | 34,485 | 117,263 |
| Mackerel (cero, king mackerel) | 232,422 | 129,180 | 361,602 |
| Wahoo | 25,911 | 210,737 | 236,649 |
| Rays 1 (giant manta ray) | 0 | 0 | 0 |
| Rays 2 (spotted eagle ray) | 0 | 0 | 0 |
| Rays 3 (southern stingray) | 0 | 0 | 0 |

| Stock/Stock Complex | Commercial ACL (lbs) | Recreational ACL (lbs) | Total ACL (lbs) |
|---|---|---|---|
| Sea Cucumbers | 0 | 0 | 0 |
| Sea Urchins | 0 | 0 | 0 |
| Corals | 0 | 0 | 0 |

## 5.13.4 Accountability Measures (AMs) and Closure Provisions

Accountability measures, including methods to identify ACL exceedance and performance standards are discussed in Section 2.5. This section lists the outcomes from the preferred alternatives, which establishes how AMs are triggered and implemented and the closure provisions associated to the AMs.

### 5.13.4.1 General

Accountability measures require the NMFS Assistant Administrator (AA) to reduce the length of the fishing season for a given stock/stock complex in the year following a determination that prior year(s) landings exceeded the respective ACL. If NMFS determines the ACL for a particular stock/stock complex has been exceeded, the Southeast Fisheries Science Center (SEFSC) evaluate whether the reported overage represents an actual increase in landings or reflects improved data collection and monitoring. If the SEFSC determines the overage reflects improved data collection and monitoring, an AM would not be applied. The intent of this approach is to eliminate any incentive for fishermen to under-report or misreport catches to avoid exceeding ACLs and triggering associated AMs (CFMC 2016).

The extent to which the fishing season for a stock/stock complex within a sector is shortened to account for a landings overage equates to the amount of time necessary to constrain landings to the ACL in the closure year. The length of an AM-based season reduction for a sector is determined using an estimate of the landings rate for each month of the closure year. The monthly landings rate would be estimated based on either the most recent year for which data are available or an average of recent available data. Once determined, each monthly landings rate is used, in a stepwise fashion, to calculate the number of months (or fraction thereof) for which sector harvest of a stock or stock complex must be prohibited in EEZ waters during the AM application year.

### 5.13.4.2 Accountability Measures for Reef Fish and Spiny Lobster

For all reef fish for which harvest is allowed and for spiny lobster, landings would be evaluated relative to the applicable ACL based on annual or average landings, as described below.

<u>Process for Triggering an AM for Reef Fish and Spiny Lobster</u>

An AM would be triggered if a sector or sector's landings (commercial or recreational) exceed the sector ACL and the total landings (commercial + recreational [as applicable]) exceeds the total ACL (commercial plus recreational, as applicable) for that stock/stock complex, unless NMFS' SEFSC determines the overage occurred because data collection/monitoring improved rather than because catch increased. The AM would be triggered only for the sector(s) that exceeded its applicable ACL.

Total landings from the following years, in order, would be used to evaluate an exceedance of the applicable ACL:

(1) Total landings from 2018
(2) Total landings from 2019
(3) Two-year average of landings from 2019 and 2020
(4) Three-year average of landings from 2019, 2020, and 2021
(5) Thereafter, a progressive running three-year average (2020-2022, 2021-2023, etc.).

The Regional Administrator in consultation with the Council may deviate from the specific time sequences based on data availability.

<u>Process for Applying an AM for Reef Fish and Spiny Lobster</u>

If an AM is triggered, NMFS would reduce the length of the fishing season for the applicable stock/stock complex for the sector or sector(s) that exceeded its ACL the year following the overage determination by the amount necessary to ensure (to the greatest practicable extent) landings do not again exceed the ACL in the year of application. Any fishing season reduction resulting from an AM application would be applied from September 30 backward, toward the beginning of the fishing year. If the length of the required fishing season reduction exceeds the time period of January 1 through September 30, any additional fishing season reduction would be applied from October 1 forward, toward the end of the fishing year.

The Council would revisit the use of September 30 as the end date for AM-based closures every two years.

*For Reef Fish only:* If applicable landings for one sector are not available for the averaging period, the sector would not be managed by a separate sector ACL. The ACL for the sector with available data would be the applicable ACL for the fishery. When landings exceed the applicable ACL for that stock/stock complex, the AM would be triggered, unless NMFS' SEFSC determines that the overage occurred because data collection/monitoring improved rather than because catch increased. The AM would operate to reduce the length of the fishing season for all sectors by the amount necessary to ensure (to the greatest practicable extent) landings do not again exceed the ACL in year of application. Any fishing season reduction resulting from an AM application would be applied on the same timeframe as above.

#### 5.13.4.3 Closure Provisions for Reef Fish

*(1) Restrictions applicable after a Puerto Rico commercial closure for reef fish stock or stock complexes:* During the closure period announced in the notification filed, the commercial sector for those stocks/stock complexes included in the notification is closed and such stocks or stock complexes in or from the Puerto Rico management area may not be purchased or sold. Harvest or possession of such stocks or stock complexes in or from the Puerto Rico management area is limited to the recreational bag and possession limits unless the recreational sector for the stock or stock complex is closed and the restrictions specified for the recreational harvest apply.

(*2) Restrictions applicable after a Puerto Rico recreational closure for reef fish stocks or stock complexes:* During the closure period announced in the notification filed, the recreational sector for those stocks/stock complexes included in the notification is closed and the recreational bag and possession limits for such stocks or stock complexes in or from the Puerto Rico management area are zero. If the seasons for both the commercial and recreational sectors for such stocks or stock complexes are closed, the restrictions specified below (i.e., (3): Restrictions applicable when both Puerto Rico commercial and recreational sectors for reef fish are closed) apply.

*(3) Restrictions applicable when both Puerto Rico commercial and Puerto Rico recreational sectors for reef fish stocks or stock complexes are closed:* If the fishing season for both the commercial and recreational sectors of a stock or stock complex is closed, specimens of that stock/stock complex in or from the Puerto Rico EEZ may not be harvested, possessed, purchased, or sold, and the bag and possession limits for such stocks or stock complexes in or from the Puerto Rico EEZ are zero.

#### 5.13.4.4 Closure Provisions for Caribbean Spiny Lobster

During the closure period, both the commercial and recreational sectors are closed. Spiny lobster in or from the Puerto Rico EEZ may not be harvested, possessed, purchased, or sold, and the bag and possession limits for spiny lobster in or from the Puerto Rico EEZ are zero.

#### 5.13.4.5 Accountability Measures for Pelagic Stocks

For the following pelagic stocks/stock complexes: dolphinfish, pompano dolphinfish (dolphinfish stock complex), little tunny, blackfin tuna (tuna stock complex), king mackerel, cero mackerel (mackerel stock complex), tripletail, and wahoo, an AM-based season length reduction in the event of an ACL overage would not be applied. Instead, the Council would establish an ACT as a percentage of the ACL that would serve as the AM (See Section 2.4.2).

<u>Process for Triggering an AM for the listed Pelagic Stocks/Stock Complexes</u>

An AM would be triggered if the total landings (commercial + recreational [as applicable]) exceed the ACT for that stock/stock complex.

Total landings from the following years, in order, would be used to evaluate an exceedance of the ACT:

(1) Total landings from 2018
(2) Total landings from 2019
(3) Two-year average of landings from 2019 and 2020
(4) Three-year average of landings from 2019, 2020, and 2021
(5) Thereafter, a progressive running three-year average (2020-2022, 2021-2023, etc.).

The AM would be triggered only for the sector(s) that exceeded the ACT. The Regional Administrator in consultation with the Council may deviate from the specific time sequences based on data availability.

Process for Applying an AM for Pelagic Stocks/Stock Complexes

If an AM is triggered, the Council in consultation with the SEFSC would assess whether corrective action is needed.

#### 5.13.4.6 Accountability Measures for Stocks with Prohibited Harvest

The harvest prohibition for the reef fish Nassau grouper, goliath grouper, midnight parrotfish, rainbow parrotfish, blue parrotfish; the coral reef resources sea cucumbers, sea urchins, and corals; and for other non-reef finfish stingrays, manta rays, and spotted eagle rays would serve as the AM.

### 5.13.5 Annual Catch Target

Annual catch targets are discussed in Section 2.4.2. The following ACTs apply to the pelagic stocks/stock complexes listed in Table 5.13.2. The ACTs were set at 90% of the total (commercial + recreational, as applicable) ACL.

**Table 5.13.2.** Annual catch targets (ACT) for pelagic stocks/stock complexes in the Puerto Rico FMP.

| Stock/Stock Complex | ACT |
|---|---|
| Dolphin complex | 1,571,441 |
| Wahoo | 212,984 |
| Mackerel complex | 325,442 |
| Tuna complex | 105,537 |

| | |
|---|---|
| Tripletail | 35,348 |

### 5.13.6 Stocks Under Rebuilding Plans

Three stocks and one stock complex were identified in the 2005 Sustainable Fisheries Act (SFA) Amendment (CFMC 2005) as in need of rebuilding. The three stocks included queen conch (15-year plan), Nassau grouper (25-year plan), and goliath grouper (30-year plan). Each of those three stocks remains in a rebuilding status, and all provisions designed to ensure rebuilding within the defined time frames remain in place. Specifically, harvest of all three stocks remains prohibited in Puerto Rico EEZ waters. The rebuilding plan for stock complex Grouper Unit 4 (yellowfin, red, tiger, black), lasted ten years and ended in 2015. The rebuilding plans for queen conch, Nassau, and goliath grouper are listed in the Caribbean SFA Amendment (CFMC 2005) and are incorporated herein by reference and summarized below.

Rebuilding plan for Nassau grouper: Rebuild Nassau grouper to BMSY in 25 years, using the formula TMIN (10 years) + one generation (15 years) = 25 years.
Rebuilding strategies:
- Prohibit the filleting of fish in federal waters of the U.S. Caribbean. Require that fish captured or possessed in federal waters be landed with heads and fins intact.
- Develop a memorandum of understanding (MOU) between NMFS and the USVI government to develop compatible regulations to achieve the objectives for Nassau grouper set forth in the Council's Reef Fish FMP in USVI and federal waters of the U.S. Caribbean.

Rebuilding plan for goliath grouper: Rebuild goliath grouper to $B_{MSY}$ in 30 years, using the formula $T_{MIN}$ (10 years) + one generation (20 years) = 30 years.
Rebuilding strategy:
- Prohibit the filleting of fish in federal waters of the U.S. Caribbean. Require that fish captured or possessed in federal waters be landed with heads and fins intact.

Rebuilding plan for queen conch: Rebuild queen conch to $B_{MSY}$ in 15 years, using the formula $T_{MIN}$ (10 years) + one generation (5 years) = 15 years.
Rebuilding Strategies:
- Prohibit commercial and recreational catch, and possession of queen conch in federal waters of the U.S. Caribbean, with the exception of Lang Bank near St. Croix.
- Develop a memorandum of understanding (MOU) between NMFS and the state governments to develop compatible regulations to achieve the management objectives set forth in the Council's Queen Conch FMP in state and federal waters of the U.S. Caribbean.

# Chapter 6. Fishery Impact Statement

# Chapter 7. Regulatory Impact Review

# Chapter 8. Regulatory Flexibility Analysis

# Chapter 9. List of Preparers

**Table 9.1.** List of Interdisciplinary Plan Team (IPT) Members

| Name | Agency | Title |
|---|---|---|
| Bill Arnold | NMFS/SF | Caribbean Branch Chief / Fishery Biologist |
| María del Mar López | NMFS/SF | IPT Co-lead / Fishery Biologist |
| Sarah Stephenson | NMFS/SF[72] | Fishery Biologist |
| Graciela García-Moliner | CFMC | IPT Co-lead / Fishery Biologist |
| Miguel Lugo | NMFS/SF | Fishery Biologist (Former IPT Co-lead) |
| Michael Jepson | NMFS/SF | Anthropologist |
| David Dale | NMFS/HC | EFH Specialist |
| Kate Quigley | CFMC[73] | Economist |
| Karla Gore | NMFS/SF | Fishery Biologist |
| Denise Johnson | NMFS/SF | Economist |
| Jennifer Lee | NMFS/PR | Fishery Biologist |
| Pat O'Brian | NMFS/PR | Fishery Biologist |
| Michael Larkin | NMFS/SF | Data Analyst |
| Shannon Cass-Calay | NMFS/SEFSC | Fishery Biologist |
| Jocelyn D'Ambrosio | NOAA/GC | Attorney |
| Iris Lowery | NOAA/GC | Attorney |
| Shepherd Grimes | NOAA/GC | Attorney |
| Adam Bailey | NMFS/SF | Technical Writer |
| Jose Rivera | NMFS/HC | EFH Specialist |
| Brent Stoffle | NMFS/SEFSC | Anthropologist |
| Lynn Rios | NOAA/OLE | Enforcement Officer |
| Noah Silverman | NMFS/SERO | Regional NEPA Coordinator |
| Nancie Cummings | NMFS/SEFSC | Biologist |

[72] Currently at NOAA NMFS Seafood Inspection Program, Southeast Inspection Branch
[73] Currently at NOAA Office for Coastal Management, South Carolina

| | | |
|---|---|---|
| Pace Wilber | NMFS | Habitat Specialist |
| Walter R Keithly | CFMC | Economist |
| Peggy Overbey | Contractor | Social Sciences |

NMFS = National Marine Fisheries Service, CFMC = Caribbean Fishery Management Council, SFD = Sustainable Fisheries Division, PRD = Protected Resources Division, SERO = Southeast Regional Office, HC = Habitat Conservation Division, GC = General Counsel, SEFSC = Southeast Fisheries Science Center, OLE= Office of Law Enforcement

# Chapter 10. List of Agencies, Organizations, and Persons Consulted

Department of Commerce Office of General Counsel
National Marine Fisheries Service Office of General Counsel
National Marine Fisheries Service Office of General Counsel Southeast Region
National Marine Fisheries Service Southeast Regional Office
National Marine Fisheries Service Southeast Fisheries Science Center
National Marine Fisheries Service Silver Spring Office
National Marine Fisheries Service Office of Law Enforcement Southeast Division
United States Coast Guard
United States Department of the Interior
U.S. Virgin Islands Department of Planning and Natural Resources
Puerto Rico Department of Natural and Environmental Resources
Puerto Rico Junta de Calidad Ambiental (Puerto Rico Environmental Quality Board)

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# Appendices

# Appendix A. Outcomes from Scoping Hearings and NEPA

The National Environmental Policy Act (NEPA) requires federal agencies to conduct an environmental review when proposing major federal actions. The environmental review is a multi-step process that involves (a) defining the proposed action, (b) determining the nature and significance of potential consequences of the action on the human environment, which guides the choice as to whether the action requires an Environmental Assessment (EA) or an Environmental Impact Statement (EIS), (c) completing an EA and publishing a Finding of No Significant Impact (FONSI), or (d) where there are the potential for significant impacts, meaning an EIS is required, publishing a Notice of Intent (NOI) to prepare an EIS, then (e) conducting initial scoping to determine relevant issues to be evaluated in the EIS, and (f) preparing the EIS. The EIS development process itself has two-steps, first requiring the preparation of a Draft EIS (DEIS) and the presentation of that DEIS to the public for comment, followed by a Final EIS (FEIS) that addresses, as appropriate, those public comments.

To initiate public discussion of the island-based approach to management in accordance with NOAA Administrative Order NAO 216-6 regarding compliance with NEPA[74], Council, and NMFS staff prepared a scoping document for consideration by the Council at their April 2012 meeting. The scoping document included draft language regarding the purpose and need for shifting from species-based to island-based management, as well as alternative approaches to subdividing the island management zones (two, three, or four island approach) and other considerations for and implications of making the shift. The Council directed staff to conduct initial scoping hearings regarding the general concepts of island-based management throughout Puerto Rico and the USVI, during July 2012, and to inform the Council at their August 2012 meeting of the outcomes from those scoping hearings. Scoping hearings were held at various sites throughout Puerto Rico on July 23 (San Juan), July 24 (Naguabo), July 25 (Mayagüez) and July 26 (Ponce), and in the USVI on July 24 (St. Thomas) and July 25 (St. Croix).

At their August 2012 meeting, the Council was informed of perspectives and concerns regarding island-based management obtained at the July 2012 scoping hearings. There was consensus support for the management transition at all scoping hearings, and a clear preference for subdividing the islands into three management groups (Puerto Rico, St. Thomas/St. John, St.

[74] On April 22, 2016, NOAA issued NAO 216-6A, which supersedes NAO 216-6 and, together with the Companion Manual to NAO 216-6A, provides NOAA's policies and procedures for compliance with NEPA. The scoping document was prepared before NOAA updated its NEPA policies and procedures.

Croix) as opposed to the two island (Puerto Rico/St. Thomas/St. John, St. Croix) or four island (Puerto Rico, St. Thomas, St. John, St. Croix) options. Based on that public response, the Council directed staff to prepare an EA titled: *Development of Island-Based FMPs in the U.S. Caribbean: Transition from Species-Based FMPs to Island-Based FMPs* (NMFS 2014) to thoroughly analyze the issues associated with transitioning from species-based to island-based management, to evaluate the impact of incorporating most current regulations under the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs into each of the FMPs for Puerto Rico, St. Thomas/St. John, and St. Croix, and to provide the public with a full and formal evaluation of the impacts of such a shift in federal fisheries management in the U.S. Caribbean region. The Council and NMFS provided an opportunity to submit verbal or written comments on the proposed action. Soliciting public comment ensured the public was provided a thorough and transparent opportunity to comment on the basic concept of an island-based management approach prior to committing Council and NMFS resources to the substantial job of preparing the requisite EISs and FMPs. The draft EA was presented to the Council at their March 2013 meeting. At that meeting, the Council formally decided to initiate the transition from species-based fisheries management to island-based fisheries management.

As a first step in developing the island-based FMPs, at their March 2013 meeting, the Council directed staff to prepare three island-specific scoping documents and to hold a second round of scoping hearings in summer 2013 to receive public feedback on possible actions and alternatives to consider while developing each of the Puerto Rico, St. Thomas/St. John, and St. Croix FMPs. The pertinent scoping document was presented at scoping hearings throughout Puerto Rico (Vieques on July 8, San Juan on July 9, Naguabo on July 11, Arecibo on July 12, Mayagüez on August 5, and Ponce on August 6), on St. Croix (July 9), and on St. Thomas (August 5). Of the roughly 150 total attendees across these eight hearings, only one attendee expressed any opposition to the proposed alternative approaches to development of island-based management. Though supportive of the approach, the attendees provided numerous suggestions as to how fishery management in the U.S. Caribbean EEZ could be enhanced. Ideas ranged from better use of marine protected areas to better management of recreational fisheries.

Coincident with the 2013 scoping hearings, and to ensure broad and substantial public input on this proposed change in U.S. Caribbean fisheries management, NMFS published an initial NOI to prepare an EIS evaluating alternative approaches to developing island-based management of U.S. Caribbean fisheries. The NOI published in June 2013 with a 30-day comment period, during which nine written comments were received. All expressed general support for transitioning from species-based to island-based management.

In response to public comments submitted at the July 2013 scoping hearings and via written response to the initial NOI, the Council at their December 2013 meeting reviewed and approved a preliminary list of actions and alternatives designed to form the foundation of the shift to

island-based management. The Council then directed staff to hold a third round of scoping hearings during spring 2014 to obtain comments on this more robust set of actions and alternatives. Scoping hearings were held in the Puerto Rico municipalities of Hatillo (April 7), Mayaguez (April 8), Naguabo (April 9), San Juan (April 10) and Ponce (April 11), and on both St. Thomas (April 7) and St. Croix (April 8). Much of the input received at these hearings was outside the scope of the island-based FMP development process. Pertinent comments focused on the need to enhance management of recreational fisheries, add species such as octopus and sea urchins to the management regime, and manage Puerto Rico by coast rather than as a single entity.

A Supplemental NOI was published contemporaneous with the 2014 scoping hearings, once again to ensure broad and substantial public input on the complex topic of island-based fishery management. Four comments were received during the 30-day comment period, including one comment requesting that a longer comment period be provided. In response to that comment, a second Supplemental NOI was published in May 2014. Fourteen written comments were submitted during the 90-day comment period. The majority of the 18 total written comments supported island-based management, although some comments disagreed with the approach. Most of the comments in disagreement opined that stocks should be managed at a species rather than stock level, but such comments represented a minority of the total. Supportive comments noted that island-based management would provide an opportunity to implement an ecosystem-based fishery management approach, and offered suggestions for improving on island-based management, including developing and relying on better data and better science and more effectively using local knowledge.

Since March 2013, the Council has been developing a *Comprehensive Fishery Management Plan for the Exclusive Economic Zone of Puerto Rico* (Puerto Rico FMP) to implement island-based fishery management in Puerto Rico. At the same time, the Council and NMFS developed a NEPA document to describe alternatives solutions and analyze and compare the direct, indirect, and cumulative environmental impacts of those alternative approaches proposed for inclusion in the Puerto Rico FMP on the social, biological, economic, ecological, and administrative environments. The new Puerto Rico FMP would then apply the Council's preferred solution, applying the best available scientific information regarding the management of fisheries in Puerto Rico EEZ waters, within the context of federal fisheries management in the U.S. Caribbean. Alternatives considered in the EA analyzing the Puerto Rico FMP include a "no action" alternative, which essentially maintains provisions established in the species-based FMPs, as well as a range of viable alternative approaches for revising the management of U.S. Caribbean fisheries.

# Appendix B. Other Applicable Law

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) (16 U.S.C. 1801 et seq.) provides the authority for fishery management in federal waters of the exclusive economic zone. However, fishery management decision-making is also affected by a number of other federal statutes designed to protect the biological and human components of U.S. fisheries, as well as the ecosystems that support those fisheries. Major laws affecting federal fishery management decision-making are summarized below.

**Administrative Procedures Act (APA)**

All federal rulemaking is governed under the provisions of the APA (5 U.S.C. Subchapter II), which establishes a "notice and comment" procedure to enable public participation in the rulemaking process. Under the APA, the National Marine Fisheries Service (NMFS) is required to publish notification of proposed rules in the *Federal Register* and to solicit, consider and respond to public comment on those rules before they are finalized. The APA also establishes a 30-day wait period from the time a final rule is published until it takes effect.

**Coastal Zone Management Act (CZMA)**

The CZMA of 1972 (16 U.S.C. 1451 et seq.) encourages state and federal cooperation in the development of plans that manage the use of natural coastal habitats, as well as the fish and wildlife those habitats support. When proposing an action determined to directly affect coastal resources managed under an approved coastal zone management program, NMFS is required to provide the relevant State agency with a determination that the proposed action is consistent with the enforceable policies of the approved program to the maximum extent practicable at least 90 days before taking final action. NMFS may presume State agency concurrence if the State agency's response is not received within 60 days from receipt of the agency's consistency determination and supporting information as required by 15 C.F.R. §930.41(a).

**Data Quality Act**

The Data Quality Act (Public Law 106-443), which took effect October 1, 2002, requires the government for the first time to set standards for the quality of scientific information and statistics used and disseminated by federal agencies. Information includes any communication or representation of knowledge such as facts or data, in any medium or form, including textual, numerical, cartographic, narrative, or audiovisual forms (includes web dissemination, but not hyperlinks to information that others disseminate; does not include clearly stated opinions). Specifically, the Act directs the Office of Management and Budget (OMB) to issue government wide guidelines that "provide policy and procedural guidance to federal agencies for ensuring and maximizing the quality, objectivity, utility, and integrity of information disseminated by federal agencies." Such guidelines have been issued, directing all federal agencies to create and issue agency-specific standards to: 1) Ensure information quality and develop a pre-

dissemination review process; 2) establish administrative mechanisms allowing affected persons to seek and obtain correction of information; and 3) report periodically to OMB on the number and nature of complaints received.

Scientific information and data are key components of fishery management plans (FMPs) and amendments and the use of best available information is the second national standard under the Magnuson-Stevens Act. To be consistent with the Act, FMPs and amendments must be based on the best information available. They should also properly reference all supporting materials and data, and be reviewed by technically competent individuals. With respect to original data generated for FMPs and amendments, it is important to ensure that the data are collected according to documented procedures or in a manner that reflects standard practices accepted by the relevant scientific and technical communities. Data will also undergo quality control prior to being used by the agency and a pre-dissemination review.

**Endangered Species Act (ESA)**

The ESA of 1973 (16 U.S.C. Section 1531 et seq.) requires federal agencies to ensure actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of threatened or endangered species or the habitat designated as critical to their survival and recovery. The ESA requires federal agencies to consult with the appropriate administrative agency (NMFS for most marine species, and the U.S. Fish and Wildlife Service for all remaining species) when proposing an action that may jeopardize the continued existence of threatened or endangered species or destroy or adversely modify critical habitat. Consultations are necessary to determine the potential impacts of the proposed action. They are concluded informally when proposed actions may affect but are “not likely to adversely affect” threatened or endangered species or designated critical habitat. Formal consultations, resulting in a biological opinion, are required when proposed actions may affect and are “likely to adversely affect” threatened or endangered species or designated critical habitat.

A summary of recent completed consultations of the Council’s previous FMPs can be found in Appendix D.

**Marine Mammal Protection Act (MMPA)**

The MMPA established a moratorium, with certain exceptions, on the taking of marine mammals in U.S. waters and by U.S. citizens on the high seas. It also prohibits the importing of marine mammals and marine mammal products into the United States. Under the MMPA, the Secretary of Commerce (authority delegated to NMFS) is responsible for the conservation and management of cetaceans and pinnipeds (other than walruses). The Secretary of the Interior is responsible for walruses, sea otters, polar bears, manatees, and dugongs.

In 1994, Congress amended the MMPA, to govern the taking of marine mammals incidental to commercial fishing operations. The MMPA requires a commercial fishery to be placed in one of three categories, based on the relative frequency of incidental serious injuries and mortalities of marine mammals. Category I designates fisheries with frequent serious injuries and mortalities incidental to commercial fishing; Category II designates fisheries with occasional serious injuries and mortalities; Category III designates fisheries with a remote likelihood or no known serious injuries or mortalities. To legally fish in a Category I and/or II fishery, a fisherman must obtain a marine mammal authorization certificate by registering with the Marine Mammal Authorization Program (50 CFR 229.4) and accommodate an observer if requested (50 CFR 229.7(c)) and they must comply with any applicable take reduction plans.
This section will be updated soon.

**Paperwork Reduction Act**

The Paperwork Reduction Act (PRA) of 1995 (44 U.S.C. 3501 et seq.) regulates the collection of public information by federal agencies to ensure that the public is not overburdened with information requests, that the federal government's information collection procedures are efficient, and that federal agencies adhere to appropriate rules governing the confidentiality of such information. The PRA requires NMFS to obtain approval from the Office of Management and Budget before requesting most types of fishery information from the public. This action does not contain a collection-of-information requirement for purposes of the PRA.

**Small Business Act**

The Small Business Act of 1953, as amended, Section 8(a), 15 U.S.C. 634(b)(6), 636(j), 637(a) and (d); Public Laws 95-507 and 99-661, Section 1207; and Public Laws 100-656 and 101-37 are administered by the Small Business Administration. The objectives of the act are to foster business ownership by individuals who are both socially and economically disadvantaged; and to promote the competitive viability of such firms by providing business development assistance including, but not limited to, management and technical assistance, access to capital and other forms of financial assistance, business training and counseling, and access to sole source and limited competition federal contract opportunities, to help the firms to achieve competitive viability. Because most businesses associated with fishing are considered small businesses, NMFS, in implementing regulations, must assess how those regulations will affect small businesses.

**Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Provisions**

The Magnuson-Stevens Act includes EFH requirements, and as such, each existing, and any new FMPs must describe and identify EFH for the fishery, minimize to the extent practicable adverse

effects on that EFH caused by fishing, and identify other actions to encourage the conservation and enhancement of that EFH.

The areas affected by the proposed action have been identified as EFH for queen conch, spiny lobster, corals, and reef fish. As specified in the Magnuson-Stevens Act, EFH consultation is required for federal actions which may adversely affect EFH.

**National Environmental Policy Act**

The National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 et seq.) requires federal agencies to consider the environmental and social consequences of proposed major actions, as well as alternatives to those actions, and to provide this information for public consideration and comment before selecting a final course of action. This document contains an Environmental Impact Statement to satisfy the NEPA requirements. The Purpose and Need can be found in Section 1.2, Alternatives are found in Chapters 4-8, the Environmental Consequences are also found in Chapters 4-8, the List of Preparers is in Chapter 14, and a list of the agencies/people consulted is found in Chapter 15.

**Regulatory Flexibility Act (RFA)**

The purpose of the Regulatory Flexibility Act (RFA 1980, 5 U.S.C. 601 et seq.) is to ensure that federal agencies consider the economic impact of their regulatory proposals on small entities, analyze effective alternatives that minimize the economic impacts on small entities, and make their analyses available for public comment. The RFA does not seek preferential treatment for small entities, require agencies to adopt regulations that impose the least burden on small entities, or mandate exemptions for small entities. Rather, it requires agencies to examine public policy issues using an analytical process that identifies, among other things, barriers to small business competitiveness and seeks a level playing field for small entities, not an unfair advantage.

After an agency determines that the RFA applies, it must decide whether to conduct a full regulatory flexibility analysis (Initial Regulatory Flexibility Analysis [IRFA] and Final Regulatory Flexibility Analysis [FRFA]) or to certify that the proposed rule will not "have a significant economic impact on a substantial number of small entities." In order to make this determination, the agency conducts a threshold analysis, which has the following 5 parts: 1) Description of small entities regulated by the proposed action, which includes the SBA size standard(s), or those approved by the Office of Advocacy, for purposes of the analysis and size variations among these small entities; 2) descriptions and estimates of the economic impacts of compliance requirements on the small entities, which include reporting and recordkeeping burdens and variations of impacts among size groupings of small entities; 3) criteria used to determine if the economic impact is significant or not; 4) criteria used to determine if the number of small entities that experience a significant economic impact is substantial or not; and 5)

descriptions of assumptions and uncertainties, including data used in the analysis. If the threshold analysis indicates that there will not be a significant economic impact on a substantial number of small entities, the agency can so certify.

## Executive Orders

### E.O. 12630: Takings

The Executive Order on Government Actions and Interference with Constitutionally Protected Property Rights, which became effective March 18, 1988, requires that each federal agency prepare a Takings Implication Assessment for any of its administrative, regulatory, and legislative policies and actions that affect, or may affect, the use of any real or personal property. Clearance of a regulatory action must include a takings statement and, if appropriate, a Takings Implication Assessment. The NOAA Office of General Counsel will determine whether a Takings Implication Assessment is necessary for this amendment.

### E.O. 12866: Regulatory Planning and Review

Executive Order 12866, signed in 1993, requires federal agencies to assess the costs and benefits of their proposed regulations, including distributional impacts, and to select alternatives that maximize net benefits to society. To comply with E.O. 12866, NMFS prepares a Regulatory Impact Review (RIR) for all fishery regulatory actions that either implement a new fishery management plan or significantly amend an existing plan. RIRs provide a comprehensive analysis of the costs and benefits to society associated with proposed regulatory actions, the problems and policy objectives prompting the regulatory proposals, and the major alternatives that could be used to solve the problems. The reviews also serve as the basis for the agency's determinations as to whether proposed regulations are a "significant regulatory action" under the criteria provided in E.O. 12866 and whether proposed regulations will have a significant economic impact on a substantial number of small entities in compliance with the Regulatory Flexibility Act analysis.

### E.O. 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations

This Executive Order mandates that each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions. See Section 3.11 for Environmental Justice considerations as they relate to this fishery management plan.

### E.O. 12962: Recreational Fisheries

This Executive Order requires federal agencies, in cooperation with States and Tribes, to improve the quantity, function, sustainable productivity, and distribution of U.S. aquatic resources for increased recreational fishing opportunities through a variety of methods including, but not limited to, developing joint partnerships; promoting the restoration of recreational fishing areas that are limited by water quality and habitat degradation; fostering sound aquatic conservation and restoration endeavors; and evaluating the effects of federally-funded, permitted, or authorized actions on aquatic systems and recreational fisheries, and documenting those effects.

Additionally, it establishes a seven-member National Recreational Fisheries Coordination Council responsible for, among other things, ensuring that social and economic values of healthy aquatic systems that support recreational fisheries are considered by federal agencies in the course of their actions, sharing the latest resource information and management technologies, and reducing duplicative and cost-inefficient programs among federal agencies involved in conserving or managing recreational fisheries. The Council also is responsible for developing, in cooperation with federal agencies, States and Tribes, a Recreational Fishery Resource Conservation Plan - to include a five-year agenda. Finally, the Order requires NMFS and the U.S. Fish and Wildlife Service to develop a joint agency policy for administering the ESA.

**E.O. 13089: Coral Reef Protection**

The Executive Order on Coral Reef Protection (June 11, 1998) requires federal agencies whose actions may affect U.S. coral reef ecosystems to identify those actions, utilize their programs and authorities to protect and enhance the conditions of such ecosystems; and, to the extent permitted by law, ensure that actions they authorize, fund or carry out not degrade the condition of that ecosystem. By definition, a U.S. coral reef ecosystem means those species, habitats, and other national resources associated with coral reefs in all maritime areas and zones subject to the jurisdiction or control of the United States (e.g., federal, state, territorial, or commonwealth waters).

The actions in this FMP/DEIS will have no direct impacts on coral reefs. Regulations are already in place to limit or reduce impacts to coral reef habitat in the U.S. Caribbean EEZ. In addition, NMFS approved and implemented the 2011 Annual Catch Limit (ACL) Amendment, which established ACLs and accountability measures for species within the Corals and Reef Associated Plants and Invertebrates FMP. These actions aim to prevent overfishing of coral reef resources, which contain species that play important roles on coral reef ecosystems of the U.S. Caribbean.

**E.O. 13132: Federalism**

The Executive Order on Federalism requires agencies, when formulating and implementing policies, to be guided by the fundamental Federalism principles. The Order serves to guarantee

the division of governmental responsibilities between the national government and the states that was intended by the framers of the Constitution. Federalism is rooted in the belief that issues not national in scope or significance are most appropriately addressed by the level of government closest to the people. This Order is relevant to FMPs and amendments given the overlapping authorities of NMFS, the states, and local authorities in managing coastal resources, including fisheries, and the need for a clear definition of responsibilities. It is important to recognize those components of the ecosystem over which fishery managers have no direct control and to develop strategies to address them in conjunction with appropriate international, State, Tribal, and local entities. No Federalism issues have been identified relative to the action proposed in this regulatory amendment. Therefore, consultation with state officials under Executive Order 13132 is not necessary.

**E.O. 13112: Invasive Species**

This Executive Order requires agencies to use their authority to prevent introduction of invasive species, respond to and control invasions in a cost effective and environmentally sound manner, and to provide for restoration of native species and habitat conditions in ecosystems that have been invaded. Further, agencies shall not authorize, fund, or carry out actions that are likely to cause or promote the introduction or spread of invasive species in the U.S. or elsewhere unless a determination is made that the benefits of such actions clearly outweigh the potential harm; and that all feasible and prudent measures to minimize the risk of harm will be taken in conjunction with the actions. The actions undertaken in this FMP will not introduce, authorize, fund, or carry out actions that are likely to cause or promote the introduction or spread of invasive species in the U.S. or elsewhere.

**E.O. 13158: Marine Protected Areas (MPAs)**

Executive Order 13158 (May 26, 2000) requires federal agencies to consider whether their proposed action(s) will affect any area of the marine environment that has been reserved by Federal, State, territorial, Tribal, or local laws or regulations to provide lasting protection for part or all of the natural or cultural resource within the protected area. This action is not expected to affect any MPA in federal waters of the U.S. Caribbean.

# Appendix C. History of Federal Fisheries Management

Tables C.1-C.4 summarize actions in the Caribbean Fishery Management Council (Council) fishery management plan (FMP) for the Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands (USVI) (Reef Fish FMP), FMP for the Spiny Lobster Fishery of Puerto Rico and the USVI (Spiny Lobster FMP), FMP for the Queen Conch Resources of Puerto Rico and the USVI (Queen Conch FMP), and the FMP for Corals and Reef Associated Plants and Invertebrates of Puerto Rico and the USVI (Coral FMP). Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs and their respective amendments. Not all details are included in the tables. Please refer to the respective proposed and final rules to obtain more information.

## C.1 Reef Fish FMP

**Table C.1.** History of management for the Reef Fish FMP and subsequent amendments and regulatory actions.

| Fishery Management Plan (FMP) or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| **FMP for the Shallow-water Reef Fish Fishery** (1985) | 9/22/1985; except *669.24(a)(1) which became effective on 9/22/1986 | FR: 50 FR 34850 (8/28/1985) | - Identified the fishery management unit (FMU) to include 64 shallow water reef fish distributed among 14 families as the most commonly landed species in Puerto Rico and the USVI. These 64 species accounted for 60% of the total finfish landings in the area extending from shoreline to the edge of the insular platform;<br>- Identified the maximum sustainable yield (MSY) and the optimum yield (OY) to be 7.7 million pounds (mp) for the entire shallow-water reef fish FMU;<br>- Concluded that local fishermen were harvesting 100% of the OY. Therefore, there was no remaining harvest identified for foreign fishing;<br>- Established a minimum mesh size for fish traps of 1 ¼ to allow for the escape of juvenile fish;<br>- Required a self-destruct panel (not smaller than the funnel opening of the trap) and/or self-destruct door fastening in fish traps;<br>- Required owner identification and marking of traps, buoys, and boats in the EEZ. Marking/identification |

| Fishery Management Plan (FMP) or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| ***(Cont. FMP for the Shallow-water Reef Fish Fishery)*** | | | systems required by the Puerto Rico and USVI management agencies can be used by fishermen of those states to meet the federal marking requirements;<br>- If the state(s) eliminates the marking system or a fisherman will fish only in the U.S. Caribbean EEZ, an identification number and color code will be assigned by the NMFS Southeast Regional Director upon application;<br>- Prohibited the hauling or tampering of another person's traps without the owner's written permission, except by authorized enforcement officer to alleviate the theft of fish traps.<br>- Prohibited the use of poisons, drugs, other chemicals, and explosives for fishing in the management area as these practices do not discriminate between species or species sizes and are detrimental to the environment;<br>- Required a minimum size for yellowtail snapper of eight inches total length (TL) the first year following implementation, increasing one inch per year until reaching 12 inches TL;<br>- Required a minimum size for Nassau grouper of 12 inches TL the first year following implementation, increasing one inch per year until reaching 24 inches TL;<br>- Established a closed season for Nassau grouper to protect their spawning aggregations. Landings were prohibited from January 1 to March 31 of each calendar year; fish of this species caught during the closed season had to be returned to the sea immediately with minimum injury in such a manner as to ensure maximum probability of survival;<br>- Increased the collection of catch/effort and length/frequency data, as well as any necessary biological information, through improvement of the existing state-federal agreements formulated by |

| Fishery Management Plan (FMP) or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| | | | NMFS/Puerto Rico (PR)/USVI and/or Council's own data gathering program;<br>- Described the characteristics of the habitat used by the stocks in the shallow water reef fish FMU.<br>- *669.24 - Fish traps must have a minimum mesh size of 1 ¼ inches in the smallest dimension of the opening. |
| **Emergency Interim Rule** | | | - To close fishing in area in St. Thomas |
| **Amendment #1 to the Reef Fish FMP** 1990 | 11/29/1990, except 669.24(a)(1), which became effective on 9.14.1991 | FR: 55FR 46214 | - Increased the minimum mesh size from 1 ¼ in to 2 in to further reduce bycatch of juveniles and herbivorous fish essential to the maintenance of the reef ecosystem balance;<br>- Prohibited the harvest and possession of Nassau grouper due to low abundance;<br>- Revised the data collection efforts to include the collection of socio-economic information on the different managed fisheries;<br>- Per request of the St. Thomas and St. John fishermen, the Council established an annual December 1 through February 28 closed area (Hind Bank) southwest of St. Thomas where the use of any fishing gear capable of capturing reef fish, such as fish traps, hook and line, and spear is prohibited during this time[75].<br>- Defined overfishing (OF) and overfished conditions for shallow water reef fish;<br>- Established management measures, which the Council could implement via the framework process. |
| **Regulatory Amendment #1 to the Reef Fish FMP** (1991) | 9/20/1991, except that 669.24(a)(3) is effective 09/20/1991 | FR: 56 FR 48755 | - Modified the minimum mesh size and degradable panel requirements for fish traps: Minimum allowable mesh sizes for fish traps: |

[75] The Hind Bank Marine Conservation District was established through Amendment 1 to the Coral FMP in 1999. This amendment established the current fishing (all) and anchoring prohibitions year-round.

| Fishery Management Plan (FMP) or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| | through 09/13/1993 | | ▪ 1.5 inches (3.8 centimeters) for hexagonal mesh;<br>▪ 1.5 inches for square mesh through September 13, 1993; and<br>▪ 2.0 inches (5.1 centimeters) for square mesh, effective September 14, 1993.<br>- Added more specific requirements for degradable panel on fish traps. |
| **Amendment #2 to the Reef Fish FMP**<br>(1993)<br><br>*(Cont. Amendment #2)* | 11/15/1993 | FR: 58 FR 53145 | - Expanded the existing FMU to include the following deep-water reef fish to address their decline in landings: tiger grouper, black snapper, queen snapper, blackfin snapper, silk snapper, wenchman, vermilion snapper, yellowedge grouper, red grouper, misty grouper, tiger grouper, greater amberjack, almaco jack, blackline tilefish, and sand tilefish;<br>- Extended protection to the aquarium trade finfish species (included them in the FMU);<br>- Prohibited the use of chemical substances or other destructive devices to harvest aquarium trade species, limited gear to hand-held dip nets and slurp guns;<br>- Prohibited the harvest and possession of certain aquarium trade species:<br>▪ Live red hind (*Epinephelus guttatus*) and mutton snapper (*Lutjanus analis*) juveniles to allow for the recovery of these rebuilding species;<br>▪ Seahorses (*Hippocampu*s spp.) and basslets (*Liopropom*a) due to their scarcity;<br>▪ Coney (*Epinephelus fulvus*) and queen triggerfish (*Balistes vetula*) juveniles to avoid over harvest and user conflict as these were important species both commercially and recreationally;<br>▪ Foureye butterflyfish (*Chaetodon capistratus*), banded butterflyfish (*C. striatus*) longsnout butterlfyfish (*C.* |

| Fishery Management Plan (FMP) or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| *(Cont. Amendment #2)* | | | *aculeatus*), due to their high mortality in captivity;<br>▪ Certain species of wrasses, basslets, and angelfishes notably *Thalassoma bifasciatum*, *Bodianus rufus*, *Gamma loreto*, and *Pomacanthus paru* due to their impotance to the reef ecosystem.<br>- Recommended continued assessments of heavily fished aquarium trade species such as royal gramma (*Gramma loreto)*, rock beauty (*Holacanthus tricolor)*, yellowhead jawfish (*Opistognathus aurifrons)*, french angelfish (*Pomacanthus paru)*, queen angelfish *(Holacanthus ciliaris)*, pygmy angelfish *Centropyge argi)*, bluehead wrasse *(Thalassoma bifasciatum)*, puddingwife wrasse Halichoeres radiatus), blue chromis (*Chromis cyanea)*, and redlip blenny (*Ophioblennius atlanticus)*.<br>- Retitled the FMP from the Shallow Water Reef Fish FMP to the FMP for the Reef Fish Fishery of Puerto Rico and the USVI;<br>- Applied existing definitions of MSY and OY to all reef fish within the revised FMU, with the exception of marine aquarium finfish. The MSY and OY of marine aquarium finfish remained undefined;<br>- Required that the fish traps be constructed as follows:<br>▪ Basic construction material must be 1.5-in hexagonal mesh wire or 2.0-in square mesh wire;<br>▪ Escape openings in the trap must be at least 8x8 in and located on any two sides (except top, bottom, or side containing the funnel);<br>▪ Access door may serve as an escape opening provided it meets all the requirements for size and location, and is fastened in such a manner that the door will fall open when the fasteners degrade; |

| Fishery Management Plan (FMP) or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| | | | ▪ Panels covering escape openings must be of a mesh at least as large as the mesh used in constructing the trap, and fastened with untreated jute twine 1/8-in or less in diameter when traps are fitted with zinc anodes; or fastened with 18-gauge ungalvanized wire or 1/8-in untreated just twine (maximum diameter) if anodes are not used;<br>- Prohibited the harvest of Goliath grouper in the U.S. Caribbean EEZ;<br>- Established prohibitions on red hind harvest to protect spawning aggregations from December 1 through February 28 each year within the Tourmaline Bank area off the west coast of Puerto Rico and the Lang Bank area off the east coast of St. Croix;<br>- Prohibited all fishing from March 1 through June 30 of each year within the Mutton Snapper Spawning Aggregation Area southwest of St. Croix. |
| **Technical Amendment to the Reef Fish FMP** (1994) | 3/11/1994 | 59 FR 11560 | - Modified the regulations regarding minimum allowable mesh size to be the distance between the centers of strands rather than the smallest dimension of the opening, consistent with industry standards. |
| **Regulatory Amendment #2 to the Reef Fish FMP** (1996) | January 1997 | 61 FR 64485 | - Reduced the size of the Tourmaline Bank closed area originally implemented in 1993;<br>- Established seasonal closures in two additional areas off the west coast of Puerto Rico (Abrir La Sierra Bank and Bajo de Sico);<br>- Closed the EEZ portions in three areas to all fishing between December 1 and February 28, each year:<br>▪ 1.5 mile radius centered around a buoy to be deployed in the area known as Bajo de Sico;<br>▪ 1.5 mile radius around Buoy 8 at Tourmaline Bank (this is part of the area already closed but it allows for |

| Fishery Management Plan (FMP) or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| | | | the use of the sandy area where red hind are not found);<br>▪ 1.5 mile radius around Buoy 6 at Abrir La Sierra Bank. |
| **Amendment #3 to the Reef Fish FMP**<br>(2005)<br><br>Part of the Caribbean Sustainable Fisheries Act Amendment<br><br>***(Cont. Amendment #3 [SFA Amendment 2005])*** | 11/28/2005 | PR:70 FR 53979<br>FR:70 FR 62073 | - Amended current requirements for trap construction such that only one escape panel is required, which could be the trap door (modifying the regulation implemented through Regulatory Amendment 1, which required that each fish trap contained two degradable (escape) panels in addition to a self-destruct door fastening);<br>▪ The degradable panel must be at least 8 x 8 in and with mesh not smaller than the mesh of the trap;<br>- Individual traps or pots must have at least one buoy attached that floats on the surface;<br>- Required that traps or pots tied together in a trap line have at least one buoy that floats at the surface at each end of the trap line;<br>- Prohibited the use of gillnets and trammel nets in the EEZ, with the exception of those nets used for catching ballyhoo, gar, and flying fish. Nets used for the harvest of these species must be tended at all times;<br>- Prohibited the use of bottom tending gear (traps, pots, gillnets, trammel nets, bottom longlines) in the seasonally closed areas of Tourmaline, Bajo de Sico, Abrir la Sierra, Lang Bank, the Mutton Snapper Spawning Aggregation Area, and Grammanik Bank.<br>- Required an anchor retrieval system for anyone fishing for or possessing reef fish species;<br>- Prohibited the filleting of fish at sea;<br>- Established a seasonal closure in the area known as Grammanik Bank south of St. Thomas prohibiting all fishing from February 1 – April 30 of each year |

| Fishery Management Plan (FMP) or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| ***(Cont. Amendment #3 [SFA Amendment 2005])*** | | | - Established seasonal closures (no fishing or possession), every year during the specified months, for:<br>▪ Silk, black, blackfin and vermillion snapper from October 1 through December 31;<br>▪ Tiger, yellowfin, yellowedge, red and black from February 1 through April 30;<br>▪ Red hind from December 1 through the last day of February;<br>▪ Lane and mutton snapper from April 1 through June 30.<br>- In the absence of MSY estimates, the proxy for MSY was derived from recent average catch (C), and from estimates of the current biomass ($B_{CURR}/B_{MSY}$) and fishing mortality ($F_{CURR}/F_{MSY}$) ratios as: MSY = C/[($F_{CURR}/F_{MSY}$) x ($B_{CURR}/B_{MSY}$)]; where C was calculated based on commercial landings for the years 1997-2001 for Puerto Rico and 1994-2002 for the USVI, and on recreational landings for the years 2000-2001.<br>- For each FMU sub-unit for which $B_{CURR}/B_{MSY}$ and $F_{CURR}/F_{MSY}$ had not been estimated through a stock assessment or other scientific exercise (i.e., stock status unknown), the following estimates were used for the $B_{CURR}/B_{MSY}$ and $F_{CURR}/F_{MSY}$ proxies: 1) For species believed not to be "at risk" based on the best available information, the $F_{CURR}/F_{MSY}$ proxy was estimated as 0.75 and the $B_{CURR}/B_{MSY}$ proxy estimated as 1.25; 2) For species for which no positive or negative determination could be made on the status of their condition, the default proxies for $F_{CURR}/F_{MSY}$ and $B_{CURR}/B_{MSY}$ were estimated as 1.00; and 3) For species that were believed to be "at risk" based on the best available information, the $F_{CURR}/F_{MSY}$ proxy was |

| Fishery Management Plan (FMP) or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| ***(Cont. Amendment #3 [SFA Amendment 2005])*** | | | estimated as 1.50 and the $B_{CURR}/B_{MSY}$ proxy estimated as 0.75.<br>- Defined OY equal to the average yield associated with fishing on a continuing basis at $F_{OY}$; where $F_{OY} = 0.75F_{MSY}$.<br>- Defined MSST = $B_{MSY}(1-c)$; where c = the natural mortality rate (M) or 0.50, whichever is smaller.<br>- Specified an MSY control rule to define ABC = $F_{MSY}(B)$. When the data needed to determine $F_{MSY}$ were not available, use natural mortality (M) as a proxy for $F_{MSY}$.<br>- Specified an OY control rule to define target catch limits such that they equal $F_{OY}(B)$.<br>- In the case of a sub-unit with multiple M values, the lowest documented M value would be used in this formula to reduce the risk that the most vulnerable species in a particular sub-unit would be overexploited. The specific MSST values that would be defined by this alternative in accordance with the preferred MSY alternatives are presented for each stock or complex;<br>- Rebuild Nassau grouper to $B_{MSY}$ in 25 years, using the formula $T_{MIN}$ (10 years) + one generation (15 years) = 25 years.<br>- Rebuild Goliath grouper to $B_{MSY}$ in 30 years, using the formula $T_{MIN}$ (10 years) + one generation (20 years) = 30 years.<br>- Rebuild grouper unit 4 to $B_{MSY}$ in 10 years;<br>- Eliminated existing regulations defining a marine aquarium fish as "a Caribbean reef fish that is smaller than 5.5 inches (14.0 cm) TL" and restricting the harvest gear for marine aquarium fish to hand-held dip nets or hand-held slurp guns (50 CFR 622.41§(b));<br>- Eliminated the regulation prohibiting the harvest and possession of butterflyfish and seahorses from federal |

| Fishery Management Plan (FMP) or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| | | | waters of the U.S. Caribbean (50 CFR §622.32(b)(1)(ii));<br>- Described and identified essential fish habitat (EFH) according to functional relationships between life history stages of Council managed species and Caribbean marine and estuarine habitats;<br>- Designated habitat areas of particular concern (HAPCs) in the Reef Fish FMP based on confirmed spawning locations and on areas or sites identified as having particular ecological importance to managed species. |
| **Amendment #4 to the Reef Fish FMP**<br>(started in 1997, but postponed)<br><br>To implement escape vents in the trap fishery | POSTPONED | N/A<br><br>NOI:72 FR 57307 | N/A |
| **Regulatory Amendment #3 to the Reef Fish FMP**<br>(2010)<br><br>To address management in Bajo de Sico, Puerto Rico<br><br>*The Final rule included other management measures not part of the amendment. | 12/2/2010 | PR: 75 FR 44209 (7/28/2010)<br>FR: 75 FR 67247 | - Extended the original length of the yearly seasonal closure for Bajo de Sico from December 1 through February 28 (3-months) to October 1 through March 31 (6-months);<br>- Prohibited fishing for or possession of Council-managed reef fish species in Bajo de Sico;<br>- Prohibited anchoring year-round within the Bajo de Sico closed area. Fishing for highly migratory species (HMS), coastal migratory pelagics (dolphin, wahoo, jacks, and mackerel) and spiny lobster would be allowed all year.<br>- *The final rule added spear to the list of allowable gears in the commercial sector of the Caribbean reef fish fishery and revised the title of the FMP in the list of authorized fisheries and gear. |
| | 1/30/2012 | PR: 76 FR 66675<br>FR: 76 FR 82404 | - Prohibited harvest of midnight, blue, and rainbow parrotfish to address potential overharvest of these species due to their combination of large body size, a high susceptibility to spear gear and fish traps, relatively low resilience |

| Fishery Management Plan (FMP) or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| **Amendment #5 to the Reef Fish FMP**<br>(2011)<br><br>Part of the 2010 Caribbean Annual Catch Limit (ACL) Amendment<br><br>***(Cont. Amendment #5 to the Reef Fish FMP 2011)*** | | | in comparison with other Caribbean parrotfish species, and lack of abundance compared with most parrotfish occupying U.S. Caribbean waters;<br>- Amended the stock complexes in the Reef Fish FMUs:<br>▪ Separated grouper unit (GU) 4 into GU4 (yellowfin, red, tiger [black grouper was added to GU4]) and GU5 (yellowedge, misty).<br>▪ Removed creole fish from GU3 and fisheries management<br>▪ Modified the snapper FMU by adding cardinal snapper to snapper unit (SU) 2 and moved wenchman to SU1;<br>- Specified ACLs and accountability measures (AMs) for species undergoing overfishing (snappers, groupers, parrotfish, and queen conch) to end and prevent overfishing of species considered overfished or undergoing overfishing.<br>- Established or redefined management reference points, including a proxy for maximum sustainable yield (MSY proxy) and an estimate of OY, OFLs, for species undergoing overfishing (snappers, groupers, queen conch, parrotfish). Established ABCs for parrotfish and queen conch.<br>- Modified existing management measures as needed to constrain harvest to specified ACLs.<br>- Specified separate commercial and recreational ACLs in Puerto Rico based on the preferred management reference point time series;<br>- Allocated the ACLs in the U.S. Caribbean EEZ by island groups (i.e. Puerto Rico, St. Thomas/St. John, and St. Croix) according to the subzones established in the 2010 Caribbean ACL amendment; |

| Fishery Management Plan (FMP) or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| | | | - Established a recreational aggregate bag limit for snapper, grouper, and parrotfish of five per fisher per day including not more than two parrotfish per fisher per day. A vessel limit was also established, limiting recreational harvest to an aggregate of 15 snapper, grouper, and parrotfish per day of which no more than six can be parrotfish;<br>- Modified framework measures for the Reef Fish FMP established in Amendment 1. |
| **Amendment #6 to the Reef Fish FMP**<br>(2011)<br><br>Part of the 2011 Caribbean ACL Amendment | 1/30/2012 | PR: 76 FR 68711<br>FR: 76 FR 82414 | - For the reef fish species that were not determined to be undergoing overfishing and therefore not included in Amendment 5, redefined management reference points, including MSY, OFL, ABC, and established ACLs and AMs.<br>- For those species included in Amendment 6, allocated ACLs among island management areas;<br>- Established aggregate recreational bag limits for angelfish, boxfish, goatfish, grunts, wrasses, jacks, scups and porgies, squirrelfish, triggerfish and filefish, tilefish:<br>▪ 5 fish per person/day or, if 3 or more persons are aboard, 15 fish from aggregate per vessel/day, but not to exceed: 1 surgeonfish per person/day or 4 surgeonfish per vessel/day.<br>- Redefined management reference points, including MSY, OFL, ABC, ACL, AMs;<br>- Allocated the ACLs for the 2011 species by each island's subzone;<br>- Aquarium trade species listed in both the Coral FMP and the Reef Fish FMP into a new FMP specific to aquarium trade species would be moved into a new FMP, however this is still pending. |
| **Regulatory Amendment #4 to the Reef Fish FMP**<br>(2013) | 8/29/2013 | PR:78 FR 15338<br>FR:78 FR 45894 | - Established a commercial and recreational minimum size limit for |

| Fishery Management Plan (FMP) or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| Addressed parrotfish in St. Croix, USVI | | | parrotfish harvest in the federal waters off St. Croix, USVI:<br>▪ Minimum size limit of 8 inches (20.3 cm), fork length, for redband parrotfish (*Sparisoma aurofrenatum*)<br>▪ Minimum size limit of 9 inches (22.9 cm), fork length, for all other parrotfish: princess, queen, striped, redtail, stoplight, redfin.<br>- The current harvest prohibition for midnight, blue, and rainbow parrotfish remains in effect. |
| **Amendment #7 to the Reef Fish FMP (2016)**<br><br>Revised language to reflect current regulatory language | 06/10/2016 | NOA: 81 FR 5978<br>PR: 81 FR 9800<br>FR: 81 FR 29166 | - Revised language within the Reef Fish FMP to be consistent with language in the implementing regulations at 50 CFR Part 622 describing the application of AMs in the U.S. Caribbean EEZ |
| **Amendment #8 to the Reef Fish FMP (2016)**<br><br>Modified date of implementation of AM-based closures | 06/08/2017 | NOA: 82 FR 1308<br>PR: 82 FR 10324<br>FR: 82 FR 21475 | - Modified the date for implementation of an AM-based closure in the event of an ACL overage for a species/species group managed by the Council in Puerto Rico, St. Thomas/St. John, and St. Croix under the Reef Fish, Coral, and Spiny Lobster FMPs. An AM-based closure will be implemented from September 30 of the closure year backward, toward the beginning of the fishing year, for the number of days necessary to achieve the reduction in landings required to ensure landings do not exceed the applicable ACL.<br>- Required that the Council revisit using September 30 as the end date for AM-based closures no longer than 2 years from the implementation of the amendment and no longer than every 2 years thereafter. |
| **Regulatory Amendment #6 to the Reef Fish FMP(2017)**<br><br>Revised the method used to trigger the application of AMs for Council managed-reef fish species/species groups in the Puerto Rico EEZ | 1/2/2018 | PR: 82 FR 43733<br>FR: 82 FR 56917 | - Applies only to reef fish stocks and stock complexes in the EEZ off Puerto Rico, as these are the only stocks/stock complexes currently managed by separate commercial and recreational sector ACLs in U.S. Caribbean federal waters. |

| Fishery Management Plan (FMP) or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| | | | - Revised method used to trigger the application. Required application of an AM to either the recreational or commercial sector of a stock/stock complex only if NMFS determines that both the sector-specific ACL and the total (combined recreational and commercial) ACL were exceeded, and the exceedance is not the result of enhanced data collection and monitoring efforts.<br>- The purpose of this final rule is to increase the likelihood that OY is achieved on a continuing basis and to minimize, to the extent practicable, adverse socio-economic effects of AM-based closures. |

## C.2 Spiny Lobster FMP

**Table C.2.** History of management for the Spiny Lobster FMP and subsequent amendments and regulatory actions.

| Fishery Management Plan or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| | 1/1981 | FR: 49 FR 50049 | - Defined the Caribbean spiny lobster fishery management unit (FMU) to include *Panulirus argus*, described objectives for the management of the spiny lobster fishery, and established management measures to achieve those objectives.<br>- Defined the maximum sustainable yield (MSY) for the spiny lobster fishery at 830,000 pounds (lbs) per year, which is the greatest amount or yield that can be sustainably harvested under prevailing environmental conditions;<br>- Defined the U.S. Caribbean-wide optimum yield (OY) as “all the non-egg-bearing spiny lobsters in the management area having a carapace length (CL) of 3.5 inches (in) or |

| Fishery Management Plan or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| **Spiny Lobster FMP** (1981)<br><br>*(Cont. Spiny Lobster FMP)* | | | greater, that can be harvested on an annual basis;"<br>- Established a domestic annual harvest under the proposed CL of 3.5 in;<br>- Size and harvest requirements included:<br>▪ Land lobster whole and with a CL equal or larger than 3.5 in;<br>▪ No retention of egg-bearing (berried) lobsters (berried female lobsters may be kept in pots or traps until the eggs are shed), no stripping or removing the eggs from a lobster, undersized lobster may be kept in the fish pots as attractors but may not be harvested;<br>- Gear requirements included:<br>▪ Include a self-destruct panel and/or self-destruct door fastenings on traps and pots to eliminate "ghost traps;"<br>▪ Identify and mark traps, pots, buoys, and boat;<br>▪ Prohibit the use of poisons, drugs, or other chemicals, and use of spears, hooks, explosives, or similar devices to take spiny lobsters, reducing injury to lobsters that if landed would be illegal to retain;<br>▪ Report catch and effort information through improvement of the existing data collection systems.<br>- Defined the U.S. Caribbean spiny lobster stock, although the question of whether or not biologically distinct sub-stocks of *P. argus* may be identified was not resolved. For the purpose of the Spiny Lobster FMP, three biological assessments areas (distinguished by their user groups and geography) were |

| Fishery Management Plan or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| | | | assumed: (1) Puerto Rico, (2) St. Thomas and St. John, and (3) St. Croix. A single OY was established. |
| **Amendment #1 to the Spiny Lobster FMP** (1990) (addressing overfishing) | May 1991 | FR: 56 FR 19098 | - Implemented definitions for overfished and overfishing, outlined framework actions that could be taken by the Council should overfishing occur, and better described the habitat for the spiny lobster;<br>- Defined "overfished" as a biomass level below 20 percent of the spawning potential ratio (SPR) and defined "overfishing" as a harvest rate that is not consistent with a program implemented to rebuild the stock to the 20% SPR.<br>- Established management measures to halt overfishing should overfishing occur. |
| **Amendment #2 to the Spiny Lobster FMP** (2005)<br><br>Part of the Caribbean Sustainable Fisheries (SFA) Act | 11/28/2005 | PR: 70 FR 53979<br>FR: 70 FR 62073 | - Redefined the MSY from 830,000 lbs to 547,000 lbs per year; OY to 513,000 lbs, ABC/MFMT = 547,000 lbs, defined the MSST = $B_{MSY}(1-c)$; where c = the natural mortality rate (M) or 0.50, whichever is smaller.<br>- Minimized bycatch and bycatch mortality to the extent practicable;<br>- Described and identified essential fish habitat (EFH) and habitat areas of particular concern for the spiny lobster;<br>- Established modifications to anchoring techniques, modified construction specifications for pots/traps, and closed areas to certain recreational and commercial fishing gears (i.e., pots /traps, gill/trammel nets, bottom longlines) to prevent, mitigate, or minimize adverse fishing impacts to EFH in the U.S. Caribbean EEZ. Including:<br>▪ Require at least one buoy that floats on the surface on all individual traps/pots; |

| Fishery Management Plan or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| | | | ▪ Require at least one buoy at each end of trap lines linking traps/pots, for all fishing vessels that fish for or possess spiny lobster (or reef fish species) in or from the EEZ;<br>▪ Require an anchor retrieval system that ensures the anchor is recovered by its crown in order to prevent the anchor from dragging along the bottom during recovery.<br>- Prohibited the use of pots/traps, gill/trammel nets, and bottom longlines on coral or hard bottom habitat year-round in the existing seasonally closed areas and Grammanik Bank in the U.S. Caribbean EEZ under the Spiny Lobster (and Reef Fish FMPs). |
| **Amendment #3 to the Spiny Lobster FMP** (started in 2007, not finalized) (Escape vents) | Postponed | N/A<br>NOI: 72 FR 57307 | N/A |
| **Amendment #4 to the Spiny Lobster FMP** (2008) | 2/11/2009 | NOA: 73 FR 61015<br>PR: 73 FR 64295<br>FR: 74 FR 1148 | - Restricted spiny lobster imports into the U.S.;<br>- Established conservation standards to achieve an increase in spawning stock biomass and increase the long-term yield of the fishery;<br>- Prohibited any person from importing spiny lobster less than 6.0 ounces tail weight to Puerto Rico or the USVI. |
| **Amendment #5 to the Spiny Lobster FMP** (2011)<br><br>Part of the 2011 Caribbean Annual Catch Limit (ACL) Amendment | 1/30/2012 | NOA: 76 FR 59377<br>PR: 76 FR 68711<br>FR: 76 FR 82414 | - Revised the management reference points and status determination criteria established in Amendment 2 (i.e, 2005 SFA Amendment);<br>- Established ACLs and accountability measures (AMs) for spiny lobster;<br>- Allocated spiny lobster ACLs among island management areas: PR ACL (all sectors) = 327,920; St. Croix ACL (all sectors) = 107,307; St. Thomas/St. John ACL = 104,199.<br>- Established recreational bag limits for spiny lobster of 3 spiny lobsters |

| Fishery Management Plan or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| | | | per fisher/day, and no more than 10 spiny lobsters per vessel/day.<br>- Revised framework procedures for the spiny lobster. |
| **Amendment #6 to the Spiny Lobster FMP** (2015)<br><br>Part of the Comprehensive Amendment to the U.S. Caribbean Fishery Management Plans: Application of Accountability Measures<br><br>*(Cont. Amendment #6 to the Spiny Lobster FMP)* | 6/10/2016 | NOA: 81 FR 5978<br>PR: 81 FR 9800<br>FR: 81 FR 29166 | - Revised language within the FMP to be consistent with language in the implementing regulations at 50 CFR Part 622 describing the application of AMs in the U.S. Caribbean EEZ.<br>- Clarified that any AM-based closure would only apply for the fishing year for which it was implemented, consistent with the Council's intent.<br>- The final rule (not included in the amendment) clarified that:<br>▪ The spiny lobster ACL in Puerto Rico management area is applied as a single ACL for both the commercial and recreational sectors, consistent with the Council's intent. If the AM is triggered due to an ACL overage, the commercial and recreational fishing seasons are reduced. During such a closure, spiny lobster may not be harvested, possessed, purchased, or sold, and the bag and possession limits for spiny lobster would be zero.<br>▪ For spiny lobster in the St. Croix and St. Thomas/St. John island management areas, if AMs are triggered due to an ACL overage and the fishing season is reduced, spiny lobster in or from the applicable management area may not be harvested, possessed, purchased, or sold, and the bag and possession limits would be zero. |
| **Amendment #7 to the Spiny Lobster FMP** (2016)<br><br>Part of the Amendments to the U.S. Caribbean Reef Fish, Spiny Lobster, and | 6/08/2017 | NOA: 82 FR 1308<br>PR: 82 FR 10324<br>FR: 82 FR 21475 | - Modified the implementation date for AM-based closures. Specifically:<br>▪ Instead of using December 31st as the implementation date, an AM-based closure will be implemented from September 30 of the closure year backward, toward the |

| Fishery Management Plan or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| Corals and Reef Associated Parts and Invertebrates FMP: Timing of Accountability-Measure-Based Closures | | | beginning of the fishing year, for the number of days necessary to achieve the reduction in landings required to ensure landings do not exceed the applicable ACL.<br>▪ If the length of the required fishing season reduction exceeds the period of January 1-September 30, any additional reduction required will be applied from October 1 forward, toward the December 31.<br>- Requires that the Council revisit the use of September 30th as the end date for AM-based closures no longer than 2 years from implementation of the amendment and no longer than every 2 years thereafter. |

## C.3 Queen Conch FMP

**Table C.3.** History of management for the Queen Conch FMP and subsequent amendments and regulatory actions.

| Fishery Management Plan or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| | 1/13/1997 | PR: 61 FR 45395<br>FR: 61 FR 65481 | - Defined the maximum sustainable yield (MSY) of queen conch as 738,000 lbs per year;<br>- Defined the optimum yield (OY) as "all queen conch commercially and recreationally harvested from the exclusive economic zone (EEZ) and landed consistent with the management measures set forth in this FMP under a goal of allowing 20% of the spawning stock biomass to remain intact;"<br>- Required that all conch species in the fishery management unit be landed in the shell;<br>- Prohibited the sale of undersized queen conch and queen conch shells; |

| Fishery Management Plan or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| **Queen Conch FMP** (1996)<br><br>*(Cont. Queen Conch FMP)* | | | - Implemented a recreational bag limit of three queen conch per day, not to exceed 12 per boat;<br>- Prohibited the possession of queen conch that measured less than 9 in total length or that have a shell lip thickness of less than 3/8 in;<br>- Implemented a commercial catch limit of 150 queen conch per day:<br>▪ The commercial fishermen' daily quota will be lowered to one hundred (100) queen conch for the second year and to seventy-five (75) the third year;<br>▪ The quota reduction is subject to review upon receipt of empirical information on which to base the decisions for new limits;<br>- All conch harvested under these provisions must conform to minimum size specifications and be landed still attached to the shell;<br>- Implemented an annual spawning season closure that extended from July 1 through September 30;<br>- Prohibited the use of hookah gear to harvest queen conch;<br>- Established the following framework measures:<br>▪ Establish closed areas, and address significant changes in fishing practices or environmental disasters;<br>▪ Other available framework adjustments include changes to the Fishery Management Unit (FMU), harvest limitations (including quotas, trip or daily landing limits), gear restrictions, and closed seasons or areas. |
| **Amendment #1 to the Queen Conch FMP** (2005) | 11/28/2005 | NOA: 70 FR 35053<br>PR: 70 FR 53979<br>FR: 70 FR 62073 | - Established a new FMU for the queen conch by removing the Caribbean helmet (*Cassis tuberosa*), Caribbean vase (*Vasum* |

| Fishery Management Plan or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| Part of the Caribbean Sustainable Fisheries Act (SFA) Amendment | | | *muricatum*), flame helmet (*Cassis flammea*), and whelk (West Indian top shell, *Cittarium pica*);<br>- Nine species remained in the FMU;<br>- Prohibited commercial and recreational catch and possession of queen conch in federal waters of the U.S. Caribbean, with the exception of Lang Bank east of St. Croix. Lang Bank consists of federal waters east of 64° 34' W longitude;<br>- Where fishing was allowed in the EEZ, conch must be maintained intact and all other regulations of bag limits, gear restrictions, and minimum size apply;<br>- Moved all species in the Caribbean conch resource FMU, with the exception of queen conch, to a data collection only category (removed all species except queen conch from federal regulation);<br>▪ Consequently, existing regulations requiring that all species in the Caribbean conch resource FMU taken from the U.S. EEZ be maintained with meat and shell intact (50 CFR §622.38(f)) would no longer apply to these species, and would instead only apply to queen conch;<br>▪ Inclusion in a data collection only category would result in no specification of MSY, OY, or other stock status determination criteria for these species |
| **Regulatory Amendment #1 to the Queen Conch FMP: Establishing Compatible Closures** (2010) | 5/31/2011 | PR: 76 FR 3596<br>FR: 76 FR 23907 | Established a quota and seasonal closures compatible with the USVI:<br>▪ Modified the Lang Bank seasonal closure from the previous yearly closure of July 1 through September 30 (3-months), to the new closure of |

| Fishery Management Plan or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| | | | June 1 through October 31 (5-months).<br>▪ Prohibited fishing for and possession of queen conch in or from the Caribbean EEZ east of 64°34′ W. longitude, which includes Lang Bank east of St. Croix, USVI, when harvest and possession of queen conch is prohibited in St. Croix territorial waters as a result of a territorial quota closure. |
| **Amendment #2 to the Queen Conch FMP** (2010)<br><br>Part of the 2010 Caribbean Annual Catch Limit Amendment | 1/30/2012 | NOA: 76 FR 59375<br>PR: 76 FR 66675<br>FR: 76 FR 82404 | - Revised the management reference points (i.e., MSY, overfishing limit (OFL), OY, acceptable biological catch (ABC)) for the queen conch FMU previously established in the 2005 Caribbean SFA Amendment (i.e. Amendment 1 to the Queen Conch FMP);<br>- Redefined the management reference points or proxies for queen conch based on the longest time series of pre-Caribbean SFA Amendment landings data considered consistently reliable across all islands.<br>- Established the MSY proxy based on the average annual commercial landings from 1999-2005 for Puerto Rico and St. Croix and from 2000-2005 for St. Thomas/St. John;<br>▪ Established the OFL equal to the MSY proxy with overfishing occurring when annual catches exceed the OFL, unless NMFS' Southeast Fisheries Science Center (SEFSC) (in consultation with the Council and its Scientific and Statistical Committee (SSC)) determined the overage occurred because data collection/monitoring improved, rather than because catches actually increased. |

| Fishery Management Plan or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| | | | ▪ The SSC recommended an ACL of 50,000 lbs equal to OY and ABC. |
| **Amendment #3 to the Queen Conch FMP** (2012)<br><br>Part of the 2011 Caribbean Annual Catch Limit Amendment | 1/30/2012 | NOA: 76 FR 53977<br>PR: 76 FR 68711<br>FR: 76 FR 82414 | - Removed eight conch species from the Queen Conch FMU: Milk conch (*Strombus costatus)*, West Indian Fighting Conch *(S. pugilis)*, Roostertail Conch (*S. gallus)*, Hawkwing Conch (*S. raninus)*, True Tulip (*Fasciolaria tulipa)*, Atlantic Triton's Trumpet (*Charonia variegate)*, Cameo Helmet (*Cassis madagascarensis)*, and Green Start Shell (*Astrea tuber)*. The queen conch, *Strombus gigas* is the only species in the FMU. |

## C.4 Coral FMP

**Table C.4.** History of management for the Coral FMP and subsequent amendments and regulatory actions.

| Fishery Management Plan or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| **Coral FMP** (1994) | Effective 12/27/1995, except for §670.23(b) (Restrictions on sale or purchase), which became effective 3/1/1996 | PR: 60 FR 46806<br>FR: 60 FR 58221 | - Prohibited the take or possession, whether dead or alive, of gorgonians, stony corals, and any species in the fishery management unit (FMU) if attached or existing upon live rock;<br>- Prohibited the sale or possession of any prohibited coral unless fully documented as to point of origin;<br>- Prohibited the use of chemicals, plants, or plant-derived toxins, and explosives to take species in the coral FMU;<br>- Required that dip nets, slurp guns, hands, and other non-habitat destructive gear types be used to harvest allowable corals;<br>- Required that harvesters of allowable corals obtain a permit from the local or federal government;<br>- Framework measures allowed NMFS Southeast Regional Administrator (RA) to modify management measures, including the establishment of marine conservation districts, changes to the list of prohibited species, changes to the FMU, harvest limitations, including quotas, trip or daily landing limits, and gear restrictions. |
| **Amendment #1 to the Coral FMP establishing a Marine Conservation District (MCD)** (1999) | 12/6/1999 | PR: 64 FR 42068<br>FR: 64 FR 60132 | Established a no-take MCD in the U.S. exclusive economic zone (EEZ) southwest of St. Thomas, USVI, including:<br>- No anchoring by fishing vessels, no fishing of any kind (including no bottom fishing and no spear fishing), and no removal of any organism in the MCD (including, but not limited to, those organisms listed in the FMUs of the Coral FMP, Reef Fish |

| Fishery Management Plan or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| | | | FMP, Queen Conch FMP, and Spiny Lobster FMP).<br>- Scientific research would be allowed as long as it fits under the proper definition and guidance of "scientific research" under the Magnuson Stevens Act. |
| **Amendment #2 to the Coral FMP (2005)**<br><br>(Part of the Caribbean Sustainable Fisheries Act Amendment) | 11/28/2005 | PR: 70 FR 53979<br>FR: 70 FR 62073 | - Moved the aquarium trade species in both the Reef Fish and Coral FMPs into a 'data collection only' category. Inclusion in the data collection only category resulted in no specification of maximum sustainable yield (MSY), optimum yield (OY), or other stock status determination criteria (i.e., fishing mortality, biomass, minimum stock size threshold, maximum fishing mortality threshold) for these species due to no real need for federal conservation and management of these species. Consequently, existing regulations defining a marine aquarium fish as "a Caribbean reef fish that is smaller than 5.5 inches (14.0 cm) total length" and restricting the harvest of a marine aquarium fish to hand-held dip nets or hand-held slurp guns (50 CFR 622.41§(b)) were eliminated.<br>- Described and identified essential fish habitat (EFH) according to functional relationships between life history stages of federally managed species and Caribbean marine and estuarine habitats. The EFH for the coral fishery in the U.S. Caribbean consists of all waters from mean low water to the outer boundary of the EEZ – habitats used by larvae – and coral and hard bottom substrates from mean low water to 100 fathoms depth – used by other life stages. |
| **Amendment #3 to the Coral FMP** (2011) | 1/30/2012 | PR: 76 FR 68711<br>FR: 76 FR 82414 | - Established management reference points, ACLs, and accountability measures (AMs) for species in the Coral FMP, including aquarium trade species, which were not determined to |

| Fishery Management Plan or Amendment | Final Rule Effective Date | Proposed Rule (PR) Final Rule (FR) | Major Actions |
|---|---|---|---|
| (Part of the 2011 Caribbean Annual Catch Limit [ACL] Amendment) | | | be undergoing overfishing. The ACL for aquarium trade species is a U.S. Caribbean-wide ACL. The U.S. Caribbean-wide ACL for the aquarium trade species was established using landings data from the Puerto Rico commercial and recreational sectors.<br>- Established framework measures for species in the Coral FMP. |
| **Amendment #4 to the Coral FMP: Seagrass Management** (2013) | 7/5/2013 | PR: 78 FR 14503<br>FR: 78 FR 33255 | - Removed seagrass species from the Coral FMP as there was no known targeted or indirect harvest of any seagrass species from the EEZ or from Puerto Rico or USVI state waters, and future harvest was not anticipated. |
| **Amendment #5 to the Coral FMP** (2015)<br><br>Part of the Comprehensive Amendment to the U.S. Caribbean Fishery Management Plans: Application of Accountability Measures | 6/10/2016 | NOA: 81 FR 5978<br>PR: 81 FR 9800<br>FR: 81 FR 29166 | - Revised language within the FMP to be consistent with language in the implementing regulations at 50 CFR Part 622 describing the application of AMs in the U.S. Caribbean EEZ.<br>- Clarified that any AM-based closure would only apply for the fishing year for which it was implemented, consistent with the Council's intent. |

# Appendix D. Universe of Species Considered for the Puerto Rico Fishery Management Plan

| Group | Scientific name | Common name | Previously Managed |
|---|---|---|---|
| Lobster | *Panulirus argus* | Caribbean spiny lobster | Yes |
| Conch | *Lobatus gigas* | Queen conch | Yes |
| Angelfishes | *Holacanthus ciliaris* | Queen angelfish | Yes |
| Angelfishes | *Pomacanthus arcuatus* | Gray angelfish | Yes |
| Angelfishes | *Pomacanthus paru* | French angelfish | Yes |
| Boxfishes | *Lactophrys polygonia* | Honeycomb cowfish | Yes |
| Boxfishes | *Lactophrys quadricornis* | Scrawled cowfish | Yes |
| Boxfishes | *Lactophrys trigonus* | Trunkfish | Yes |
| Boxfishes | *Lactophrys bicaudalis* | Spotted trunkfish | Yes |
| Boxfishes | *Lactophrys triqueter* | Smooth trunkfish | Yes |
| Filefishes | *Aluterus scriptus* | Scrawled filefish | Yes |
| Filefishes | *Cantherhines macrocerus* | Whitespotted filefish | Yes |
| Filefishes | *Melichthys niger* | Black durgon | Yes |
| Goatfishes | *Pseudupeneus maculatus* | Spotted goatfish | Yes |
| Goatfishes | *Mulloidichthys martinicus* | Yellow goatfish | Yes |
| Groupers | *Epinephelus striatus* | Nassau Grouper | Yes |
| Groupers | *Epinephelus itajara* | Goliath grouper | Yes |
| Groupers | *Epinephelus fulvus* | Coney | Yes |
| Groupers | *Epinephelus cruentatus* | Graysby | Yes |
| Groupers | *Epinephelus guttatus* | Red hind | Yes |
| Groupers | *Epinephelus adscensionis* | Rock hind | Yes |
| Groupers | *Mycteroperca bonaci* | Black grouper | Yes |
| Groupers | *Epinephelus morio* | Red grouper | Yes |
| Groupers | *Mycteroperca tigris* | Tiger grouper | Yes |
| Groupers | *Mycteroperca venenosa* | Yellowfin grouper | Yes |
| Groupers | *Epinephelus mystacinus* | Misty grouper | Yes |
| Groupers | *Epinephelus flavolimbatus* | Yellowedge grouper | Yes |
| Grunts | *Haemulon plumieri* | White grunt | Yes |
| Grunts | *Haemulon album* | Margate | Yes |
| Grunts | *Haemulon aurolineatum* | Tomtate | Yes |
| Grunts | *Haemulon sciurus* | Bluestriped grunt | Yes |
| Grunts | *Haemulon flavolineatum* | French grunt | Yes |
| Grunts | *Anisotremus virginicus* | Porkfish | Yes |
| Jacks | *Caranx crysos* | Blue runner | Yes |
| Jacks | *Caranx latus* | Horse-eye jack | Yes |
| Jacks | *Caranx lugubris* | Black jack | Yes |
| Jacks | *Seriola rivoliana* | Almaco jack | Yes |
| Jacks | *Caranx ruber* | Bar jack | Yes |
| Jacks | *Seriola dumerili* | Greater amberjack | Yes |
| Jacks | *Caranx bartholomaei* | Yellow jack | Yes |
| Parrotfishes | *Scarus coeruleus* | Blue parrotfish | Yes |
| Parrotfishes | *Scarus coelestinus* | Midnight parrotfish | Yes |
| Parrotfishes | *Scarus taeniopterus* | Princess parrotfish | Yes |
| Parrotfishes | *Scarus vetula* | Queen parrotfish | Yes |
| Parrotfishes | *Scarus guacamaia* | Rainbow parrotfish | Yes |
| Parrotfishes | *Sparisoma rubripinne* | Redfin parrotfish | Yes |

| Group | Scientific name | Common name | Previously Managed |
|---|---|---|---|
| Parrotfishes | *Sparisoma chrysopterum* | Redtail parrotfish | Yes |
| Parrotfishes | *Sparisoma viride* | Stoplight parrotfish | Yes |
| Parrotfishes | *Sparisoma aurofrenatum* | Redband parrotfish | Yes |
| Parrotfishes | *Scarus croicensis* | Striped parrotfish | Yes |
| Porgies | *Calamus bajonado* | Jolthead porgy | Yes |
| Porgies | *Archosargus rhomboidalis* | Sea bream | Yes |
| Porgies | *Calamus penna* | Sheepshead porgy | Yes |
| Porgies | *Calamus pennatula* | Pluma | Yes |
| Snappers | *Apsilus dentatus* | Black snapper | Yes |
| Snappers | *Lutjanus buccanella* | Blackfin snapper | Yes |
| Snappers | *Lutjanus vivanus* | Silk snapper | Yes |
| Snappers | *Rhomboplites aurorubens* | Vermilion snapper | Yes |
| Snappers | *Pristipomoides aquilonaris* | Wenchman | Yes |
| Snappers | *Pristipomoides macrophthalmus* | Cardinal snapper | Yes |
| Snappers | *Etelis oculatus* | Queen snapper | Yes |
| Snappers | *Lutjanus griseus* | Gray snapper | Yes |
| Snappers | *Lutjanus synagris* | Lane snapper | Yes |
| Snappers | *Lutjanus analis* | Mutton snapper | Yes |
| Snappers | *Lutjanus jocu* | Dog snapper | Yes |
| Snappers | *Lutjanus apodus* | Schoolmaster | Yes |
| Snappers | *Lutjanus mahogani* | Mahogany snapper | Yes |
| Snappers | *Ocyurus chrysurus* | Yellowtail snapper | Yes |
| Squirrelfishes | *Myripristis jacobus* | Blackbar soldierfish | Yes |
| Squirrelfishes | *Priacanthus arenatus* | Bigeye | Yes |
| Squirrelfishes | *Holocentrus rufus* | Longspine squirrelfish | Yes |
| Squirrelfishes | *Holocentrus adscensionis* | Squirrelfish | Yes |
| Surgeonfishes | *Acanthurus coeruleus* | Blue tang | Yes |
| Surgeonfishes | *Acanthurus bahianus* | Ocean surgeonfish | Yes |
| Surgeonfishes | *Acanthurus chirurgus* | Doctorfish | Yes |
| Tilefishes | *Caulolatilus cyanops* | Blackline tilefish | Yes |
| Tilefishes | *Malacanthus plumieri* | Sand tilefish | Yes |
| Triggerfishes | *Canthidermis sufflamen* | Ocean triggerfish | Yes |
| Triggerfishes | *Balistes vetula* | Queen triggerfish | Yes |
| Triggerfishes | *Xanthichthys rigens* | Sargassum triggerfish | Yes |
| Wrasses | *Lachnolaimus maximus* | Hogfish | Yes |
| Wrasses | *Halichoeres radiatus* | Puddingwife | Yes |
| Wrasses | *Bodianus rufus* | Spanish hogfish | Yes |
| Aquarium Trade Reef Fish | *Antennarius spp.* | Frogfish | Yes |
| Aquarium Trade Reef Fish | *Apogon maculatus* | Flamefish | Yes |
| Aquarium Trade Reef Fish | *Astrapogen stellatus* | Conchfish | Yes |
| Aquarium Trade Reef Fish | *Ophioblennius atlanticus* | Redlip blenny | Yes |
| Aquarium Trade Reef Fish | *Bothus lunatus* | Peacock flounder | Yes |
| Aquarium Trade Reef Fish | *Chaetodon aculeatus* | Longsnout butterflyfish | Yes |
| Aquarium Trade Reef Fish | *Chaetodon capistratus* | Foureye butterflyfish | Yes |
| Aquarium Trade Reef Fish | *Chaetodon ocellatus* | Spotfin butterflyfish | Yes |
| Aquarium Trade Reef Fish | *Chaetodon striatus* | Banded butterflyfish | Yes |
| Aquarium Trade Reef Fish | *Amblycirrhitus pinos* | Redspotted hawkfish | Yes |
| Aquarium Trade Reef Fish | *Dactylopterus volitans* | Flying gurnard | Yes |
| Aquarium Trade Reef Fish | *Chaetodipterus faber* | Atlantic spadefish | Yes |
| Aquarium Trade Reef Fish | *Gobiosoma oceanops* | Neon goby | Yes |

| Group | Scientific name | Common name | Previously Managed |
|---|---|---|---|
| Aquarium Trade Reef Fish | *Priolepis hipoliti* | Rusty goby | Yes |
| Aquarium Trade Reef Fish | *Gramma loreto* | Royal gramma | Yes |
| Aquarium Trade Reef Fish | *Clepticus parrae* | Creole wrasse | Yes |
| Aquarium Trade Reef Fish | *Halichoeres cyanocephalus* | Yellowcheek wrasse | Yes |
| Aquarium Trade Reef Fish | *Halichoeres garnoti* | Yellowhead wrasse | Yes |
| Aquarium Trade Reef Fish | *Halichoeres maculipinna* | Clown wrasse | Yes |
| Aquarium Trade Reef Fish | *Hemipteronotus novacula* | Pearly razorfish | Yes |
| Aquarium Trade Reef Fish | *Hemipteronotus splendens* | Green razorfish | Yes |
| Aquarium Trade Reef Fish | *Thalassoma bifasciatum* | Bluehead wrasse | Yes |
| Aquarium Trade Reef Fish | *Echidna catenata* | Chain moray | Yes |
| Aquarium Trade Reef Fish | *Gymnothorax funebris* | Green moray | Yes |
| Aquarium Trade Reef Fish | *Gymnothorax miliaris* | Goldentail moray | Yes |
| Aquarium Trade Reef Fish | *Ogcocepahalus spp.* | Batfish | Yes |
| Aquarium Trade Reef Fish | *Myrichthys ocellatus* | Goldspotted eel | Yes |
| Aquarium Trade Reef Fish | *Opistognathus aurifrons* | Yellowhead jawfish | Yes |
| Aquarium Trade Reef Fish | *Opistognathus whitehursti* | Dusky jawfish | Yes |
| Aquarium Trade Reef Fish | *Centropyge argi* | Cherubfish | Yes |
| Aquarium Trade Reef Fish | *Holacanthus tricolor* | Rock beauty | Yes |
| Aquarium Trade Reef Fish | *Abudefduf saxatilis* | Sergeant major | Yes |
| Aquarium Trade Reef Fish | *Chromis cyanea* | Blue chromis | Yes |
| Aquarium Trade Reef Fish | *Chromis insolata* | Sunshinefish | Yes |
| Aquarium Trade Reef Fish | *Microspathodon chrysurus* | Yellowtail damselfish | Yes |
| Aquarium Trade Reef Fish | *Pomacentrus fuscus* | Dusky damselfish | Yes |
| Aquarium Trade Reef Fish | *Pomacentrus leucostictus* | Beaugregory | Yes |
| Aquarium Trade Reef Fish | *Pomacentrus partitus* | Bicolor damselfish | Yes |
| Aquarium Trade Reef Fish | *Pomacentrus planifrons* | Threespot damselfish | Yes |
| Aquarium Trade Reef Fish | *Priacanthus cruentatus* | Glasseye snapper | Yes |
| Aquarium Trade Reef Fish | *Equetus acuminatus* | High-hat | Yes |
| Aquarium Trade Reef Fish | *Equetus lanceolatus* | Jackknife-fish | Yes |
| Aquarium Trade Reef Fish | *Equetus punctatus* | Spotted drum | Yes |
| Aquarium Trade Reef Fish | *Scorpaenidae* | Scorpionfishes | Yes |
| Aquarium Trade Reef Fish | *Hypoplectrus unicolor* | Butter hamlet | Yes |
| Aquarium Trade Reef Fish | *Liopropoma rubre* | Swissguard basslet | Yes |
| Aquarium Trade Reef Fish | *Rypticus saponaceus* | Greater soapfish | Yes |
| Aquarium Trade Reef Fish | *Serranus annularis* | Orangeback bass | Yes |
| Aquarium Trade Reef Fish | *Serranus baldwini* | Lantern bass | Yes |
| Aquarium Trade Reef Fish | *Serranus tabacarius* | Tobaccofish | Yes |
| Aquarium Trade Reef Fish | *Serranus tigrinus* | Harlequin bass | Yes |
| Aquarium Trade Reef Fish | *Serranus tortugarum* | Chalk bass | Yes |
| Aquarium Trade Reef Fish | *Symphurus arawak* | Caribbean tonguefish | Yes |
| Aquarium Trade Reef Fish | *Hippocampus spp.* | Seahorses | Yes |
| Aquarium Trade Reef Fish | *Syngnathus spp.* | Pipefishes | Yes |
| Aquarium Trade Reef Fish | *Synodus intermedius* | Sand diver | Yes |
| Aquarium Trade Reef Fish | *Canthigaster rostrata* | Sharpnose puffer | Yes |
| Aquarium Trade Reef Fish | *Diodon hystrix* | Porcupinefish | Yes |
| Hydrocorals | *Millepora* spp. | Fire corals | Yes |
| Hydrocorals | *Stylaster roseus* | Rose lace corals | Yes |
| Soft corals | *Erythropodium caribaeorum* | Encrusting gorgonian | Yes |
| Soft corals | *Iciligorgia schrammi* | Deepwater sea fan | Yes |
| Soft corals | *Briareum asbestinum* | Corky sea finger | Yes |
| Soft corals | *Carijoa riisei* | Snowflake coral | Yes |

| Group | Scientific name | Common name | Previously Managed |
|---|---|---|---|
| Soft corals | *Telesto* spp. | - | Yes |
| Gorgonian corals | *Ellisella* spp. | Sea whips | Yes |
| Gorgonian corals | *Gorgonia flabellum* | Venus sea fan | Yes |
| Gorgonian corals | *G. mariae* | Venus sea fan | Yes |
| Gorgonian corals | *G. ventalina* | Common sea fan | Yes |
| Gorgonian corals | *Pseudopterogorgia acerosa* | Venus sea fan | Yes |
| Gorgonian corals | *P. albatrossae* | - | Yes |
| Gorgonian corals | *P. americana* | Slimy sea plume | Yes |
| Gorgonian corals | *P. bipinnata* | Bipinnate plume | Yes |
| Gorgonian corals | *P. rigida* | - | Yes |
| Gorgonian corals | *Pterogorgia anceps* | Angular sea whip | Yes |
| Gorgonian corals | *P. citrina* | Yellow sea whip | Yes |
| Gorgonian corals | *Eunicea calyculata* | Warty sea rod | Yes |
| Gorgonian corals | *E. clavigera* | Knobby candelabra | Yes |
| Gorgonian corals | *E. fusca* | Doughnut sea rod | Yes |
| Gorgonian corals | *E. knighti* | Knight’s flexible sea rod | Yes |
| Gorgonian corals | *E. laciniata* | Black sausage coral | Yes |
| Gorgonian corals | *E. laxispica* | Tube-knob candelabrum | Yes |
| Gorgonian corals | *E. mammosa* | Swollen-knob | Yes |
| Gorgonian corals | *E. succinea* | Shelf-knob sea rod | Yes |
| Gorgonian corals | *E. touneforti* | - | Yes |
| Gorgonian corals | *Muricea atlantica* | - | Yes |
| Gorgonian corals | *M. elongata* | Orange spiny rod | Yes |
| Gorgonian corals | *M. laxa* | Delicate spiny rod | Yes |
| Gorgonian corals | *M. muricata* | Spiny sea fan | Yes |
| Gorgonian corals | *M. pinnata* | Long spine sea fan | Yes |
| Gorgonian corals | *Muriceopsis* spp. | - | Yes |
| Gorgonian corals | *M. flavida* | Rough sea plume | Yes |
| Gorgonian corals | *M. sulphurea* | Spiny Gorgonian, Sulfur soft coral | Yes |
| Gorgonian corals | *Plexaura flexuosa* | Bent sea rod | Yes |
| Gorgonian corals | *P. homomalla* | Black sea rod | Yes |
| Gorgonian corals | *Plexaurella dichotoma* | Slit-pore sea rod | Yes |
| Gorgonian corals | *P. fusifera* | Sea rod | Yes |
| Gorgonian corals | *P. grandiflora* | Slit-pore sea rod | Yes |
| Gorgonian corals | *P. grisea* | Gray sea rod | Yes |
| Gorgonian corals | *P. nutans* | Giant slit-pore | Yes |
| Gorgonian corals | *Pseudoplexaura crucis* | False cross plexaura | Yes |
| Gorgonian corals | *P. flagellosa* | 0 | Yes |
| Gorgonian corals | *P. porosa* | Porous sea rod | Yes |
| Gorgonian corals | *P. wagenaari* | - | Yes |
| Hard corals | *Acropora cervicornis* | Staghorn coral | Yes |
| Hard corals | *A. palmata* | Elkhorn coral | Yes |
| Hard corals | *A. prolifera* | Fused staghorn | Yes |
| Hard corals | *Agaricia agaricities* | Lettuce leaf coral | Yes |
| Hard corals | *A. fragilis* | Fragile saucer | Yes |
| Hard corals | *A. lamarcki* | Lamarck's sheet | Yes |
| Hard corals | *A. tenuifolia* | Thin leaf lettuce | Yes |
| Hard corals | *Leptoseris cucullata* | Sunray lettuce | Yes |
| Hard corals | *Stephanocoenia michelinii* | Blushing star | Yes |
| Hard corals | *Eusmilia fastigiata* | Flower coral | Yes |
| Hard corals | *Tubastrea aurea* | Cup coral | Yes |

| Group | Scientific name | Common name | Previously Managed |
|---|---|---|---|
| Hard corals | *Cladocora arbuscula* | Tube coral | Yes |
| Hard corals | *Colpophyllia natans* | Boulder coral | Yes |
| Hard corals | *Diploria clivosa* | Knobby brain coral | Yes |
| Hard corals | *D. labyrinthiformis* | Grooved brain | Yes |
| Hard corals | *D. strigosa* | Symmetrical brain | Yes |
| Hard corals | *Favia fragum* | Golfball coral | Yes |
| Hard corals | *Manicina areolata* | Rose coral | Yes |
| Hard corals | *M. mayori* | Tortugas rose coral | Yes |
| Hard corals | *Montastrea annularis* | Boulder star coral | Yes |
| Hard corals | *M. cavernosa* | Great star coral | Yes |
| Hard corals | *Solenastrea bournoni* | Smooth star coral | Yes |
| Hard corals | *Dendrogyra cylindrus* | Pillar coral | Yes |
| Hard corals | *Dichocoenia stellaris* | Pancake star | Yes |
| Hard corals | *D. stokesi* | Elliptical star | Yes |
| Hard corals | *Meandrina meandrites* | Maze coral | Yes |
| Hard corals | *Isophyllastrea rigida* | Rough star coral | Yes |
| Hard corals | *Isophyllia sinuosa* | Sinuous cactus | Yes |
| Hard corals | *Mussa angulosa* | Large flower coral | Yes |
| Hard corals | *Mycetophyllia aliciae* | Thin fungus coral | Yes |
| Hard corals | *M. danae* | Fat fungus coral | Yes |
| Hard corals | *M. ferox* | Grooved fungus | Yes |
| Hard corals | *M. lamarckiana* | Fungus coral | Yes |
| Hard corals | *Scolymia cubensis* | Artichoke coral | Yes |
| Hard corals | *S. lacera* | Solitary disk | Yes |
| Hard corals | *Oculina diffusa* | Ivory bush coral | Yes |
| Hard corals | *Madracis decactis* | Ten-ray star coral | Yes |
| Hard corals | *M. mirabilis* | Yellow pencil | Yes |
| Hard corals | *Porites astreoides* | Mustard hill coral | Yes |
| Hard corals | *P. branneri* | Blue crust coral | Yes |
| Hard corals | *P. divaricata* | Small finger coral | Yes |
| Hard corals | *P. porites* | Finger coral | Yes |
| Hard corals | *Astrangia solitaria* | Dwarf cup coral | Yes |
| Hard corals | *Phyllangia americana* | Hidden cup coral | Yes |
| Hard corals | *Siderastrea radians* | Lesser starlet | Yes |
| Hard corals | *S. siderea* | Massive starlet | Yes |
| Black corals | *Antipathes spp.* | Bushy black coral | Yes |
| Black corals | *Stichopathes spp.* | Wire coral | Yes |
| Aquarium Trade Invertebrates | *Aphimedon compressa* | Erect rope sponge | Yes |
| Aquarium Trade Invertebrates | *Chondrilla nucula* | Chicken liver sponge | Yes |
| Aquarium Trade Invertebrates | *Cynachirella alloclada* | - | Yes |
| Aquarium Trade Invertebrates | *Geodia neptuni* | Potato sponge | Yes |
| Aquarium Trade Invertebrates | *Haliclona* spp. | Finger sponge | Yes |
| Aquarium Trade Invertebrates | *Myriastra* spp. | - | Yes |
| Aquarium Trade Invertebrates | *Niphates digitalis* | Pink vase sponge | Yes |
| Aquarium Trade Invertebrates | *N. erecta* | Lavender rope sponge | Yes |
| Aquarium Trade Invertebrates | *Spinosella policifera* | - | Yes |
| Aquarium Trade Invertebrates | *S. vaginalis* | Branching vase sponge | Yes |
| Aquarium Trade Invertebrates | *Tethya crypta* | - | Yes |
| Aquarium Trade Invertebrates | *Aiptasia tagetes* | Pale anemone | Yes |
| Aquarium Trade Invertebrates | *Bartholomea annulata* | Corkscrew anemone | Yes |
| Aquarium Trade Invertebrates | *Condylactis gigantea* | Giant pink-tipped anemone | Yes |

| Group | Scientific name | Common name | Previously Managed |
|---|---|---|---|
| Aquarium Trade Invertebrates | *Hereractis lucida* | Knobby anemone | Yes |
| Aquarium Trade Invertebrates | *Lebrunia* spp. | Staghorn anemone | Yes |
| Aquarium Trade Invertebrates | *Stichodactyla helianthus* | Sun anemone | Yes |
| Aquarium Trade Invertebrates | *Zoanthus* spp. | Sea mat | Yes |
| Aquarium Trade Invertebrates | *Discosoma* spp. (formerly Rhodactis) | False coral | Yes |
| Aquarium Trade Invertebrates | *Ricordia florida* | Florida false coral | Yes |
| Aquarium Trade Invertebrates | *Sabellastarte* spp. | Tube worms | Yes |
| Aquarium Trade Invertebrates | *S. magnifica* | Magnificent duster | Yes |
| Aquarium Trade Invertebrates | *Spirobranchus giganteus* | Christmas tree worm | Yes |
| Aquarium Trade Invertebrates | *Tridachia crispata* | Lettuce sea slug | Yes |
| Aquarium Trade Invertebrates | *Oliva reticularis* | Netted olive | Yes |
| Aquarium Trade Invertebrates | *Cyphoma gibbosum* | Flamingo tongue | Yes |
| Aquarium Trade Invertebrates | *Lima* spp. | Fileclams | Yes |
| Aquarium Trade Invertebrates | *L. scabra* | Rough fileclam | Yes |
| Aquarium Trade Invertebrates | *Spondylus americanus* | Atlantic thorny oyster | Yes |
| Aquarium Trade Invertebrates | *Octopus* spp. (except the Common octopus, O.vulgaris) | - | Yes |
| Aquarium Trade Invertebrates | *Alpheaus armatus* | Snapping shrimp | Yes |
| Aquarium Trade Invertebrates | *Paguristes* spp. | Hermit crabs | Yes |
| Aquarium Trade Invertebrates | *P. cadenati* | Red reef hermit | Yes |
| Aquarium Trade Invertebrates | *Percnon gibbesi* | Nimble spray crab | Yes |
| Aquarium Trade Invertebrates | *Lysmata* spp. | Peppermint shrimp | Yes |
| Aquarium Trade Invertebrates | *Thor amboinensis* | Anemone shrimp | Yes |
| Aquarium Trade Invertebrates | *Mithrax* spp. | Clinging crabs | Yes |
| Aquarium Trade Invertebrates | *M. cinctimanus* | Banded clinging | Yes |
| Aquarium Trade Invertebrates | *M. sculptus* | Green clinging | Yes |
| Aquarium Trade Invertebrates | *Stenorhynchus seticornis* | Yellowline arrow | Yes |
| Aquarium Trade Invertebrates | *Periclimenes* spp. | Cleaner shrimp | Yes |
| Aquarium Trade Invertebrates | *Gonodactylus* spp. | - | Yes |
| Aquarium Trade Invertebrates | *Lysiosquilla* spp. | - | Yes |
| Aquarium Trade Invertebrates | *Stenopus hispidus* | Banded shrimp | Yes |
| Aquarium Trade Invertebrates | *S. scutellatus* | Golden shrimp | Yes |
| Aquarium Trade Invertebrates | *Analcidometra armata* | Swimming crinoid | Yes |
| Aquarium Trade Invertebrates | *Davidaster* spp. | Crinoids | Yes |
| Aquarium Trade Invertebrates | *Nemaster* spp. | Crinoids | Yes |
| Aquarium Trade Invertebrates | *Astropecten* spp. | Sand stars | Yes |
| Aquarium Trade Invertebrates | *Linckia guildingii* | Common comet star | Yes |
| Aquarium Trade Invertebrates | *Ophidiaster guildingii* | Comet star | Yes |
| Aquarium Trade Invertebrates | *Oreaster reticulatus* | Cushion sea star | Yes |
| Aquarium Trade Invertebrates | *Astrophyton muricatum* | Giant basket star | Yes |
| Aquarium Trade Invertebrates | *Ophiocoma* spp. | Brittlestars | Yes |
| Aquarium Trade Invertebrates | *Ophioderma* spp. | Brittlestars | Yes |
| Aquarium Trade Invertebrates | *O. rubicundum* | Ruby brittlestar | Yes |
| Aquarium Trade Invertebrates | *Diadema antillarum* | Long-spined urchin | Yes |
| Aquarium Trade Invertebrates | *Echinometra* spp. | Purple urchin | Yes |
| Aquarium Trade Invertebrates | *Eucidaris tribuloides* | Pencil urchin | Yes |
| Aquarium Trade Invertebrates | *Lytechinus* spp. | Pin cushion urchin | Yes |
| Aquarium Trade Invertebrates | *Tripneustes ventricosus* | Sea egg | Yes |
| Aquarium Trade Invertebrates | *Holothuria* spp. | Sea cucumbers | Yes |
| Anchovies | *Anchoa hepsetus* | Stiped anchovy | No |

| Group | Scientific name | Common name | Previously Managed |
|---|---|---|---|
| Anchovies | *Cetengraulis edentulus* | Whalebone anchovy | No |
| Barracudas | *Sphyraena guachancho* | Guanchanche | No |
| Barracudas | *Sphyraena barracuda* | Great barracuda | No |
| Barracudas | *Sphyraena picudilla* | Southern sennet | No |
| Beardfish | *Polymixia lowei* | Beardfish | No |
| Billfish | *Istiophorus platypterus* | Sailfish | No |
| Billfish | *Makaira nigricans* | Blue marlin | No |
| Bonefish | *Albula vulpes* | Bonefish | No |
| Butterfish | *Peprilus paru* | Southern harvestfish | No |
| Catfish | *Ictalurus punctatus* | Channel catfish | No |
| Catfish | *Ameiurus catus* | White catfish | No |
| Cichlids | *Cichla ocellaris* | Peacock bass | No |
| Cichlids | *Oreochromis mossambicus* | Mozambique tilapia | No |
| Cobia | *Rachycentron canadum* | Cobia | No |
| Cornetfish | *Fistularia tabacaria* | Bluespotted cornetfish | No |
| Cusk eels | *Brotula barbata* | Bearded brotula | No |
| Cutlassfish | *Trichiurus lepturus* | Atlantic cutlassfish | No |
| Damselfishes | *Chromis multilineata* | Brown chromis | No |
| Dolphinfish | *Coryphaena hippurus* | Dolphin | No |
| Dolphinfish | *Coryphaena equiselis* | Pompano dolphin | No |
| Driftfish | *Nomeus gronovii* | Man-of-war fish | No |
| Drums | *Cynoscion jamaicensis* | Mongolar drummer | No |
| Drums | *Bairdiella ronchus* | Ground drummer | No |
| Drums | *Micropogonias furnieri* | Whitemouth drummer | No |
| Drums | *Umbrina coroides* | Sand drum | No |
| Drums | *Odontoscion dentex* | Reef croaker | No |
| Eels | *Anguilla rostrata* | American eel | No |
| Eels | *Enchelycore nigricans* | Viper moray | No |
| Eels | *Gymnothorax ocellatus* | White spotted moray | No |
| Eels | *Conger triporiceps* | Manytooth conger | No |
| Filefish | *Aluterus schoepfi* | Orange filefish | No |
| Filefish | *Cantherhines pullus* | Orangespot filefish | No |
| Filefish | *Monacanthus setifer* | Pygmy filefish | No |
| Flying fish | *Cypselurus melanurus* | Atlantic flyingfish | No |
| Frogfish | *Histrio histrio* | Sargassumfish | No |
| Gnomefish | *Scombrops oculatus* | Atlantic scombrops | No |
| Gobies | *Bathygobius soporator* | Frillfin goby | No |
| Gobies | *Gobioides broussonnetii* | Violet goby | No |
| Gobies | *Awaous tajasica* | River goby | No |
| Gobies | *Sicydium plumieri* | Sirajo goby | No |
| Groupers | *Epinephelus inermis* | Marbled grouper | No |
| Groupers | *Alphestes afer* | Mutton hamlet | No |
| Groupers | *Mycteroperca interstitialis* | Yellowmouth grouper | No |
| Groupers | *Diplectrum bivittatum* | Dwarf sand perch | No |
| Groupers | *Gonioplectrus hispanus* | Spanish flag | No |
| Groupers | *Hypoplectrus nigricans* | Black hamlet | No |
| Groupers | *Paranthias furcifer* | Creole fish | No |
| Groupers | *Serranus phoebe* | Tattler | No |
| Grunts | *Haemulon bonariense* | Black grunt | No |
| Grunts | *Haemulon carbonarium* | Caesar grunt | No |
| Grunts | *Haemulon chrysargyreum* | Smallmouth grunt | No |

| Group | Scientific name | Common name | Previously Managed |
|---|---|---|---|
| Grunts | *Haemulon macrostomum* | Spanish grunt | No |
| Grunts | *Haemulon melanurum* | Cottonwick | No |
| Grunts | *Anisotremus surinamensis* | Black margate | No |
| Grunts | *Conodon nobilis* | Barred grunt | No |
| Grunts | *Pomadasys crocro* | Burro grunt | No |
| Halfbeak | *Hemiramphus brasiliensis* | Ballyhoo | No |
| Halfbeak | *Hyporhamphus unifasciatus* | Silverstripe halfbeak | No |
| Herrings | *Opisthonema oglinum* | Atlantic thread herring | No |
| Herrings | *Harengula humeralis* | Redear sardine | No |
| Herrings | *Harengula jaguana* | Scaled sardine | No |
| Herrings | *Jenkinsia lamprotaenia* | Dwarf herring | No |
| Herrings | *Chirocentrodon bleekerianus* | Dog-tooth herring | No |
| Houndfish | *Tylosurus crocodilus* | Houndfish | No |
| Jacks | *Alectis ciliaris* | African pompano | No |
| Jacks | *Caranx hippos* | Crevalle jack | No |
| Jacks | *Chloroscombrus chrysurus* | Atlantic bumper | No |
| Jacks | *Oligoplites saurus* | Leatherjack | No |
| Jacks | *Selar crumenophthalmus* | Bigeye scad | No |
| Jacks | *Selene setapinnis* | Atlantic moonfish | No |
| Jacks | *Trachinotus falcatus* | Permit | No |
| Jacks | *Trachinotus goodei* | Palometa | No |
| Jacks | *Decapterus macarellus* | Mackerel scad | No |
| Jacks | *Decapterus punctatus* | Round scad | No |
| Jacks | *Elagatis bipinnulata* | Rainbow runner | No |
| Livebearers | *Gambusia affinis* | Mosquitofish | No |
| Livebearers | *Poecilia reticulata* | Guppy | No |
| Livebearers | *Xiphophorus helleri* | Green swordtail | No |
| Livebearers | *Xiphophorus maculatus* | Southern platyfish | No |
| Minnows | *Pimephales promelas* | Fathead minnow | No |
| Mojarras | *Eucinostomus gula* | Silver jenny | No |
| Mojarras | *Diapterus rhombeus* | Rhomboid mojarra | No |
| Mojarras | *Diapterus plumieri* | Striped mojarra | No |
| Mojarras | *Gerres cinereus* | Yellowfin mojarra | No |
| Mullet | *Mugil curema* | White mullet | No |
| Mullet | *Mugil liza* | Liza | No |
| Mullet | *Agonostomus monticola* | Mountain mullet | No |
| Mullet | *Joturus pichardi* | Hog nose mullet | No |
| Needlefish | *Ablennes hians* | Flat needlefish | No |
| Porgies | *Calamus calamus* | Saucereye porgy | No |
| Pufferfish | *Lagocephalus laevigatus* | Smooth puffer | No |
| Pufferfish | *Sphoeroides spengleri* | Bandtail puffer | No |
| Rays | *Dasyatis americana* | Southern stingray | No |
| Rays | *Aetobatus narinari* | Spotted eagle ray | No |
| Rays | *Manta birostris* | Giant manta ray | No |
| Remora | *Remora remora* | Remora | No |
| Remora | *Echeneis naucrates* | Sharksucker | No |
| Sea chubs | *Kyphosus incisor* | Yellow chub | No |
| Sea chubs | *Kyphosus sectatrix* | Bermuda chub | No |
| Sharks | *Hexanchidae* | Cow shark | No |
| Sharks | *Hexanchus vitulus* | Bigeyed sixgill shark | No |
| Sharks | *Heptranchias perlo* | Seven gill shark | No |

| Group | Scientific name | Common name | Previously Managed |
|---|---|---|---|
| Sharks | *Rhincodon typus* | Whale shark | No |
| Sharks | *Orectolobidae* | Carpet shark | No |
| Sharks | *Lamnidae* | Mackerel shark | No |
| Sharks | *Isurus oxyrinchus* | Shortfin mako shark | No |
| Sharks | *Ginglymostoma cirratum* | Nurse shark | No |
| Sharks | *Carcharhinidae* | Requiem shark | No |
| Sharks | *Galeocerdo cuvier* | Tiger shark | No |
| Sharks | *Mustelus canis* | Smooth dogfish shark | No |
| Sharks | *Mustelus norrisi* | Florida smooth shark | No |
| Sharks | *Carcharhinus obscurus* | Dusky shark | No |
| Sharks | *Carcharhinus limbatus* | Blacktip shark | No |
| Sharks | *Carcharhinus perezii* | Caribbean reef shark | No |
| Sharks | *Prionace glauca* | Blue shark | No |
| Sharks | *Negaprion brevirostris* | Lemon shark | No |
| Sharks | *Sphyrnidae* | Hammerhead shark | No |
| Sharks | *Sphyrna lewini* | Scalloped hammerhead shark | No |
| Sharks | *Sphyrna mokarran* | Great hammerhead shark | No |
| Shellfish | *Cittarium pica* | West Indian top snail | No |
| Shellfish | *Fasciolaria tulipa* | True tulip | No |
| Shellfish | *Crassostrea rhizophorae* | Cupped mangrove oyster | No |
| Shellfish | *Panulirus guttatus* | Spotted spiny lobster | No |
| Shellfish | *Scyllarides aequinoctialis* | Spanish slipper lobster | No |
| Shellfish | *Calappa flammea* | Flame box crab | No |
| Shellfish | *Arenaeus cribrarius* | Speckled swimming crab | No |
| Shellfish | *Callinectes sapidus* | Blue crab | No |
| Shellfish | *Cardisoma guanhumi* | Blue land crab | No |
| Silversides | *Atherinomorus stipes* | Hardhead silverside | No |
| Sleepers | *Gobiomorus dormitor* | Bigmouth sleeper | No |
| Sleepers | *Eleotris pisonis* | Spinycheek sleeper | No |
| Snake mackerel | *Gempylus serpens* | Snake mackerel | No |
| Snake mackerel | *Ruvettus pretiosus* | Oilfish | No |
| Snake mackerel | *Promethichthys prometheus* | Bermuda catfish | No |
| Snappers | *Lutjanus cyanopterus* | Cubera snapper | No |
| Snappers | *Lutjanus purpureus* | Southern red snapper | No |
| Snooks | *Centropomus ensiferus* | Swordpine snook | No |
| Snooks | *Centropomus parallelus* | Fat snook | No |
| Snooks | *Centropomus pectinatus* | Tarpon snook | No |
| Snooks | *Centropomus undecimalis* | Common snook | No |
| Sunfish | *Lepomis auritus* | Redbreast sunfish | No |
| Sunfish | *Chaenobryttus gulosus* | Warmouth | No |
| Sunfish | *Lepomis macrochirus* | Bluegill | No |
| Sunfish | *Lepomis microlophus* | Readear sunfish | No |
| Sunfish | *Micropterus coosae* | Redeye bass | No |
| Swordfish | *Xiphias gladius* | Swordfish | No |
| Tarpon | *Megalops atlanticus* | Tarpon | No |
| Threadfins | *Polydactylus virginicus* | Barbu | No |
| Tilapia | *Tilapia aurea* | Blue tilapia | No |
| Tilapia | *Tilapia nilotica* | Nile tilapia | No |
| Tilapia | *Tilapia rendalli* | Congo perch | No |
| Tilapia | *Tilapia hornorum* | Redeye tilapia | No |
| Triggerfish | *Balistes capriscus* | Gray triggerfish | No |

| Group | Scientific name | Common name | Previously Managed |
|---|---|---|---|
| Tripletail | *Lobotes surinamensis* | Tripletail | No |
| Trumpetfish | *Aulostomus maculatus* | Trumpetfish | No |
| Tunas and Mackerels | *Katsuwonus pelamis* | Skipjack tuna | No |
| Tunas and Mackerels | *Euthynnus alletteratus* | Little tunny | No |
| Tunas and Mackerels | *Thunnus alalunga* | Albacore tuna | No |
| Tunas and Mackerels | *Thunnus albacares* | Yellowfin tuna | No |
| Tunas and Mackerels | *Thunnus atlanticus* | Blackfin tuna | No |
| Tunas and Mackerels | *Thunnus obesus* | Bigeye tuna | No |
| Tunas and Mackerels | *Scomberomorus cavalla* | King maackerel | No |
| Tunas and Mackerels | *Scomberomorus regalis* | Cero mackerel | No |
| Tunas and Mackerels | *Acanthocybium solandri* | Wahoo | No |
| Tunas and Mackerels | *Auxis rochei* | Bullet mackerel | No |

# Appendix E. Alternatives Considered but Rejected

The Caribbean Fishery Management Council (Council) often considers a number of alternatives for a particular purpose and need. Some of these alternatives could be considered reasonable while others are unlikely to accomplish the stated purpose and need. The Council on Environmental Quality guidelines state that if alternatives are eliminated from further analysis, then the supporting document, *i.e.* this draft environmental impact statement, should briefly discuss the reasons for their elimination (40 CFR 1502.14(a)).

The Council did not reject a complete alternative, but it rejected a component of two alternatives considered under Action 2 (Stocks Managed under the St. Croix Fishery Management Plan [FMP]). As mentioned in the Action 2 discussion, Criterion E was originally considered under **Preferred Alternative 2** and **Alternative 3** as the final criterion for selecting stocks for inclusion in the St. Croix FMP. This criterion would exclude from management species with a level of landings considered to be *de minimis*[76]. No stocks were excluded from management under this criterion during the stock selection process or during subsequent meetings.

Rejected:
Criterion E in Action 2, **Preferred Alternative 2** and **Alternative 3**, would remove from management any stocks for which the total of average reported landings (recreational and commercial) during a pre-defined reporting period were less than X[77] pounds, indicating the fishery is "*de minimis*[1]", unless conservation and management is otherwise required because of the factors identified in Criterion A. Stocks identified for removal under Criterion E would instead be classified as Ecosystem Component species.

Rationale:
At the 163rd Council meeting in August 2018, NMFS staff recommended to the Council that they consider but reject Criterion E described above. The Council's Scientific and Statistical Committee and National Marine Fisheries Service were not ready at that time to define that X level of landings, especially for stocks new to management. Defining that *de minimus* landings level, and ensuring the level was not indicative of a stock or stock complex in need of conservation and management, would require substantial analysis of landings and socioeconomic data. The Council will therefore not address *de minimus* landings until the new FMPs are in place and allowed to perform for a period of time adequate to determine that level of landings.

[76]As defined in the Merriam-Webster online dictionary, *de minimis* refers to a quantity lacking significance or importance, or so minor as to merit disregard.
[77] Threshold of landings yet to be determined below which the fishery for stock or stock complex was considered to be *de minimis.*

# Appendix F. National Standard 1 Guidelines

National Standard (NS) 1 requires that conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the OY from each fishery for the U.S. fishing industry.

In addition, NS1 provides guidance on:

A. Specifying MSY and OY;

B. Specifying status determination criteria so that overfishing and overfished determinations can be made for stocks and stock complexes that are part of a fishery;

C. Preventing overfishing and achieving OY, incorporating scientific and management uncertainty in control rules, and conducting adaptive management using annual catch limits (ACL) and measures to ensure accountability (AM); and

D. Rebuilding stocks and stock complexes.

NS1 Guidelines

In 2016, the NS1 guidelines were revised to enhance their utility for managers and the public and provide flexibility in meeting current Magnuson-Stevens Act mandates. The revisions do not establish new requirements or require Councils to revise their current FMPs.

Issues addressed in the revisions include:

- Providing stability to fisheries;
- Adding flexibility to rebuilding plans;
- Updating OY and maximum sustainable yield concepts;
- Improving guidance on managing data-limited stocks;
- Consolidating guidance on identifying stocks to be included in federal FMPs;
- Provisions to further advance ecosystem-based fisheries management.

The 2016 NS1 Guidelines include new or modified provisions, as described below.

1) Determining which stocks require conservation and management – Under the Magnuson-Stevens Act, federal management is required when a fishery is in need of conservation and management. The new NS guidelines clarify and streamline guidance on determining whether a stock requires conservation and management.

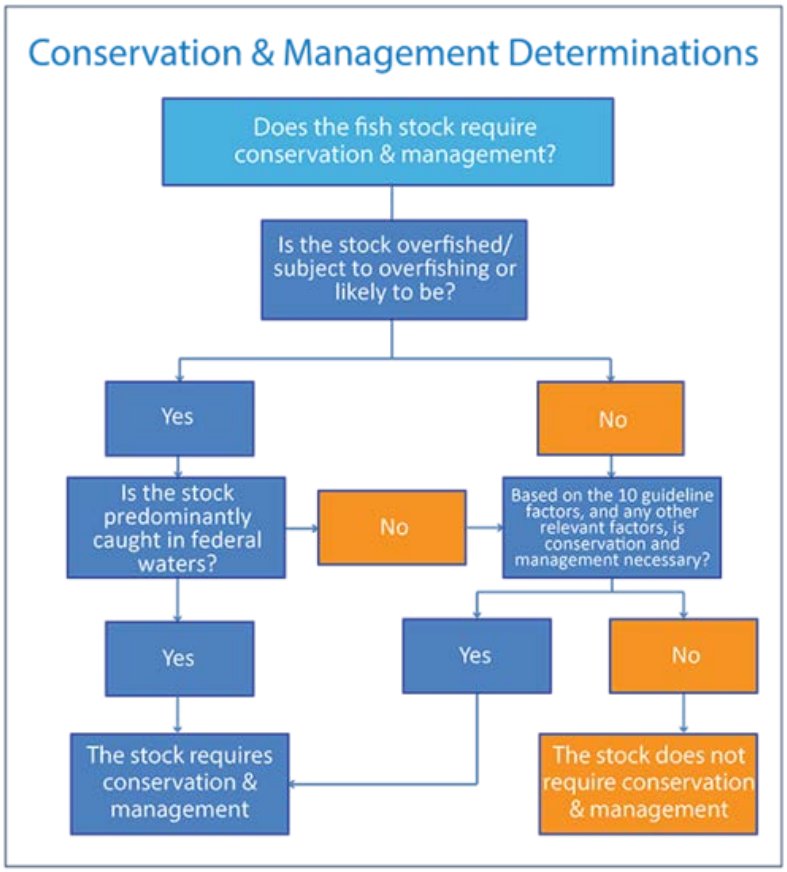


**Figure ~~6.2.1~~.** Guidance for determining whether a stock requires conservation and management. (Source: https://www.fisheries.noaa.gov/national/laws-and-policies/2016-revisions-national-standard-1-guidelines)

2) Multi-year approaches to overfishing stock status determinations – Includes guidance on a method for determining the overfishing status of a stock based on a multi-year approach. The Magnuson-Stevens Act defines overfishing as a "rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce MSY on a continuing basis." (16 U.S.C. 1802(34)). Thresholds for deciding whether a stock is subject to overfishing can be determined either by comparing rates of fishing mortality (F) to the MFMT or catch to the OFL (§600.310(e)(2)(i)(B)-(D)).

3) Phasing-in changes to catch levels – Allow changes to catch limits to be gradually phased in over a period of time not to exceed three years, as long as overfishing is prevented. Before, changes in catch limits were made over the course of one year.

4) Carrying-over unused quota into the next year – If a fishery does not catch all of its ACL during one fishing season, the NS1 guidelines allow a Council to carry-over a portion of the catch underage into the next year. Carrying-over unused catch is designed to relieve pressure on fishermen to catch their entire catch limit, which can result in fishing in unsafe situations or harvesting fish during poor market conditions.

Pursuant to Magnuson-Stevens Act section 304(e)(1), NMFS must report annually to Congress and the eight Councils on the status of all Federally-managed fish stocks (16 U.S.C. 1854(e)(1)). Overfishing status determinations are typically made based on the most recent year for which there is information. When utilizing the F-based approach, the estimate of F for the most recent year for which there are data is often more uncertain than the estimates of F in prior years (NRC 1998). In addition, the extent to which the effort or catch exceeded the threshold for overfishing has not traditionally been considered when determining whether the stock was subject to overfishing. Small amounts of excess effort or catch in a single year may not jeopardize a stocks' ability to produce MSY over the long term, thus an overfishing stock status determination based on that single year's reference point may not be the most appropriate characterization of stock status. To address this issue, the proposed revisions introduced a multi-year approach (that may not exceed 3 years) to allow a Council to examine whether the extent to which a stock has surpassed its overfishing threshold actually jeopardizes the stock's ability to produce MSY on a continuing basis (See §600.310(e)(2)(ii)(A)(3)). A multi-year approach to determine overfishing stock status is best used when managers believe the most recent year of data may not reflect the overall status of the stock[78].

5) An Acceptable Biological Catch (ABC) Control Rule (CR) accounts for scientific uncertainty in the OFL and for the Council's risk policy when establishing an ABC. The revised guidelines allow, but do not require, Councils to develop an ABC CR that would phase-in changes to the ABC over a period of time not to exceed 3 years, so long as overfishing is prevented. See Sections 6.3 and 6.4 for more information about the ABC CR for Caribbean stocks.

6) Adequate progress determinations for rebuilding plans.

7) Adding flexibility in rebuilding plans.

## Maximum Sustainable Yield (MSY)

The Magnuson Stevens Act requires that each FMP include an estimate of MSY for the stocks and stock complexes that require conservation and management. MSY may also be specified for the fishery as a whole.

The Magnuson-Stevens Act establishes the MSY as the basis for fishery management and requires that the fishing mortality rate does not jeopardize the capacity of a stock or stock complex to produce MSY, that the abundance of an overfished stock or stock complex be rebuilt to a level that is capable of producing MSY, and that OY (see below) not exceed MSY. The

[78] Source https://www.federalregister.gov/documents/2016/10/18/2016-24500/magnuson-stevens-act-provisions-national-standard-guidelines.

fishing mortality rate at MSY ($F_{MSY}$) is that rate of fishing mortality that, if applied over the long term, would result in MSY. The stock size at MSY ($B_{MSY}$) is the long-term average size of the stock or stock complex, measured in terms of spawning biomass or other appropriate measure of the stock's reproductive potential that would be achieved by fishing at $F_{MSY}$ (600.310(e)(1)(i)(A-C)).

The MSY is the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological and environmental conditions, fishery technological characteristics (e.g., gear selectivity), and the distribution of catch among fleets.

The MSY for stocks should be estimated for each stock based on the best scientific information available. When stock complexes are used, MSY should be estimated for one or more indicator stocks or for the complex as a whole. Estimating MSY for an aggregate group of stocks (including stock complexes and the fishery as a whole) can be done using models that account for multi-species interactions, composite properties for a group of similar species, biomass (energy) flow and production patterns, or other relevant factors.

Because MSY is a long-term average, it need not be estimated annually, but it must be based on the best scientific information available, and should be re-estimated as required by changes in long-term environmental or ecological conditions, fishery technological characteristics, or new scientific information. When data are insufficient to estimate MSY directly, Councils should adopt other measures of reproductive potential that can serve as reasonable proxies for MSY, $F_{MSY}$, and $B_{MSY}$. The MSY for a stock or stock complex is influenced by its interactions with other stocks in its ecosystem and these interactions may shift as multiple stocks in an ecosystem are fished. Ecological and environmental information should be taken into account, to the extent practicable, when assessing stocks and specifying MSY. Ecological and environmental information that is not directly accounted for in the specification of MSY can be among the ecological factors considered when setting OY below MSY.

As MSY values are estimates or are based on proxies, they would have some level of uncertainty associated with them. The degree of uncertainty in the estimates should be identified, when practicable, through the stock assessment process and peer review (see § 600.335), and should be taken into account when specifying the ABC CR.

**Scientific Uncertainty** refers to uncertainty in the information about a stock and its maximum sustainable yield reference points. Sources of scientific uncertainty could include uncertainty in stock assessment results, uncertainty in the estimates of MFMT, MSST, the biomass of the stock, and OFL, time lags in updating assessments, the degree of retrospective revision of assessment results, uncertainty in projections, uncertainties due to the choice of assessment model, longer-term uncertainties due to potential ecosystem and environmental effects, or other factors.

**Management Uncertainty** refers to uncertainty in the ability of managers to constrain catch so that the ACL is not exceeded, and the uncertainty in quantifying the true catch amounts (i.e., estimation errors). The sources of management uncertainty could include late catch reporting, misreporting or underreporting of catches, lack of sufficient in-season management, including in-season closure authority, or other factors.

The degree of uncertainty in the estimates should be identified, when possible, through the stock assessment process and peer review, and should be taken into account when specifying the ABC CR (see Sections 6.3 and 6.4 for the ABC CR). When this uncertainty cannot be directly calculated, such as when proxies are used, then a proxy for the uncertainty itself should be established based on the best scientific information, including comparison to other stocks.

## Status Determination Criteria (SDC)

Section 303(a) of the Magnuson-Stevens-Act requires that an FMP specify objective and measurable criteria, or reference points, for determining when a stock is subject to overfishing or is overfished. In the case of a fishery which the Council or the Secretary of Commerce has determined is approaching an overfished condition or is overfished, the FMP must contain conservation and management measures to prevent overfishing or end overfishing and rebuild the fishery. Another required provision is to establish a mechanism for specifying ACLs in the plan (including a multi-year plan), and implementing regulations or annual specifications (including measures to ensure accountability) at a level such that overfishing does not occur in the fishery.

Status determination criteria are the measurable and objective factors, MFMT, OFL, and MSST (see below), or their proxies, that are used to determine if overfishing has occurred, or if the stock or stock complex is overfished. The Magnuson-Stevens Act Section 3(34) defines both “overfishing” and “overfished” to mean a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the MSY on a continuing basis. This section clarifies that “overfished” relates to biomass of a stock or stock complex, and “overfishing” pertains to a rate or level of removal of fish from a stock or stock complex. Generally, NMFS uses outcomes from a formal stock assessment, a scientific analysis of the abundance and composition of a fish stock which evaluates the stock against its reference points. Stock assessments use the best information available, which may include data from fishery landings, scientific surveys, and biological and ecological studies. A stock assessment typically undergoes peer review by independent scientists before it is accepted as the best scientific information available. The resultant reference points are used to determine whether the stock is subject to overfishing or is overfished. Outcomes from the stock assessment are reviewed by the Council’s Scientific and Statistical Committee (SSC). If the SSC accepts those outcomes, it then uses them to establish the level of ABC for the stock/stock complex.

*Overfished Status*
A stock or stock complex is considered overfished when its biomass has declined below the MSST. That is, the biomass is below that at which the capacity of the stock or stock complex to produce MSY on a continuing basis has been jeopardized.

*Overfishing Status*
The Magnuson-Stevens Act defines overfishing as a ‘‘rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the MSY on a continuing basis.’’ (16 U.S.C. 1802(34)). Overfishing occurs whenever a stock or stock complex is subjected to a level of fishing mortality or total catch that jeopardizes the capacity of a stock or stock complex to produce MSY on a continuous basis.

Thresholds for deciding whether a stock is subject to overfishing can be determined either by comparing rates of F to the MFMT or catch to the OFL.

*Maximum fishing mortality threshold* is the level of F, on an annual basis, above which overfishing is occurring. The MFMT or reasonable proxy may be expressed either as a single number (a fishing mortality rate or F value), or as a function of spawning biomass or other measure of reproductive potential.

*Overfishing limit* is the annual amount of catch that corresponds to the estimate of MFMT applied to a stock or stock complex's abundance and is expressed in terms of numbers or weight of fish.

## Sustainable Yield Level (SYL)

The SYL is the maximum level of landings that can be sustained over the long term given the abundance of the stock at the time the limit was put in place. It is intended to be used when the information or resources needed to produce a quantitative stock assessment are not available to determine the MSY or corresponding reference point such as the OFL. As such, the SYL may be determined on the basis of historic landings patterns, Productivity Susceptibility Analyses, or other available information including expert opinion.

The SYL is an equilibrium (long-term) concept. This is in contrast to OFL, which is a non-equilibrium (short-term) quantity defined as the annual amount of catch that corresponds to the estimate of the MFMT applied to a stock’s abundance. The value of OFL thus increases or decreases in accordance with the abundance of the stock, and MSY is the long-term average of such catches. OFLs are set accounting for this variation and are intended to represent the annual metric that corresponds to MSY. The SYL is considered to be a proxy for OFL and a minimum estimate of MSY (where MSY $\geq$ SYL). The SYL is not intended as a metric for reporting stock status in terms of overfishing or overfished. SYL will be used to understand the sustainability of

the fishery. While landings in excees of SYL will not establish that overfishing is occurring, they indicate that catch could be above a sustainable level and will be investigated to determine whether overfishing is occurring, and whether, as a result of such SYL exceedances, the stock or stock complex is overfished.

MSY $\geq$ SYL $\geq$ ABC $\geq$ ACL = OY

## Acceptable Biological Catch (ABC)

The ABC is a product of the ABC CR, as developed and applied by the Council's SSC. The ABC CR is presented in Section 6.3. The analytical process used to develop ABCs for each stock or stock complex (and, as appropriate, indicator stock for a stock complex) is fully described in Section 6.4. Note that "catch" is defined as the total quantity of fish, measured in weight or numbers of fish, taken in commercial, recreational, subsistence, tribal, and other fisheries. Catch includes fish that are retained for any purpose as well as fish that suffer mortality when discarded (i.e., returned to the water rather than being retained).

## Annual Catch Limit (ACL)

An ACL is the total amount of a stock or stock complex that can be taken by fishermen per calendar year. Annual catch limits can be measured in pounds or numbers of individuals. An ACL can apply to a single stock (for example queen conch) or to a stock complex. The ACL is the level of annual catch of a stock or stock complex that serves as the basis for invoking AM.

Any FMP prepared by a Council shall establish a mechanism for specifying ACLs in the FMP (including a multi-year plan), and implementing regulations or annual specifications at a level such that overfishing does not occur in the fishery, including measures to ensure accountability. MSA 303(a)(15)). In general, when specifying limits and AMs intended to avoid overfishing and achieve sustainable fisheries, Councils must take an approach that considers uncertainty in both the scientific information and the management control of the fishery. The process for setting ACLs for stocks and stock complexes (including indicator stocks) is presented in Section 6.3 and fully described in Section 6.4.

Flexibility in the application of,the NS1 guidelines are provided (50 CFR 600.310(h)(2)). For example, for stocks for which data are not available either to set reference points based on MSY or an MSY proxy, or to manage to those MSY- (or proxy) based reference points, the Council may propose alternative methods for satisfying Magnuson-Stevens Act requirements and must document their rationale for the alternative approach. In all cases, the FMP must contain statutorily required elements.

*Relationship to the ABC*
An ACL cannot exceed the ABC. An ACL may be divided into sector-ACLs. Annual catch limits in coordination with AMs (see Section 6.2.8 below) must prevent overfishing. If a Council recommends an ACL which equals ABC, and the ABC is equal to OFL, the Secretary may presume that the proposal would not prevent overfishing, in the absence of sufficient analysis and justification for the approach (50 CFR 600.310(f)(4)(i)).

### ~~6.2.6~~ Optimum Yield (OY)

The Magnuson-Stevens Act defines "optimum", with respect to the yield from a fishery, as the amount of fish that would provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities and taking into account the protection of marine ecosystems; that is prescribed on the basis of the MSY from the fishery. The OY is also reduced by any relevant economic, social, or ecological factors. In addition, in the case of an overfished fishery, OY must provide for rebuilding to a level consistent with producing the MSY in such fishery (MSA 3(33)). The OY may be established at the stock or stock complex level, or at the fishery level. The OY is a long-term average amount of desired yield from a stock, stock complex, or fishery. An FMP must contain conservation and management measures, including ACLs and AMs, to achieve OY on a continuing basis, and provisions for information collection that are designed to determine the degree to which OY is achieved (50 CFR 600.310(f)(3)).

Exceeding OY does not necessarily constitute overfishing. However, even if no overfishing resulted from exceeding OY, continual harvest at a level above OY would violate NS1, because OY was not achieved on a continuing basis. A Council must identify those economic, social, and ecological factors relevant to management of a particular stock, stock complex, or fishery, and then evaluate them to determine the OY. The choice of a particular OY must be carefully documented to show that the OY selected would produce the greatest benefit to the Nation and prevent overfishing.

In determining the greatest benefit to the Nation, the values that should be weighed and receive serious attention when considering the economic, social, or ecological factors used in reducing from MSY to obtain OY are:

- The benefits of food production derived from providing seafood to consumers, maintaining an economically viable fishery together with its attendant contributions to the national, regional, and local economies, and utilizing the capacity of the Nation's fishery resources to meet nutritional needs;
- The benefits of recreational opportunities reflect the quality of both the recreational fishing experience and non-consumptive fishery uses such as ecotourism, fish

watching, and recreational diving. Benefits also include the contribution of recreational fishing to the national, regional, and local economies and food supplies;

- The benefits of protection afforded to marine ecosystems are those resulting from maintaining viable populations (including those of unexploited species), maintaining adequate forage for all components of the ecosystem, maintaining evolutionary and ecological processes (e.g., disturbance regimes, hydrological processes, nutrient cycles), maintaining the evolutionary potential of species and ecosystems, and accommodating human use.

50 CFR 600.310(f)(3)(iii)(A)

When establishing the OY, if the estimates of MFMT and current biomass are known with a high level of certainty, and management controls can accurately limit catch, then OY could be set very close to MSY assuming no other reductions are necessary for social, economic, or ecological factors. To the degree that such MSY estimates and management controls are lacking or unavailable, OY should be set farther from MSY (50 CFR 600.310(f)(3)(iv)). If management measures cannot adequately control fishing mortality so that the specified OY can be achieved without overfishing, the Council should reevaluate the management measures and specification of OY so that the dual requirements of NS1 (preventing overfishing while achieving OY on a continuing basis) are met (50 CFR 600.310(f)(3)(ii)). The OY for stocks in the Puerto Rico FMP is presented in Section 6.3 and fully described in Section 6.4.

## Annual Catch Target (ACT)

The ACT is the amount of annual catch of a stock that is the management target of the fishery, and accounts for further management uncertainty in controlling the actual catch at or below the ACL. An ACT set less than the ACL provides a buffer so the risk of exceeding the ACL is reduced and, therefore, the likelihood of triggering an AM is reduced. An ACT lowers the allowed catch below the ACL, but provides stability for fisheries that are apt to fluctuate around a target catch rate (50 CFR 600.310(g)(4)).

## Accountability Measures (AMs)

Accountability measures are management controls to prevent ACLs from being exceeded, and to correct overages of the ACL if they occur. Accountability measures should address and minimize both the frequency and magnitude of overages, and correct the problems that caused the overage in as short a time as possible. NMFS identifies two categories of AMs, in-season AMs designed to prevent an ACL overage, and post-season AMs to correct overages, that is, designed to ensure that the ACL would not again be exceeded (50 CFR 600.310(g)(1)). The

Magnuson-Stevens Act NS1 also indicates that the FMP should identify what sources of data would be used to implement AMs (e.g., in-season data, annual catch compared to the ACL, or multi-year averaging approach) (50 CFR 600.310(g)(1)).

In-Season AMs

In-season AMs take place during the fishing season. If an ACL exceedance is identified within the fishing season, an AM (or multiple AMs) must be triggered and implemented as soon as possible to correct the operational issue that caused the ACL overage, as well as any known biological consequences to the stock or stock complex resulting from the overage. Available AMs include, but are not limited to, implementing an ACT and using it as the AM, closure of the fishery, closure of specific areas, changes in gear, changes in trip size or bag limits, reductions in effort, or other appropriate management controls for the fishery (50 CFR 600.310(g)(2)). For stocks and stock complexes in rebuilding plans, when the AM is based on an ACL exceedance, the AMs should include overage adjustments that reduce the ACL in the next fishing year by the full amount of the overage, unless the best scientific information available shows that a reduced overage adjustment, or no adjustment, is adequate to mitigate the effects of the overages (50 CFR 600.310(g)(3)).

If final data or data components of catch are delayed, the Council should make appropriate use of preliminary data, such as landed catch, in implementing in-season AMs(50 CFR 600.310(g)(2)). Fishery management plans should contain in-season closure authority giving NMFS the ability to close fisheries if it determines, based on data that it deems sufficiently reliable, that an ACL has been exceeded or is projected to be reached, and that closure of the fishery is necessary to prevent overfishing (50 CFR § 600.310(g)(2))

Post-season AMs

NMFS's guidance on National Standard 1 indicates that, on an annual basis, the Council must determine as soon as possible after the fishing year if an ACL was exceeded. If an ACL was exceeded, an AM (or multiple AMs) must be implemented as soon as possible to correct the operational issue that caused the ACL overage, as well as any biological consequences to the stock or stock complex resulting from the overage when it is known (50 CFR 600.310(g)(3)). As with application of an in-season AM, the AM(s) could include, among other things, the use or modification of ACTs, temporary closure of the fishery, closure of specific areas, changes in gear, changes in trip size or bag limits, reductions in effort, or other appropriate management controls for the fishery. The type of AM chosen by the Council would likely vary depending on the sector of the fishery, status of the stock, the degree of the overage, recruitment patterns of the stock, or other pertinent information. If an ACL is set equal to zero and the AM for the fishery is a closure that prohibits fishing for a stock, additional AMs are not required if only small amounts of catch (including bycatch) occur, and the catch is unlikely to result in overfishing. For stocks

and stock complexes in rebuilding plans, the AM should include overage adjustments that reduce the ACL in the next fishing year by the full amount of the overage, unless the best scientific information available shows that a reduced overage adjustment, or no adjustment, is needed to mitigate the effects of the overage (50 CFR 600.310(g)(3)).

Using Average Landings to Identify ACL Exceedance

Some fisheries have highly variable annual catches and lack reliable in-season or annual data on which to base an identification of an ACL overage. The NS1 guidelines indicates that if there are insufficient or inadequate data upon which to compare a single year of catch to the ACL, either in-season or on an annual basis, identifying an ACL exceedance could be based on comparison of average catch during a multi-year period (not to exceed three years) to the ACL. The Council should explain why using a multi-year average is appropriate. Comparison of average catch to the ACL must be conducted annually and AMs should be implemented if the average catch exceeds the ACL (50 CFR 600.310(g)(5)).

Performance Standard

The NS1 guidelines indicate that if catch exceeds the ACL for a given stock or stock complex more than once in four consecutive years, the system of ACLs and AMs should be reevaluated, and modified if necessary, to improve its performance and effectiveness. If AMs are based on multi-year average data, the performance standard is based on a comparison of the average catch to the average ACL. A Council could choose a higher performance standard (e.g., a stock's catch should not exceed its ACL more often than once every five or six years) for a stock that is particularly vulnerable to the effects of overfishing, if the vulnerability of the stock has not already been accounted for in the ABC CR ((50 CFR 600.310(g)(7)).

# Appendix G. Process used in the 2010 and 2011 Caribbean Annual Catch Limit (ACL) Amendments to establish management reference points and status determination criteria for stocks managed by the Caribbean Fishery Management Council (Council)

The Council and its Scientific and Statistical Committee (SSC) employed a variety of approaches when establishing reference points for federally managed species within the 2010 and 2011 Caribbean ACL Amendments. The process was sequential, with those species classified in NMFS' 2010 report to Congress on the status of stocks as overfished or undergoing overfishing (snappers, groupers, parrotfish, queen conch) addressed first (i.e., in the 2010 Caribbean ACL Amendment). The initial step in the reference-point-setting process involved establishing the longest time series of landings data that was consistently reliable across all islands. For all stocks/stock complexes under management, whether commercially or recreationally managed, the Council and their SSC chose 2005 as the terminal index year because it was the last year before the provisions of the Caribbean Sustainable Fisheries Act Amendment (Caribbean SFA: CFMC 2005) were implemented, an event that substantially altered federal fisheries management in the U.S. Caribbean region and therefore represented a break-point in landings consistency. In contrast to the common end-year for the sequence, the start year differed depending on island (Puerto Rico, St. Thomas/St. John, St. Croix) and sector (commercial, recreational). In the USVI, reporting forms for commercial landings were modified in the late 1990s, with new form compliance being accomplished beginning in 1999 for St. Croix and 2000 for St. Thomas/St. John. Those were therefore chosen as the start years for the St. Croix and St. Thomas/St. John time sequences, respectively. To maintain consistency among the islands, the same 1999-2005 sequence was chosen for commercial landings in Puerto Rico. Because recreational landings data, based on NOAA's Marine Recreational Fisheries Statistics Survey (MRFSS), was initiated in Puerto Rico in 2000, the recreational year sequence was established as 2000-2005. In all cases, landings data used in the determinations of reference points represent combined landings from state and federal waters. For Puerto Rico, the landings data have been adjusted (i.e., expanded) to account for under-reporting, mis-reporting, and non-reporting.

To establish reference points for the Puerto Rico stocks and stock complexes, the maximum sustainable yield (MSY) proxy was equated to average landings during each assigned island/sector year sequence. The overfishing limit (OFL) was then set equal to the MSY proxy, with the caveat that, if the Southeast Fisheries Science Center (SEFSC) in consultation with the Council and its SSC determine the overage occurred because data collection/monitoring improved rather than because landings actually increased, overfishing would be deemed to be not

occurring. In most cases, the ACL was then derived from the OFL by applying a buffer that reduced from the OFL to account for uncertainty, ecological factors, and other concerns. This reduction buffer was 0.85 for snapper and grouper. Note, however, that the Council's SSC applied two exceptions to this procedure when setting reference points for parrotfish. First the SSC applied expert knowledge to set an ad hoc ABC of 80,000 pounds for parrotfish harvest from the Puerto Rico exclusive economic zone (EEZ). Second, the Council applied the uncertainty reduction buffer of 0.85 to the ABC to derive the ACL (i.e., ABC x 0.85 = ACL) as a means to balance the directed harvest of these species with their ecological importance as algal grazers within the coral reef ecosystem. For Nassau grouper, goliath grouper, midnight, blue, and rainbow parrotfish the ACL was set as zero, indicating that the harvest of these species should be prohibited to prevent overfishing. The prohibition on fishing for and possession of parrotfish species responds to the important role these larger parrotfish have on the ecological health of the coral reefs and the testimony at Council public meetings on the decrease in numbers of these species on U.S. Caribbean coral reefs. For Nassau and goliath grouper, fishing and possession of these species was already prohibited in all Puerto Rico commonwealth and USVI territorial waters and in the EEZ. In all cases, the optimum yield (OY) was then equated to the ACL.

The Council's SSC followed a similar procedure for setting reference points for queen conch, with the important exception that queen conch harvest from U.S. Caribbean EEZ waters is prohibited west of 64º34'W latitude. Thus, queen conch harvest from federal waters in the U.S. Caribbean is allowed only from the Lang Bank area east of St. Croix. The SSC therefore assigned an ad hoc ABC of zero pounds for queen conch harvest from Puerto Rico EEZ waters. The ACL and the OY were then set equal to the acceptable biological catch (ABC).

Those species not classified in NMFS' 2010 report to Congress on the status of stocks as overfished or undergoing overfishing (all other reef fish, spiny lobster, and aquarium trade species managed within either the Reef Fish or Coral FMP) were subsequently addressed in the 2011 Caribbean ACL Amendment. The process for setting reference points for managed species in Puerto Rico that were not classified as overfished or undergoing overfishing differed in several ways from the procedure applied in the 2010 Caribbean ACL Amendment. First, 1988 was chosen as the start year for commercial landings calculations. The SSC determined this was the first year for which a clearly defined method of calculating expansion factors to account for under-reporting, mis-reporting, and non-reporting became available. The selected end year for commercial landings calculations was 2009, representing the most recent year for which complete landings were available at the time of document preparation. That same end year was chosen for recreational sector landings calculations. As previously discussed, the start year for determining recreational sector reference points was 2000, corresponding to the initiation of the MRFSS recreational sampling program in Puerto Rico.

Using those sector-specific year sequences, separate procedures (described below) were applied to each of the reef fish stocks (except angelfish, surgeonfish, and tilefish), angelfish, surgeonfish, tilefish, spiny lobster, and consolidated aquarium trade species (*i.e.*, all aquarium trade species listed in each of the Reef Fish and Coral FMPs) to set the MSY proxy. For the major reef fish grouping, for spiny lobster, and for the consolidated aquarium trade species, the median of landings from the chosen year sequence was used as the MSY proxy. In contrast, for the angelfish, surgeonfish and tilefish, for which commercial landings data were sparse, the SSC chose to use the highest single year of recreational landings from the chosen year sequence, multiplied by 3, to set the MSY proxy.

For all but the aquarium trade species, which are managed at the Caribbean-wide level, the OFL was derived from the MSY proxy by applying a scalar using the Only Reliable Catch Stocks (ORCS) expert opinion procedure (Berkson et al. 2011). As was the case with the species addressed in the 2010 Caribbean ACL Amendment, overfishing was defined to occur when annual landings exceed the OFL, with the caveat that, if the SEFSC in consultation with the Council and its SSC determine the overage occurred because data collection/monitoring improved rather than because landings actually increased, overfishing would be deemed to be not occurring. For aquarium trade species, the same procedure was followed with the exception that the ORCS procedure was not applied. The ABC was then equated to the OFL for all managed stocks. Finally, for all but the angelfish, surgeonfish, and aquarium trade species, an uncertainty reduction of 0.90 was applied to derive the ACL from the ABC. In the case of angelfish and surgeonfish that uncertainty buffer was set at 0.75 as a means to balance the directed harvest of these species with their ecological importance as algal grazers within the coral reef ecosystem. The uncertainty buffer was also set at 0.75 for aquarium trade species because not much was known about the fisheries in the EEZ and most of the harvest took place in state waters. In all cases, OY was then equated to the ACL.

# Appendix H. Process and Rationale for the Acceptable Biological Catch (ABC) Control Rule in Action 4, Preferred Alternative 3

## H.1 Process and Rationale for Applying Tier 4 of the Acceptable Biological Catch (ABC) Control Rule

Tier 4 of the ABC CR defines an MSY proxy along with MFMT and MSST, with respect to assumptions about fishing mortality rate and biomass, but these measures cannot be quantified due to data limitations. Reflecting the data-limited nature of stocks assigned to Tier 4, the SSC chose to specify an SYL for these stocks. The SYL represents a level of catch or yield that the Council's SSC has confidence a stock can sustain through time based on historical trends in catch and the SSC's evaluation of the best scientific information available, including life history information and analysis of the susceptibility of the stock to fishing pressure. Thus, the SYL is similar to the MSY, in that both are measures of catch that can be sustainably taken over the long-term; however, SYL represents a sustainable level of catch or yield whereas the MSY is the *maximum* catch or yield that can be taken from a stock or stock complex on a continuing basis. Hence, the SYL is expected to be less than or equal to the actual MSY. Although the exact relationship between SYL and the MSY is unknown, the SYL reflects the best estimate of MSY at this time and will be considered an MSY proxy. For this reason, the SYL forms the basis for the SSC's ABC recommendation where ABC = buffer * SYL, where the buffer must be $\leq$ 0.9 based on the SSC's determination of scientific uncertainty. The SYL and ABC reference points specified by Tier 4 would inform the Council's specification of ACLs. The ABC and ACL would be set below the SYL, based on consideration of scientific and management uncertainty. Setting the ABC and ACL below the SYL would hold the management system accountable to ensure the fishery's ability to sustain catches and associated economic and ecological benefits, on a long-term basis, and to prevent or rectify incidents of overfishing.

The Council believes the Tier 4 approach is consistent with the Act's intent to ensure fisheries are managed to prevent overfishing while achieving, on a continuing basis, the OY from each fishery (16 U.S.C. 1851(a)(1)). Fishery monitoring data demonstrate that Puerto Rico's fisheries have produced a sustainable yield since at least 1978 (commercial) and 2000 (recreational). The SYL and ABC specified by Tier 4 of the Council's ABC CR are designed to ensure their continued ability to do so. Because catch levels that exceed the SYL may not be sustainable, the Council and its SSC would evaluate the cause of any repeated SYL exceedances (e.g., increased effort, high recruitment, change in the size of the catch) to understand whether overfishing may be occurring and to identify any resulting impacts on stock biomass (e.g., overfished status), and to take appropriate action. Landings are not expected to exceed the SYL, though, since the ABC

and ACL are generally set at 50 percent of the SYL and AMs are in place to prevent the ACLs from being continuously exceeded. Thus, relying on the SYL as the MSY proxy and OFL proxy, and using it as a basis for the ABC and ACL, should promote the long-term sustainability of the stock.

To meet the data and analytical demands required to operate within Tiers 1, 2, and 3 of the ABC CR, NMFS is working with Puerto Rico's Department of Natural and Environmental Resources (PR-DNER) and others to achieve three important goals. Those three goals include: (1) developing a modeling toolbox suitable for application in data-limited situations; (2) evaluating and enhancing commercial fishery data acquisition methodologies and resultant data streams, and; (3) acquiring accurate and comprehensive recreational fishery data. Data and analytical improvements resulting from achievement of these three goals would serve to inform which of Tiers 1-3 can be applied. However, those data and analytical refinements are not yet complete. As a result, available data with which to assess stock status and assign numeric values for MSY and associated SDC are currently inadequate for any of the Tier 1, 2, or 3 reference point assignment processes. Thus, all of the federally managed stocks/stock complexes in the Puerto Rico FMP fall into Tier 4 of the Council's ABC CR, which applies to data-limited stocks where no accepted assessment is available and thus where specifying quantitative values for MSY and associated SDC, as opposed to MSY proxies and SDC based on those proxies, is not possible.

Data limitations for stocks managed by the Council in the Puerto Rico EEZ go beyond even those constraints typical of data-limited stocks throughout the nation (See Appendix E for Data Needs). The PR-DNER collects commercial landings data through their commercial catch report (CCR) program, and requires recreational fishermen to cooperate with port sampler requests for intercept-based interviews. When properly operating, those programs provide basic landings data for both fishing sectors. Although the recreational intercept program also allows for the collection of biological data (e.g., fish length), CCR forms do not provide an opportunity to contribute such information. Instead, obtaining biological information from commercial fishermen depends on dockside sampling (i.e., the Trip Intercept Program), which is generally inadequately effected due to budget and resultant personnel limitations. Those same personnel limitations constrain the capacity of PR-DNER to obtain information on non-reporting, under-reporting, and mis-reporting of commercial landings. To estimate the extent of reporting discrepancies, PR-DNER conducts dockside sampling of returning commercial fishermen at various landings sites around the island. They then compare data obtained from dockside samples with contemporaneous data from the CCRs, which allows an estimation of reporting discrepancies. That estimate is then applied to reported landings to derive "adjusted" landings. This approach is valid, but has practical limitations resulting from inadequate sample size. For example, although it is likely that different components of the commercial fishery (e.g., deep-water snapper, spiny lobster, pelagics) inherently differ in their reporting discrepancies, sample size limitation prevents estimation of these differences via species-level analyses. Instead, a

single, average estimate of the relationship between reported and actual catch is derived. That estimate may be higher or lower than actual, depending on the fishery component, thereby introducing an unquantified source of error into the landings estimate. Another complication results from the geography of Puerto Rico, which in addition to the main island also consists of multiple smaller islands. Both commercial and recreational fishing activities originate from those small islands, in particular Vieques and Culebra. Although out-island fishermen are similarly required to submit CCRs and to cooperate with interviewers, the latter is compromised by the logistical difficulties of sampling on those smaller islands, limiting estimation of commercial reporting discrepancies and largely preventing recreational catch sampling. As a result of these many constraints, although both commercial and recreational catch data are collected for all managed stocks landed from Puerto Rico state and federal waters, the error surrounding those estimates is not well-established, likely varies substantially among stocks, and similarly varies in direction relative to the mean estimate depending on fishery component.

The Southeast Data Assessment and Review (SEDAR) program supervises stock assessments throughout the NOAA NMFS Southeast Region. Under SEDAR program, Caribbean-specific assessments have been conducted for deep-water species (SEDAR 4), yellowtail snapper and spiny lobster (SEDAR 8), yellowfin grouper, mutton snapper, and queen conch (SEDAR 14), queen snapper, silk snapper, and redtail parrotfish (SEDAR 26), blue tang and queen triggerfish (SEDAR 30), and red hind (SEDAR 35). This list includes some of the most commonly targeted and economically valuable stocks in the region. Yet, none of these assessment efforts has produced quantitative management advice such as MSY, SDC, or OFL. Each report cited data deficiency as a fundamental problem, along with lack of basic life history data and poor understanding of the quantity and identity of fish discarded at sea. Most of those reports also cited a lack of information regarding the methods and data underlying development of expansion factors. In combination, these systemic data deficiencies render Puerto Rico specifically and the U.S. Caribbean region generally as not just data-limited but substantially data-deficient. Until these data deficiencies are addressed, a Tier 4 approach to management is unavoidable and quantitative MSY, SDC, and OFL would remain unknown.

## H2. Description of the Three-Step Process to Establish Status Determination Criteria (SDC) and Allowable Harvest Levels in Action 4, Preferred Alternative 3

**Preferred Alternative 3** would define a *three-step process* to establish SDC and allowable harvest levels (i.e., ACLs) for managed stocks caught in the Puerto Rico EEZ. In *Step 1*, the Council's ABC CR, composed of four tiers designed to respond to different levels of data availability, results in quantitative reference point estimates culminating in an ABC for each managed stock. *Step 2* establishes a proxy to use when $F_{MSY}$ cannot be determined.

*Step 3* then applies a reduction factor, which reflects the Council's estimate of management uncertainty and is specific to each stock or stock complex, to the resultant ABC to establish the ACL for that stock or stock complex.

*Preferred Alternative 3, Step 1*:

Tiers 1-3 of the ABC CR each require inputs from a quantitative assessment of stock status. Tier 1 is applicable in a data-rich environment that supports a full stage-structured stock assessment dependent on the availability of reliable time series of catch, stage composition, and index of abundance. Inputs to the ABC CR, from the stage-structured assessment, include MSST, MFMT, and the PDF of the OFL. Both OFL and ABC are derived by applying assessment outcomes within the ABC CR process, tempered by consideration of scientific uncertainty and a Council-defined risk of overfishing. Tier 1 outcomes are characterized by a minimal level of parameter uncertainty relative to the following tiers. Tier 2 is applicable in a data-moderate environment where two of the three time series described above are deemed informative. The approach and outcomes are the same as for the Tier 1 approach, but a higher level of parameter uncertainty is associated with those outcomes. Tier 3 is applicable in a data-limited environment that remains supportive of a quantitative assessment, but may also be applicable in the case of an out-of-date assessment. The data-limited assessment is expected to provide MFMT but it is likely MSST would be unknown. The OFL remains a quantitative output, but the ABC is more strongly constrained by application of conservative estimates of scientific uncertainty and risk of overfishing as determined by the Council. Tier 3 of the ABC CR results in a higher level of parameter uncertainty relative to Tiers 1 and 2. Note that for each of Tiers 1-3, MSY also may be quantified from the assessment, assuming the spawner-recruit relationship is well estimated, but is not a necessary requirement of the ABC CR process to produce OFL and ABC estimates.

Tier 4 is applicable in situations where an accepted quantitative assessment is not available, which is the present case for all stocks proposed for management in the Puerto Rico FMP. Defining reference points within this tier instead relies on landings data, ancillary information on the species in question such as life history traits and characteristics of the fishery, and expert opinion. Two sub-tiers are defined within Tier 4. Tier 4a is applicable when the Council's SSC determines the stock has a relatively low or moderate vulnerability to fishing pressure. A stock's vulnerability to fishing pressure reflects a combination of its biological productivity and its susceptibility to the fishery (Patrick et al. 2009); 50 CFR 600.310(b)(4). . Tier 4b is applied when the Council's SSC determines the stock has relatively high vulnerability to fishing pressure or when SSC consensus (= 2/3 or more members concur) cannot be reached on the use of Tier 4a. "Vulnerability to fishing pressure" is defined based on a combination of 10 productivity attributes (Table 6.4.1) and 12 susceptibility attributes (Table 6.4.2). Productivity provides an estimate of the capacity of the stock to recover if depleted, whereas, susceptibility relates to the potential of the stock to be impacted by the fishery. Note that not all attributes are used for each stock, dependent on availability of stock-specific data for each attribute. Based on published

research and expert knowledge, and using the attributes in Tables 6.4.1 and 6.4.2 as guidelines, the SSC at their July 2017 meeting assigned a productivity score and a susceptibility score to each stock selected for management in the Puerto Rico FMP.

The SSC's intent when using Tier 4a is to allow expansion of the fishery for those stocks with a relatively low vulnerability to fishing pressure, suggesting the stock may be able to sustain a higher rate of exploitation relative to average landings during the reference period. Similarly, for those stocks with a moderate vulnerability to fishing pressure, the intent of the SSC when applying Tier 4a is to hold ABC at or near average landings during the reference period. The SSC's intent when using Tier 4b is to address those situations when the stock has relatively high vulnerability to fishing pressure in order to ensure those stocks are more conservatively managed and thus minimize the likelihood of depleting the stock. For those Tier 4b stocks for which harvest is deemed by the SSC to be sustainable, the ABC would be held at or below average reference period landings. For those stocks for which even that level of harvest places the stock at risk of depletion, the ABC would be set still lower, including as appropriate a prohibition on all harvest.

**Table 6.4.1.** Attributes and scoring ranges for components of productivity.

| Productivity Attributes | High (3) | Moderate (2) | Low (1) |
|---|---|---|---|
| **r** | >0.5 | 0.5-0.16 (mid-pint 0.10) | <0.16 |
| **Maximum Age** | < 10 years | 10 - 30 years (mid-point 20) | > 30 years |
| **Maximum Size** | < 60 cm | 60-150 cm (mid-point 105) | > 150 cm |
| **von Bertalanffy Growth Coefficient (k)** | > 0.25 | 0.15-0.25 (mid-point 0.20) | < 0.15 |
| **Estimated Natural Mortality** | > 0.40 | 0.20-0.40 (mid-point 0.30) | < 0.20 |
| **Measured Fecundity** | > 10e4 | 10e2-10e3 | < 10e2 |
| **Breeding Strategy** | 0 | between 1 and 3 | ≥4 |
| **Recruitment Pattern** | highly frequent recruitment success (> 75% of year classes are successful) | moderately frequent recruitment success (between 10% and 75% of year classes are successful) | infrequent recruitment success (< 10% of year classes are successful) |
| **Age at Maturity** | < 2 years | 2-4 years (mid-point 3.0) | > 4 years |
| **Mean Trophic Level** | <2.5 | 2.5-3.5 (mid-point 3) | >3.5 |

**Table 6.4.2.** Attributes and scoring ranges for components of susceptibility.

| Susceptibility Attributes | Low (1) | Moderate (2) | High (3) |
|---|---|---|---|
| **Management Strategy** | Targeted stocks have catch limits and proactive accountability measures; Non-target stocks are closely monitored. | Targeted stocks have catch limits and reactive accountability measures | Targeted stocks do not have catch limits or accountability measures; Non-target stocks are not closely monitored. |
| **Areal Overlap** | < 25% of stock occurs in the area fished | Between 25% and 50% of the stock occurs in the area fished | > 50% of stock occurs in the area fished |
| **Geographic Concentration** | stock is distributed in > 50% of its total range | stock is distributed in 25% to 50% of its total range | stock is distributed in < 25% of its total range |
| **Vertical Overlap** | < 25% of stock occurs in the depths fished | Between 25% and 50% of the stock occurs in the depths fished | > 50% of stock occurs in the depths fished |
| **Fishing rate relative to M** | <0.5 | 0.5 - 1.0 | >1 |
| **Biomass of Spawners (SSB) or other proxies** | B is > 40% of B0 (or maximum observed from time series of biomass estimates) | B is between 25% and 40% of B0 (or maximum observed from time series of biomass estimates) | B is < 25% of B0 (or maximum observed from time series of biomass estimates) |
| **Seasonal Migrations** | Seasonal migrations decrease overlap with the fishery | Seasonal migrations do not substantially affect the overlap with the fishery | Seasonal migrations increase overlap with the fishery |
| **Schooling/Aggregation and Other Behavioral Responses** | Behavioral responses decrease the catchability of the gear | Behavioral responses do not substantially affect the catchability of the gear | Behavioral responses increase the catchability of the gear [i.e., hyperstability of CPUE with schooling behavior] |
| **Morphology Affecting Capture** | Species shows low selectivity to the fishing gear. | Species shows moderate selectivity to the fishing gear. | Species shows high selectivity to the fishing gear. |
| **Survival After Capture and Release** | Probability of survival > 67% | 33% < probability of survival < 67% | Probability of survival < 33% |
| **Desirability/Value of the Fishery** | stock is not highly valued or desired by the fishery | stock is moderately valued or desired by the fishery | stock is highly valued or desired by the fishery |
| **Fishery Impact to EFH or Habitat in General for Non-targets** | Adverse effects absent, minimal or temporary | Adverse effects more than minimal or temporary but are mitigated | Adverse effects more than minimal or temporary and are not mitigated |

To derive the ABC recommendation for Tier 4 stocks, the SSC first estimated the SYL. For Tier 4a stocks, the SYL is the product of the *75th percentile* of landings during the landings reference period and a scaling factor (*i.e.*, scalar) specific to each stock. For Tier 4b stocks, the SYL is the product of the *mean* landings during the landings reference period and a stock-specific scalar. For both Tier 4a and Tier 4b stocks, the scalar is the product of a variability adjustment factor (VAF) and the susceptibility of the stock to the fishery (Table 6.4.2). The methods used to establish the landings reference period and to quantify the scalar, for each stock, are described in turn below.

Reference Period Landings: Establishing the SYL requires defining a reference period of landings that, for each stock, reflects stability in the fishery. Because that period of relative stability differs among stocks, the year sequence chosen by the Council (in consultation with the SSC and the SEFSC) was specified separately for each stock. However, several features of the landings data were common to all stocks, resulting in common year-sequence decisions as follows:

1) Adjusted commercial landings were used for all stocks. Throughout Puerto Rico, dockside surveys are conducted by PR-DNER staff to quantify and characterize actual catch. The information on actual catch is then compared to information provided by the fishermen via their CCRs for the same interview location on the same date. That comparison provides an estimate of the amount of unreported, under-reported, and mis-reported data inherent in the CCRs. Adjusted commercial landings are then derived based on the ratio between reported landings and surveyed landings. A separate ratio (i.e., adjustment factor) is determined for each of the east, south, west, and north coasts of the island. However, within each of those four regions, a single adjustment factor is calculated for all stocks and applied to the reported annual landings for that region;

2) For all Puerto Rico commercial landings data, the year 2005 is characterized by an aberrant adjustment factor, which led to substantially higher adjusted landings for all species from all regions during that year. The SSC had concerns regarding the accuracy of the Puerto Rico commercial landings adjustment for 2005, and recommended the Council exclude 2005 landings when calculating the 75th percentile or average of landings for any year sequence that included 2005;

3) The SSC determined that zeroes in the adjusted commercial landings data were not informative of the fishery, because those zeroes provide no insight regarding the dynamics of the stock or the capacity of the stock to support the fishery. The SSC therefore recommended zeroes be removed from the applicable adjusted commercial landings data for all stocks prior to calculating the 75th percentile or mean landings for use in SYL determinations;

4) The Marine Recreational Fishery Statistics Survey (MRFSS)/MRIP program was instituted in Puerto Rico in 2000 and continued through 2016. Recreational data collected by this program are not subject to application of adjustment factors, so the SSC indicated there was no need to exclude 2005 data from the SYL determinations for the recreational sector;

5) Annual catch limits were implemented in Puerto Rico beginning with the 2012 fishing year. By definition, ACLs capped the allowable harvest for each of the commercial and recreational sectors for all stocks managed in Puerto Rico EEZ waters. Thus, 2012 represents a transition year for commercial and recreational fishing practices. The SSC therefore chose to not include landings from 2012 forward in the reference year sequence for previously managed commercial and recreational stocks. However, landings from 2012 forward through the most recent year of available landings (2016) were included in the reference year sequence for those stocks not previously managed, because those stocks were not directly influenced by the implementation of ACLs and associated AMs;

6) Although landings data were collected from Puerto Rico prior to 1988, the SSC had minimal confidence in the landings data collection process and the adjustment factors applied to the reported landings for all years prior to 1988. Therefore, only adjusted landings data from 1988 forward were considered when identifying a stock-specific period of stability.

Based on these caveats, the year sequences presented in Table 6.4.3 (commercial) and Table 6.4.4 (recreational) were chosen for use in the ABC CR Tiers 4a and 4b when calculating SYLs and ABCs for each stock proposed in Action 3, Preferred Alternative 3 for inclusion in the Puerto Rico FMP. For spiny lobster, queen conch, sea cucumbers, sea urchins, and all corals, no recreational year sequence was applicable because the MRFSS/MRIP program does not collect recreational landings data for invertebrate species.

**Table 6.4.3.** Year sequences selected for commercial stocks and stock complexes to be included in the Puerto Rico FMP.

| Commercial Year Sequence | Stocks/Stock Complexes |
|---|---|
| 1988 – 2011, excluding 2005 | Spiny Lobster; Queen Conch;<br>Snapper Units 1, 3, 4, 5, and 6;<br>Grouper Units 1, 2, 3, 4, and 6;<br>Parrotfish; Angelfish; Surgeonfish<br>Grunts;Wrasses; Triggerfish;<br>Corals, Sea Urchins, and Sea Cucumbers |
| 2000 – 2011, excluding 2005 | Snapper Unit 2 and Grouper Unit 5 |

| Commercial Year Sequence | Stocks/Stock Complexes |
|---|---|
| 1988 – 2016, excluding 2005 | Dolphinfish; Tripletail; Jacks;<br>Manta ray; Spotted eagle ray; Southern stingray |
| 1999 – 2016, excluding 2005 | Tunas and Mackerels |
| 2010 – 2016 | Wahoo |
| 1988 – 2004 | Barracuda |

**Table 6.4.4.** Year sequences selected for recreational stocks and stock complexes to be included in the Puerto Rico FMP.

| Recreational Year Sequence* | Stocks/Stock Complexes |
|---|---|
| 2000 – 2011 | Snappers; Groupers, Parrotfish; Angelfish; Surgeonfish; Grunts; Wrasses; and Triggerfish |
| 2000 – 2016 | Dolphinfish, Tunas, Mackerels, Wahoo, Barracuda, Jacks; Tripletail; Manta ray; Spotted eagle ray; Southern stingray |

75th Percentile: The 75th percentile of landings is simply that level of landings below which 75 percent of the landings during the reference period fall. For example, if there are 100 years in the annual landings reference period and they are ordered from smallest to largest, the 75th percentile of those landings would be that level of landings below which 75 of the ordered landings fall. Because the year sequences used by the SSC include no more than 27 individual years of landings data, there may be cases where the 75th percentile falls between two values. In that event, the value of the 75th percentile would be inferred from those two values using simple interpolation. As an example, consider five years of hypothetical landings data:

| Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|
| 5000 | 12000 | 8000 | 22000 | 14000 |

Ordering the data from smallest to largest = 5000, 8000, 12000, 14000, 22000.

The smallest number would be the zero percentile, because no numbers are smaller. Next would be the 25th percentile = 8,000, then the 50th percentile (i.e., median) = 12,000, the *75th percentile* = 14,000 and the 100th percentile = 22,000. The average (i.e., mean) landings during this hypothetical 5-year period would be 12,200, very similar to the median of 12,000.

With normally distributed data, it is expected that the mean (average of all included years) and the median (= 50th percentile) would be similar although rarely the same. Thus, with normally distributed data, the 75th percentile would be larger than the mean. However, in those cases where the data are not normally distributed, this relationship would not necessarily hold. In the case of non-normal data, the 75th percentile may be less than the mean, and in some cases may be

zero. For fisheries landings data, and particularly for landings of the less common or less targeted species such as angelfish, a 75th percentile less than the mean may occur because there are many years where no landings were reported.

Variability Adjustment Factor (VAF): The VAF is derived from the relationship between the maximum allowed susceptibility score (maximum = 3), which was assigned to each individual stock by the SSC, and the coefficient of variation (CV) determined from the landings data during the chosen year sequence.

As previously discussed, the susceptibility score reflects the stock's potential to be impacted by the fishery. Attributes of the susceptibility score are described in Table 2.4.3. The SSC assigned low (1), medium (2), and high (3) susceptibility scores to each stock, but they realized that in order to use the susceptibility score as a factor for calculating the VAF, it would be necessary to use the inverted susceptibility score (i.e., a score of three changes to a score of one). In this way, susceptibility scores ranged from three for stocks determined to be least susceptible to the fishery, to one for those stocks with a high susceptibility to the fishery. Generally, stocks with a high vulnerability (productivity * susceptibility) to fishing pressure were assigned to Tier 4b and had an inverted susceptibility score as low as one.

The CV = standard deviation (SD)/mean and serves to standardize variation relative to the magnitude of the mean. Without this standardization, i.e., if simply using the SD, the product of any multiplication involving the SD will become increasingly large as the numbers being measured increase, even though the variability relative to the mean is not changing. Standardization controls for that, ensuring the measure of variation does not change whether the numbers being collected are small or large. For example, if small fish and large fish are being measured, the small fish may average 10 inches in length and the SD around that average might be 2, whereas, the average size of the large fish may be 200 inches and the SD around that average might be 40. Multiplying by 40 rather than 2 will result in a much larger product, even though the relationship between the mean and the SD, when standardized, is the same. Thus, the CV for the small fish is 2/10 = 0.2 and the CV for the large fish is 40/200 = 0.2.

The VAF is then calculated using the equation VAF = (max score – CV)/max score. As noted above, the maximum susceptibility score for both Tier 4a and Tier 4b stocks is 3. Following through on the simple example above, the VAF for both of those fish species would be (3-0.2)/3 = 0.9333.

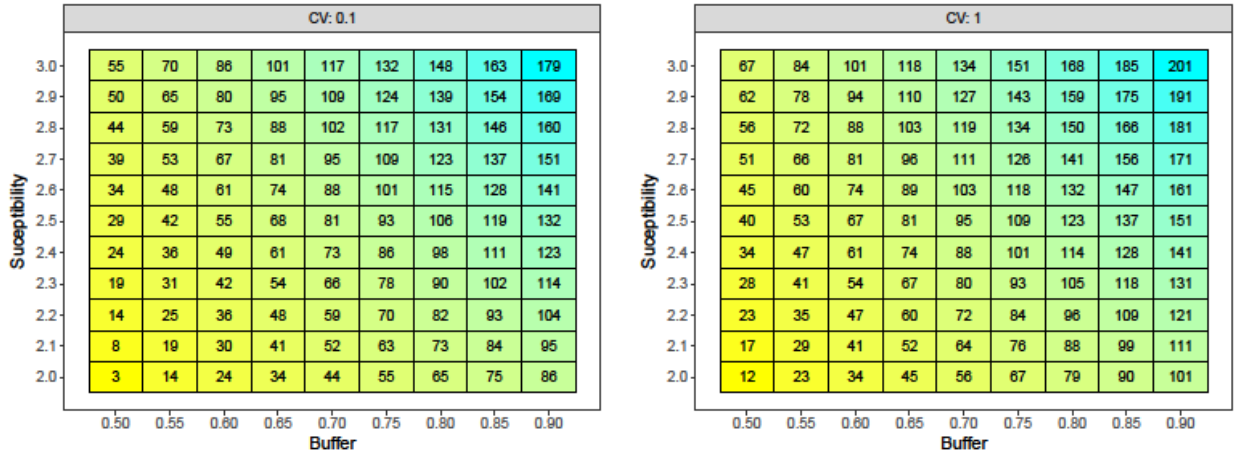


**Figure 6.4.1.** Percent change in the ABC relative to the mean landings used in the equation, when the CV = 0.1 (left) and when the CV = 1.0 (right).
The y-axis values represent the susceptibility score used in the scalar equation to calculate SYL and the x-axis values represent the buffer used in the equation to calculate ABC from SYL.

A characteristic of the VAF calculation is that, for normally distributed data, an increasing CV translates into a higher ABC relative to the mean reference period landings when the other factors employed in the calculations are held constant. Based on simulated outcomes (Figure 6.4.1), if the CV is 0.1 and a susceptibility score of 2.5 is applied along with a buffer of 0.5 (discussed below), the resultant ABC would be 29 percent higher than the mean landings for the reference period. In contrast, with the same scalar and susceptibility score but a CV of 1.0, the resultant ABC would be 40 percent higher than the mean landings for the reference period.

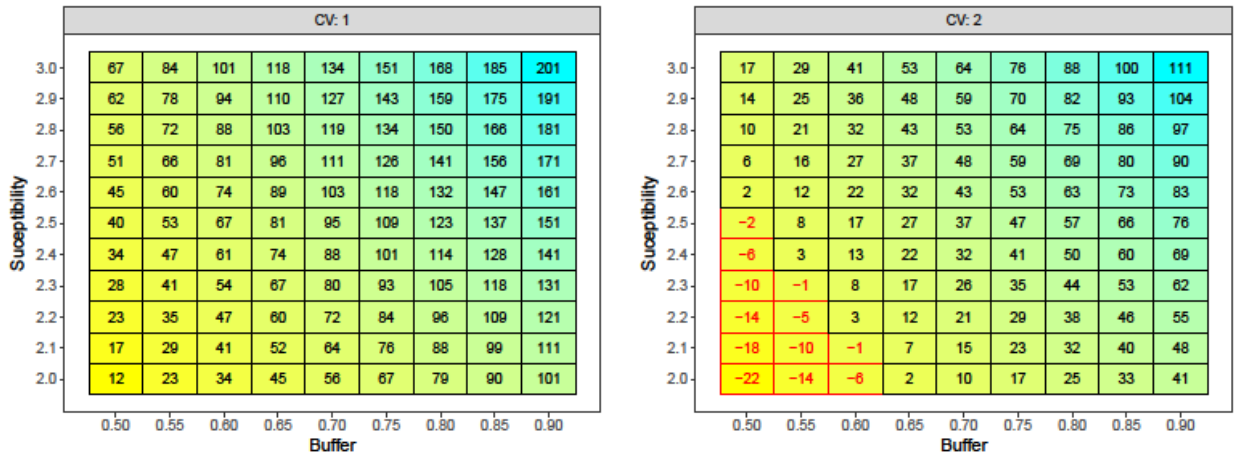


**Figure 6.4.2.** Percent change in the ABC relative to the mean landings used in the equation, when the CV = 1.0 (left) and when the CV = 2.0 (right).
The y-axis values represent the susceptibility score used in the scalar equation to calculate SYL and the x-axis values represent the buffer used in the equation to calculate ABC from SYL.

However, this relationship no longer holds when the CV > 1.0 (Figure 6.4.2). As in Figure 6.4.1, the percent increase of the ABC relative to the mean landings for the reference period remains at 40 percent when all else remains the same (Figure 6.4.2), but rather than continuing to increase when the CV = 2.0, the resultant ABC instead is 2 percent less than the mean landings for the reference period.

To correct for this decrease in the ABC relative to mean reference period landings when the CV exceeds 1.0, the SSC chose to put a cap on the CV at 1.0. If the actual CV derived from the relationship between the mean and the SD for the reference year sequence was > 1.0, the CV was set at 1.0 for purposes of the VAF calculation. This ensures that, as relative variability continues to increase above the 1.0 breakpoint, variability alone does not continue to push the resultant ABC steadily downward. The SSC carefully considered the concept of capping the CV at 1.0, including a review of the landings data for each stock (within each of the commercial and recreational sectors) with a CV > 1.0. The SSC determined that instances where the CV exceeded 1.0 reflected stocks with no or very low landings during most years, interspersed with one or a few years with relatively high landings. However, the SSC found no instances where the low landings would have been due to some high level of fishing that would have driven the population down to such a state where recruitment could have been compromised. The SSC determined capping the CV at 1.0 served their intent for Tier 4a stocks to allow expansion of the fishery for those stocks with a relatively low vulnerability to fishing pressure, and to hold ABC at or near average landings during the reference period for those stocks with a moderate vulnerability to fishing pressure. Similarly for Tier 4b stocks, capping the CV at 1.0 served to ensure stocks with a relatively high vulnerability to fishing pressure were more conservatively managed to minimize the likelihood of depleting the stock.

Scalar: The scalar was calculated as the product of the VAF and the (inverted) susceptibility score. Thus, the scalar is derived from the characteristics of the fishery for each stock as captured by the factors composing susceptibility (Table 6.4.3), combined with the inter-annual variability in harvest of the stock as captured by the CV. The VAF coefficient in the scalar equation serves to standardize the magnitude of the scalar relative to the extent of variation in the data. The susceptibility coefficient in the scalar equation serves to constrain the scalar (a multiplication factor in the SYL equation described below) as appropriate to reflect a stocks exposure to fishing activities. As a result, moderate susceptibility to fishing pressure leads to a harvest level that is similar or only marginally increased from average landings during the reference period, whereas a high susceptibility score (= low susceptibility to fishing pressure) results in an increase in allowable harvest relative to average landings during the reference period. This approach enabled the SSC to ground the scalar for a stock/stock complex within the

context of the vulnerability analysis while simultaneously accounting for inherent variability in the landings data.

In our simple example, for a stock with low susceptibility to the fishery (inverted susceptibility score = 3), the scalar = VAF x susceptibility score = 0.9333 x 3 = 2.7999. Conversely, for a stock with a high susceptibility to the fishery (inverted susceptibility score = 1), the scalar = VAF x susceptibility score = 0.9333 x 1 = 0.9333.

SYL: The SYL for Tier 4a stocks results from multiplying the 75$^{th}$ percentile by the scalar. For our simple example of a stock with low susceptibility to the fishery:

75$^{th}$ percentile = 14,000
Scalar = 2.7999
SYL = 14,000 x 2.7999 = 39,199

For a Tier 4b stock, the same process would be followed except the mean of landings during the reference period (rather than the 75$^{th}$ percentile) would be used in the calculation.

ABC: Following establishment of the SYL for each stock, a reduction factor (i.e., buffer) accounting for scientific uncertainty in the data is applied to the SYL to arrive at the ABC. Scientific uncertainty would take into account the deficiencies in and vagaries of reporting, which includes potential biases (over reporting, underreporting, trends), changes in reporting forms, changes in fisher behavior, the contribution of unspecified landings, expansion factors and validation capacity, availability of recreational landings data (quantity and quality), availability of ancillary data, and life history parameters (e.g., Table 6.4.2). The SSC was concerned that these issues created uncertainty in what the data showed and what information could be understood from the available data. Scientific uncertainty was determined based on expert input from the SSC members and user-group representatives. The latter provided input primarily through the Puerto Rico District Advisory Panel (DAP), with outcomes provided to the SSC by Puerto Rico's DAP Chair. Most Tier 4 stocks were assigned a scientific uncertainty factor of 0.5, although the factor was larger (i.e., the reduction less) for spiny lobster (0.6). However, the SSC assigned additional reductions to that 0.5 baseline buffer in cases where unspecified landings reported at the family or genus level constituted more than 10 percent of the available reference period landings. Landings that cannot be confidently assigned at the species level result in uncertainty in the landings data, and that additional contribution to scientific uncertainty must be addressed. Thus, if the percentage of the unspecified landings during the reference period was less than or equal to 10 percent, no additional reduction to account for this relatively minor contribution to scientific uncertainty was applied. If the percentage of unspecified landings during the reference period was > 10 but $\leq$ 35, an additional reduction of 0.05 (i.e., reduction buffer = 0.45) was applied. Finally, if the percentage of unspecified landings

during the reference period was > 35, an additional reduction of 0.10 was applied (i.e., reduction buffer = 0.40).

Continuing with our example, multiplying the SYL (39,199) by the most commonly assigned scientific uncertainty reduction buffer (0.50) gives:

$$ABC = 39{,}199 \times 0.50 = 19{,}600$$

Generally for Puerto Rico commercial and recreational landings data, the units associated with that number would be pounds whole weight.

*Preferred Alternative 3, Step 2*:

Step 2 addresses data limitations that prevent establishment of an MSY based on outcomes from a valid quantitative assessment. Instead, Step 2 provides three sub-alternatives for setting an $F_{MSY}$ proxy based on various fishing mortality rates. Sub-alternative 3a establishes a fishing mortality rate equivalent to $F_{max}$, whereas sub-alternatives 3b equates $F_{MS}$ to the fishing mortality rate at a 40% SPR and sub-alternative 3c sets that rate at a 30% SPR. Step 3 would specify the OY and ACL for each stock/complex.

*Preferred Alternative 3, Step 3*:

Step 3 provides six sub-alternatives for establishing the ACL as discussed in Section 2.4.2. The ACL would be reduced from ABC based on the Council's choice of buffer reduction to account for management uncertainty. The OY would be set equal to the ACL.

The description of each of the sub-alternatives in this Preferred Alternative 3 is found in Section 2.4.2. The Council chose **Preferred Sub-alternative 3e** for all managed stocks except angelfish, parrotfish and surgeonfish, which would specify an ACL equal to the ABC x 0.95. For angelfish, parrotfish, and surgeonfish, the Council chose **Preferred Sub-alternative 3g**, which would specify an ACL equal to the ABC x 0.85. Tables E.X and EY below shows the values that would result from each of the sub-alternatives proposed under **Preferred Alternative 3**.

**Table H.1.** Annual catch limits for each stock and stock complex for the commercial sector in the Puerto Rico FMP, based on **Preferred Alternative 3 Sub-alternatives 3d-3h.**
All ACLs under Sub-Alternative 3i would be equal to zero and were not included in the table. Additionally, stocks/complexes with an ABC set equal to zero by the SSC were not included in the table. Values in bold represent the ACL resulting from the preferred sub-alternative selected by the Council.

| Stock/Complex | Sub-Alt 3d ACL=ABC | Sub-Alt 3e ACL=ABC*0.95 | Sub-Alt 3f ACL=ABC*0.90 | Sub-Alt 3g ACL=ABC*0.85 | Sub-Alt 3h ACL=ABC*0.75 |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Spiny Lobster | 554,981 | **527,232** | 499,483 | 471,734 | 416,236 |
| Snapper Unit 1 | 446,325 | **424,009** | 401,693 | 379,376 | 334,744 |
| Snapper Unit 2 | 270,775 | **257,236** | 243,698 | 230,159 | 203,081 |
| Snapper Unit 3 | 257,238 | **244,376** | 231,514 | 218,652 | 192,929 |
| Snapper Unit 4 | 122,562 | **116,434** | 110,306 | 104,178 | 91,922 |
| Snapper Unit 5 | 332,427 | **315,806** | 299,184 | 282,563 | 249,320 |
| Snapper Unit 6 | 125 | **119** | 113 | 106 | 94 |
| Grouper Unit 3 | 25,147 | **23,890** | 22,632 | 21,375 | 18,860 |
| Grouper Unit 4 | 2,623 | **2,492** | 2,361 | 2,230 | 1,967 |
| Grouper Unit 5 | 16,134 | **15,327** | 14,521 | 13,714 | 12,101 |
| Grouper Unit 6 | 128,136 | **121,729** | 115,322 | 108,916 | 96,102 |
| Parrotfish Unit 2 | 173,852 | 165,159 | 156,467 | **147,774** | 130,389 |
| Surgeonfish | 173 | 164 | 156 | **147** | 130 |
| Triggerfish | 87,473 | **83,099** | 78,726 | 74,352 | 65,605 |
| Wrasses Unit 1 | 73,831 | **70,139** | 66,448 | 62,756 | 55,373 |
| Wrasses Unit 2 | 21,186 | **20,127** | 19,067 | 18,008 | 15,890 |
| Angelfish | 161 | 153 | 145 | **137** | 121 |
| Barracuda | 521 | **495** | 469 | 443 | 391 |
| Tripletail | 284 | **270** | 256 | 241 | 213 |
| Grunts | 187,287 | **177,923** | 168,558 | 159,194 | 140,465 |
| Jacks Unit 1 | 48 | **46** | 43 | 41 | 36 |
| Jacks Unit 2 | 1,108 | **1,053** | 997 | 942 | 831 |
| Jacks Unit 3 | 962 | **914** | 866 | 818 | 722 |
| Dolphinfish | 244,393 | **232,173** | 219,954 | 207,734 | 183,295 |
| Tuna | 87,135 | **82,778** | 78,422 | 74,065 | 65,351 |
| Mackerel | 244,655 | **232,422** | 220,190 | 207,957 | 183,491 |
| Wahoo | 27,275 | **25,911** | 24,548 | 23,184 | 20,456 |

**Table H.2.** The ACLs for each stock and stock complex for the recreational sector (as applicable) in the Puerto Rico FMP, based on Preferred Alternative 3 Sub-alternatives 3d-3h**.** All ACLs under Sub-Alternative 3i would be equal to zero, and were not included in the table. Additionally, stocks/complexes with an ABC set equal to zero by the SSC were not included in the table. Values in bold represent the ACL resulting from the preferred sub-alternative selected by the Council.

| Stock/Complex | Sub-Alt 3d ACL=ABC | Sub-Alt 3e ACL=ABC*0.95 | Sub-Alt 3f ACL=ABC*0.90 | Sub-Alt 3g ACL=ABC*0.85 | Sub-Alt 3h ACL=ABC*0.75 |
|---|---|---|---|---|---|
| Snapper Unit 1 | 117,834 | **111,942** | 106,051 | 100,159 | 88,376 |
| Snapper Unit 2 | 26,288 | **24,974** | 23,659 | 22,345 | 19,716 |
| Snapper Unit 3 | 22,740 | **21,603** | 20,466 | 19,329 | 17,055 |

| | | | | | |
|---|---|---|---|---|---|
| Snapper Unit 4 | 80,658 | **76,625** | 72,592 | 68,559 | 60,494 |
| Snapper Unit 5 | 25,251 | **23,988** | 22,726 | 21,463 | 18,938 |
| Snapper Unit 6 | 6,787 | **6,448** | 6,108 | 5,769 | 5,090 |
| Grouper Unit 3 | 20,668 | **19,635** | 18,601 | 17,568 | 15,501 |
| Grouper Unit 4 | 6,176 | **5,867** | 5,558 | 5,250 | 4,632 |
| Grouper Unit 5 | 4,448 | **4,226** | 4,003 | 3,781 | 3,336 |
| Grouper Unit 6 | 36,309 | **34,494** | 32,678 | 30,863 | 27,232 |
| Parrotfish Unit 2 | 20,061 | 19,058 | 18,055 | **17,052** | 15,046 |
| Surgeonfish | 1,012 | 961 | 911 | **860** | 759 |
| Triggerfish | 7,845 | **7,453** | 7,061 | 6,668 | 5,884 |
| Wrasses Unit 1 | 8,698 | **8,263** | 7,828 | 7,393 | 6,524 |
| Wrasses Unit 2 | 5,655 | **5,372** | 5,090 | 4,807 | 4,241 |
| Angelfish | 3,512 | 3,336 | 3,161 | **2,985** | 2,634 |
| Barracuda | 176,519 | **167,693** | 158,867 | 150,041 | 132,389 |
| Tripletail | 41,058 | **39,005** | 36,952 | 34,899 | 30,794 |
| Grunts | 2,591 | **2,461** | 2,332 | 2,202 | 1,943 |
| Jacks Unit 1 | 44,099 | **41,894** | 39,689 | 37,484 | 33,074 |
| Jacks Unit 2 | 6,020 | **5,719** | 5,418 | 5,117 | 4,515 |
| Jacks Unit 3 | 8,517 | **8,091** | 7,665 | 7,239 | 6,388 |
| Dolphinfish | 1,593,550 | **1,513,873** | 1,434,195 | 1,354,518 | 1,195,163 |
| Tuna | 36,300 | **34,485** | 32,670 | 30,855 | 27,225 |
| Mackerel | 135,979 | **129,180** | 122,381 | 115,582 | 101,984 |
| Wahoo | 221,829 | 210,738 | 199,646 | 188,555 | 166,372 |

# Appendix I. Acceptable Biological Catch (ABC) Control Rule Classifications and Resultant Reference Points

Calculated sustainable yield levels (SYL) and ABCs for the ABC Control Rule in Preferred Alternative 3 of Action 4

**Table I.1.** Sustainable yield level and acceptable biological catch for each stock/stock complex selected for management in the Puerto Rico FMP. Indicator stocks are marked in bold.

| Stock/Stock Complex | SYL | ABC |
|---|---|---|
| Spiny Lobster | 924,968 | 554,981 |
| Queen conch | 269,195 | 0 |
| Snapper 1 (black, blackfin, **silk**, vermilion, wenchman) | 1,128,319 | 564,159 |
| Snapper 2 (**queen**, cardinal) | 594,126 | 297,063 |
| Snapper 3 (lane) | 559,956 | 279,978 |
| Snapper 4 (**mutton**, dog, schoolmaster) | 406,441 | 203,220 |
| Snapper 5 (yellowtail) | 715,357 | 357,678 |
| Snapper 6 (cubera) | 13,825 | 6,912 |
| Grouper 1 (Nassau) | 20,983 | 0 |
| Grouper 2 (goliath) | 12,840 | 0 |
| Grouper 3 (**coney**, graysby) | 104,203 | 45,815 |
| Grouper 4 (black, red, tiger, yellowfin, yellowmouth) | 18,910 | 8,799 |
| Grouper 5 (misty, yellowedge) | 44,749 | 20,582 |
| Grouper 6 (**red hind**, rock hind) | 392,957 | 164,445 |
| Parrotfish 1 (blue, midnight, rainbow) | 8,156 | 0 |
| Parrotfish 2 (princess, queen, redtail, stoplight, redband, striped) | 392,284 | 193,913 |
| Surgeonfish (blue tang, ocean, doctorfish) | 2,370 | 1,185 |
| Triggerfish (**queen**, ocean, gray) | 190,636 | 95,318 |
| Wrasses 1 (hogfish) | 165,057 | 82,529 |
| Wrasses 2 (puddingwife, Spanish hogfish) | 53,681 | 26,841 |
| Angelfish (queen, gray, French) | 7,346 | 3,673 |
| Barracuda (great barracuda) | 354,080 | 177,040 |
| Tripletail | 82,684 | 41,342 |
| Grunts (white grunt) | 379,756 | 189,877 |
| Jacks 1 (crevalle jack) | 88,319 | 44,147 |
| Jacks 2 (African pompano) | 14,809 | 7,128 |
| Jacks 3 (rainbow runner) | 19,439 | 9,479 |
| Dolphinfish (**dolphin**, pompano dolphin) | 3,675,886 | 1,837,943 |
| Tuna (little tuny, blackfin tuna) | 254,937 | 123,435 |
| Mackerel (cero, king mackerel) | 761,268 | 380,634 |
| Wahoo | 498,207 | 249,104 |
| Rays 1 (giant manta ray) | 1,657 | 0 |

| Stock/Stock Complex | SYL | ABC |
|---|---|---|
| Rays 2 (spotted eagle ray) | 22,400 | 0 |
| Rays 3 (southern stingray) | 18,830 | 0 |
| Sea Cucumbers | NA | 0 |
| Sea Urchins | NA | 0 |
| Corals | NA | 0 |

**Table I.2.** Contribution to the SYL and ABC from the commercial sector for each stock/stock complex selected for management in the Puerto Rico FMP[79], including information on reference period used and mean commercial landings during the reference period.

| Stock/Stock Complex | Commercial Reference Period[80] | Tier[81] | Mean Commercial Landings (lbs) | Commercial Contribution to SYL | Commercial Contribution to ABC |
|---|---|---|---|---|---|
| Spiny Lobster | 1988 - 2011 | 4a | 347,713 | 924,968 | 554,981 |
| Snapper 1 | 1988 - 2011 | 4a | 343,498 | 892,650 | 446,325 |
| Snapper 2 | 2000 - 2011 | 4a | 207,996 | 541,549 | 270,775 |
| Snapper 3 | 1988 - 2011 | 4a | 232,056 | 514,475 | 257,238 |
| Snapper 4 | 1988 - 2011 | 4a | 84,602 | 245,124 | 122,562 |
| Snapper 5 | 1988 - 2011 | 4a | 322,103 | 664,855 | 332,427 |
| Snapper 6 | 1988 - 2011 | 4a | 251 | 251 | 125 |
| Grouper 3 | 1988 - 2011 | 4a | 22,308 | 62,868 | 25,147 |
| Grouper 4 | 1988 - 2011 | 4b | 5,321 | 6,558 | 2,623 |
| Grouper 5 | 2000 - 2011 | 4a | 13,490 | 35,853 | 16,134 |
| Grouper 6 | 1988 - 2011 | 4a | 120,685 | 320,340 | 128,136 |
| Parrotfish 2 | 1988 - 2011 | 4a | 106,626 | 347,704 | 173,852 |
| Surgeonfish | 1988 - 2011 | 4a | 118 | 347 | 173 |
| Triggerfish | 1988 - 2011 | 4a | 65,270 | 174,946 | 87,473 |
| Wrasses 1 | 1988 - 2011 | 4a | 64,773 | 147,662 | 73,831 |
| Wrasses 2 | 1988 - 2011 | 4a | 21,060 | 42,371 | 21,186 |
| Angelfish | 1988 - 2011 | 4a | 168 | 322 | 161 |
| Barracuda | 1988 – 2004 | 4a | 454 | 1,042 | 521 |
| Tripletail | 1988 - 2016 | 4a | 205 | 568 | 284 |
| Grunts | 1988 - 2011 | 4a | 168,656 | 374,575 | 187,287 |
| Jacks 1 | 1988 - 2016 | 4a | 75 | 121 | 48 |
| Jacks 2 | 1988 - 2016 | 4a | 807 | 2,769 | 1,108 |

[79] Stocks/complexes for which the SSC set management measures on an ad hoc basis are not included in the table (queen conch, Nassau grouper, goliath grouper, blue parrotfish, midnight parrotfish, rainbow parrotfish, giant manta ray, spotted eagle ray, southern stingray, sea cucumbers, sea urchins, and corals).

[80] The SSC recommended that landings data for Year 2005 be excluded due to an aberrant adjustment factor that led to substantially higher adjusted landings for all species from all regions during that year.

[81] For Tier 4a stocks and stock complexes, the SYL was calculated using the 75th percentile of landings during the reference period. For Tier 4b, the SYL was calculated using the mean landings during the reference period.

| Stock/Stock Complex | Commercial Reference Period[80] | Tier[81] | Mean Commercial Landings (lbs) | Commercial Contribution to SYL | Commercial Contribution to ABC |
|---|---|---|---|---|---|
| Jacks 3 | 1988 - 2016 | 4a | 1,263 | 2,404 | 962 |
| Dolphinfish | 1988 - 2016 | 4a | 156,326 | 488,786 | 244,393 |
| Tuna | 1999 - 2016 | 4a | 56,906 | 174,271 | 87,135 |
| Mackerel | 1999 - 2016 | 4a | 146,587 | 489,310 | 244,655 |
| Wahoo | 2010 - 2016 | 4a | 19,001 | 54,550 | 27,275 |

**Table I.3.** Contribution to the SYL and ABC from the recreational sector for each stock/stock complex selected for management in the Puerto Rico FMP, including information on the reference period used and mean recreational landings during the reference period. For spiny lobster, recreational landings were not collected, and SYL and ABC are based on commercial landings.

| Stock/Stock Complex | Recreational Reference Period | Tier[82] | Mean Recreational Landings (lbs) | Recreational Contribution to SYL | Recreational Contribution to ABC |
|---|---|---|---|---|---|
| Snapper 1 | 2000 – 2011 | 4a | 79,421 | 235,669 | 117,834 |
| Snapper 2 | 2000 – 2011 | 4a | 22,613 | 52,577 | 26,288 |
| Snapper 3 | 2000 – 2011 | 4a | 23,037 | 45,481 | 22,740 |
| Snapper 4 | 2000 – 2011 | 4a | 52,848 | 161,317 | 80,658 |
| Snapper 5 | 2000 – 2011 | 4a | 24,359 | 50,502 | 25,251 |
| Snapper 6 | 2000 – 2011 | 4a | 8,458 | 13,574 | 6,787 |
| Grouper 3 | 2000 – 2011 | 4a | 14,537 | 41,335 | 20,668 |
| Grouper 4 | 2000 – 2011 | 4b | 12,352 | 12,352 | 6,176 |
| Grouper 5 | 2000 – 2011 | 4a | 3,436 | 8,896 | 4,448 |
| Grouper 6 | 2000 – 2011 | 4a | 37,025 | 72,617 | 36,309 |
| Parrotfish 2 | 2000 – 2011 | 4a | 17,540 | 44,580 | 20,061 |
| Surgeonfish | 2000 – 2011 | 4a | 894 | 2,023 | 1,012 |
| Triggerfish | 2000 – 2011 | 4a | 8,335 | 15,690 | 7,845 |
| Wrasses 1 | 2000 – 2011 | 4a | 9,914 | 17,395 | 8,698 |
| Wrasses 2 | 2000 – 2011 | 4a | 3,313 | 11,310 | 5,655 |
| Angelfish | 2000 – 2011 | 4a | 1,992 | 7,024 | 3,512 |
| Barracuda | 2000 – 2016 | 4a | 112,847 | 353,038 | 176,519 |
| Tripletail | 2000 – 2016 | 4a | 28,667 | 82,116 | 41,058 |
| Grunts | 2000 – 2011 | 4a | 3,228 | 5,181 | 2,591 |
| Jacks 1 | 2000 – 2016 | 4a | 40,789 | 88,198 | 44,099 |
| Jacks 2 | 2000 – 2016 | 4a | 5,814 | 12,040 | 6,020 |
| Jacks 3 | 2000 – 2016 | 4a | 7,105 | 17,035 | 8,517 |
| Dolphinfish | 2000 – 2016 | 4a | 1,066,600 | 3,187,100 | 1,593,550 |
| Tuna | 2000 – 2016 | 4a | 46,862 | 80,666 | 36,300 |
| Mackerel | 2000 – 2016 | 4a | 120,000 | 271,958 | 135,979 |
| Wahoo | 2000 – 2016 | 4a | 163,839 | 443,657 | 221,829 |

[82] For Tier 4a stocks and stock complexes, the SYL was calculated using the 75th percentile of landings during the reference period. For Tier 4b, the SYL was calculated using the mean landings during the reference period.

# Appendix J. Description of the Species in the Puerto Rico FMP

This appendix summarizes the available information on the biology and life history for stocks/stock complexes (e.g., finfish, spiny lobster, queen conch, corals, sea cucumbers, sea urchins, and corals) managed in the Puerto Rico FMP. A complete description of the life history characteristics and ecology of all species previously-managed by the Caribbean Fishery Management Council (Council) can be found in the Caribbean Sustainable Fisheries Act (SFA) Amendment (CFMC 2005), the 2010 Caribbean Annual Catch Limit (ACL) Amendment (CFMC 2011a), and the 2011 Caribbean ACL Amendment (CFMC 2011b), and is incorporated herein by reference. Regulatory Amendment 4 to the Reef Fish FMP (CFMC 2013c) has the recent description of the biology and ecology of parrotfish, and Regulatory Amendment 2 to the Queen Conch FMP has the most updated information for queen conch in federal waters (CFMC 2013b). The biology and ecology of managed corals and reef associated plants and invertebrates were updated through Amendment 4 to the Coral FMP (CFMC 2013a).

## Queen conch, *Lobatus gigas*

The conch is an invertebrate with a hard shell and a soft body, which consists of the black speckled foot, the visceral mass within which resides the thoracic and abdominal organs, two slender tentacles, a "head" with bright yellow eyes perched on the end of two protruding stalks, and a snout-like mouth (proboscis) which the conch extends to graze on algae. Enclosing the foot and head is a snug, orange or yellow fleshy covering called the mantle, which secretes the shell and also houses the feathery gills that allow the conch to extract oxygen from the water. The queen conch's shell is its most striking feature. Adults have a heavy shell with a broad, flared lip that is a glossy pink, orange, or yellow on the interior. The outside of the shell is marked by a blunt crown of spines that project from each whorl of the spiral. Queen conchs are "right-handed," meaning that as the observer looks at the pointed crown, the spiral coils to the right. A brown, papery layer called the periostracum covers the shell and collects silt, bacteria, and algae, which help to disguise the animal. The periostracum flakes off when the shell is removed from the water and dried.

### Distribution and Habitat

The queen conch occurs in semi-tropical and tropical waters of the Atlantic Ocean, ranging from south Florida (USA) and Bermuda to northern South America, including the Caribbean Sea (Rhines 2000). This species generally occurs on expanses of shelf to about 250 ft (76 m) depth. It is commonly found on sandy bottoms that support the growth of seagrasses, primarily turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), shoal grass (*Halodule wrightii*), and epiphytic algae upon which it feeds (Randall 1964; Stoner and Waite 1990).

Queen conch also occurs on gravel, coral rubble, smooth hard coral or beach rock bottoms, and sandy algal beds (CFMC 1996). Additional information on queen conch habitat in deeper water (30-50 m) indicates that the species occurs on rhodolith reefs, a habitat that functions as a foraging ground for conch (García-Sais et al. 2010). Sandt and Stoner (1993) have shown that queen conch actively select among their habitats, with juveniles being more selective than adults, and are dependent on certainhabitat requirements. The most productive nurseries occur in shallow (5-6 m deep) seagrass meadows (Stoner 1997). Juveniles exhibit a strong preference for intermediate densities of seagrasses, whereas adults show less habitat specificity (Stoner and Waite 1990).

Juveniles settle in shallow subtidal habitats where they spend much of their first year buried in the sediment (CFMC 1996, CFMC CFRAMP 1999, Rhines 2000). At shell lengths ranging from 2.0-3.0 in (5-7.5 cm), young juveniles begin to emerge and take up an epibenthic existence. Some studies have documented a habitat shift at the time of emergence, from the area of settlement into nearby seagrass beds. Queen conch exhibit two general patterns of migration. The first is an ontogenetic migration into deeper water, a pattern which generally becomes more pronounced in large juveniles (CFMC CFRAMP 1999). Aggregations of over 100,000 juveniles have been reported in the Bahamas (CFMC 1996). The second migration is related to spawning. Conch generally move inshore to spawn as temperature begins to increase in March, and return to deeper water in October. This migration is manifested as a general shift in the distribution of conch, with conch in deep water migrating but still remaining deep relative to conch in shallow water areas (CFMC CFRAMP 1999).

**Life History**

Adult queen conch grow to 6-12 in (15-30.5 cm) in length (CFMC 1996), weigh about 4.4 lb (2 kg) on average, and generally live 6 to 7 years; although they may survive as many as 26 (Rhines 2000) or even 40 (CFMC 1996) years in deep water habitats. Growth in shell length generally ceases at the time of sexual maturity, after which growth occurs primarily through the thickening of the shell, especially at the lip (CFMC CFRAMP 1999). The shell length of an adult queen conch can progressively decrease with age due to bioerosion of the shell. The flaring of the lip starts at an age of approximately two to four years and lasts for approximately seven to ten months, or longer (Glazer and Berg 1992). While Rhines (2000) reports age at maturation as 3.5 - 4 years, the average age of maturation for both sexes of queen conch off Puerto Rico is reached at approximately five years (Appeldoorn 1994) whereas off St. John it is 3 years (CFMC 1996).

**Diet**

Queen conch larvae feed on plankton (Rhines 2000). Juvenile and adults graze on algae and seagrasses (Rhines 2000; Sefton and Webster 1986). Foraminiferans, bryozoans, and small bivalves and gastropods have also been found in conch stomachs but were probably ingested accidentally while grazing (Rhines 2000). Feeding has been observed in sand flats and shallow,

sandy lagoons (Sefton and Webster 1986), particularly in turtle grass beds (Colin 1978; Sefton and Webster 1986), on hard bottom habitats, and in rubble (Rhines 2000). Juveniles are preyed on by a variety of gastropod mollusks, cephalopods, crustaceans, and fish (Colin 1978). Adults are preyed upon by crabs, turtles, sharks, and rays (Rhines 2000). The hermit crab (*Petrochirus diogenes*) expropriates the shell of the queen conch after consuming the animal. The conch fish (*Astrapogon stellatus*), and possibly a porcellanid crab, have commensal relationships with the queen conch; the former spends the day within the conch's mantle cavity, emerging at night to feed (Colin 1978).

**Reproduction and Spawning**

Sexes are separate and fertilization is internal. Copulation can precede spawning events by several weeks (CFMC 1996). Research indicates the lack of reproduction in low-density populations is related primarily to the lack of encounters between females and males. In the Bahamas, Stoner and Ray-Culp (2000) found that reproduction increased proportionally with density levels (due to increased likeliness of encounters) and remained stable near densities of 200 individuals-ha. This highlights the importance of maintaining stock density above a critical level to prevent recruitment failure. In Puerto Rico, surveys undertaken in 1996 found densities of 7.4 individuals-ha on the East Coast and 8.5 individuals-ha on the West Coast (Mateo et al. 1998). For St Thomas, juvenile density of 1.9 individuals-ha was observed in 2001, while adult density in St Croix waters was around 26-27 individuals-ha (Gordon 2002). Recent fishery independent surveys show a marked increase in both juvenile and adult densities in Puerto Rico and the USVI (N. Jimenez, PRDNER, pers. comm.; S. Gordon, VIDPNR, pers. comm.). Rhines (2000) reports the peak reproductive season extends from April to August. Peak spawning activity in the U.S. Caribbean appears to occur from May through September, corresponding to the highest water temperatures (CFMC 1996). Spawning occurs in aggregations (CFMC 1996). Egg masses are composed of a number of gelatinous egg strings, usually deposited in clean coral sand with low organic content but sometimes also in seagrass habitat (CFMC 1996). Fecundity is highly variable: individual strings may contain as many as 185,000 - 460,000 eggs (Rhines 2000); egg masses, from 310,000 - 750,000 eggs. Females commonly spawn 6-8 times per season and produce 1-25 egg masses per season (CFMC 1996).

Embryos hatch into planktonic larvae (Colin 1978, Rhines 2000) after a period of about 5 days. Larvae spend between 18 and 40 days in the water column before settling and metamorphosing into adults. Little is known about recruitment patterns. Some studies have concluded that the majority of larvae are retained locally (e.g., within the area where they are spawned); others, that larvae could be transported 26 mi (43 km) per day, or 540 mi (900 km) during the 3-week larval period depending upon current patterns. Eggs hatched off Puerto Rico and the USVI may supply conch to areas located downstream, such as Haiti, the Dominican Republic, and Cuba. Conversely, islands situated upstream in the Caribbean arc may provide conch that settle in

Puerto Rico and the USVI (CFMC 1996). However, evidence of local entrainment of larvae suggests that it is important to focus primarily on management of the local conch stock.

## Caribbean spiny lobster, *Panulirus argus*

**Distribution and Habitat**

The Caribbean spiny lobster, *P. argus* (hereafter referred to as spiny lobster), occurs in the Western Central and South Atlantic Ocean, including the Caribbean Sea and the Gulf of Mexico. North Carolina marks its northernmost limit; Brazil, its southernmost limit (Bliss 1982). The spiny lobster occurs from the extreme shallows of the littoral fringe to depths of at least 100 m (Kanciruk 1980; Munro 1974a). CFMC (1981) reports that its distribution off Puerto Rico extends to the edge of the shelf, which is described as the 100-fathom contour (183 m).

Shallow areas with mangroves and seagrass (Thalassia testudinum) beds serve as nursery areas for pre-adult populations wherever such habitats are available (Munro 1974a). Generally, spiny lobsters move offshore when they reach reproductive size (Phillips et al. 1980). Adults are found on most shelf areas which offer adequate shelter in the form of reefs, wrecks or other forms of cover (Munro 1974a). This species shelters communally by day in groups of two to over one hundred (Cobb and Wang 1985) in holes and crevices in reefs or other refuges. The largest dominant male usually occupies the most favored and safest position deep within the refuge. At night, they emerge to feed (Munro 1974a).

Mass migrations have been reported most often from Florida and the Bahamas, where movement is usually southwards (Munro 1974a) and occurs in mid-autumn or mid-winter, usually after a period of stormy weather (Cobb and Wang 1985). This migratory behavior is especially striking in the Bahamas, where large numbers of lobsters are observed to migrate day and night in queues of 2-60 animals. As many as 100,000 individuals have been observed moving in queue formation in a southerly direction on the shelf area west of Bimini (Cobb and Wang 1985).

The significance of migratory behavior is not yet understood. While local spiny lobster populations travel the same direction each year, populations in other areas may travel in different directions. Return migrations have not been described (Cobb and Wang 1985). Some hypothesize that migrations may serve to redistribute young mature adults in areas appropriate for adult habitation and larval release (Phillips et al. 1980); others, that the lobsters may be trying to escape the stress of severe winters in shallow waters (Cobb and Wang 1985).

**Life History**

Kanciruk (1980) estimates maximum age as 20 years.

**Diet**

These animals are primarily carnivores, and serve as the major benthic carnivores in some ecosystems (Kanciruk 1980). They generally feed on smaller crustaceans, mollusks and annelids (Cobb and Wang 1985). One study reported that specimens taken from a lagoon area appeared to feed only on mollusks, but that individuals taken in reef habitat consumed algae, foraminifera, sponge spicules, polychaetes and sand, in addition to bivalve and gastropod mollusk and crustacean remains (Munro 1974a). The reported consumption of seaweed, algae, and inorganic material has been attributed both to incidental ingestion (Cobb and Wang 1985) and to a shortage of other food sources (Kanciruk 1980), as opposed to preference. A 1971 study reported that juveniles at the USVI sheltered in daytime aggregations of the sea urchin (Diadema antillarum) and thus gained access to extensive feeding areas which were otherwise devoid of shelter (Munro 1974a).

Pelagic fishes, including the tunas Katsuwonus pelamis and Thunnus atlanticus, feed on spiny lobster in their planktonic phase. Natural predators of sub-adult and adult spiny lobster include large benthic feeding fishes, sharks, octopuses (Cobb and Wang 1985), rays, skates, crabs, dolphins (Munro 1974a) and turtles (CMI 1996). A small whelk (Murex pomum) is reported to eat lobsters in traps, and presumably in nature, by boring through the carapace. Barnacles (Balanus ebureus) settle on the carapace of large specimens and could serve as indicators of habitat and of the intermolt period (Munro 1974a).

**Reproduction and Spawning**

Sexes are separate and anatomically distinct. Males have larger and heavier carapaces, but lighter and shorter tails than females. But relationships between total length and total weight are very nearly identical for males and females in Caribbean waters (Munro 1974a). Molting appears to be tied to reproduction for females (Munro 1974a; Phillips et al. 1980), but males appear to be able to reproduce successfully year round (Phillips et al. 1980).

Maturity occurs at a single molt (the “maturity molt”) and is generally related to length, rather than age. According to CFMC (1981), most females reach sexual maturity between 3.1-3.5 in (7.9-8.9 cm) carapace length (CL) and are at peak egg production between 4.3-5 in CL. Conservation Management Institute reports that intense fishing may have caused a decline in the minimum size of spawning females in Florida waters (CMI 1996). Fecundity varies greatly among size classes, but is generally high. In the early years of a spiny lobster, the larger a female, the more eggs produced. But fecundity begins to decrease at a certain age; possibly around the time when molting decreases in frequency (Munro 1974a). Munro (1974) reports that egg production per unit body weight ranges from about 670 to 1,210 eggs/g of total body weight, with an average of 830 eggs/g. CFMC (1981) reports that the number of eggs ranges from 0.5-1.7 million per spawning.

Spiny lobsters spawn at least once a year (Cobb and Wang 1985). Females in Bermuda have been reported to spawn at least twice (Morgan 1980; Munro 1974a) between May and August.

But the numbers of broods produced in Caribbean waters, where the spawning period appears to be more extended are not known. For most territories within the Caribbean Sea, egg-bearing (berried) females have been observed in all months of the year, but with greatest frequency in the months from February to August (Munro 1974a). CFMC (1981) reports that reproduction occurs yearround, but declines in the fall.

Fertilization is external (Bliss 1982). Females carry fertilized eggs until they are fully developed (Cobb and Wang 1985), a period of about four weeks, and tend to move towards deeper water when the eggs are ready to hatch (Munro 1974a). Embryos hatch as planktonic larvae (Bliss 1982), which spend up to eleven months (Phillips et al. 1980) or more (Munro 1974a; Phillips and Sastry 1980) at sea before metamorphosing into the puerulus stage (Cobb and Wang 1985) and settling on the ocean bottom. This extended planktonic stage could permit extremely wide dispersal of the larvae. It appears most likely that larvae spawned in the Caribbean could, for example, settle at Bermuda (Munro 1974a).

**Snappers, Lutjanidae**

Snappers are generally slow-growing and moderately long-lived and occur near the bottom, from shallow waters to depths of 550 m. Thirteen snappers are managed as three individual stocks (lane, yellowtail, and cubera snapper) and three stock complexes in the in the Puerto Rico FMP.

## Black snapper, *Apsilus dentatus*

**Distribution and Habitat**

Black snapper occurs in the Western Central Atlantic, off the Florida Keys (USA), and in the western Gulf of Mexico and Caribbean Sea. A demersal species, the black snapper is primarily found over rocky bottom habitat, although juveniles are sometimes found near the surface (Allen 1985 in Froese and Pauly 2002). It moves offshore to deep-water reefs and rocky ledges as it grows and matures (SAFMC 1999). Allen (1985), in Froese and Pauly (2002) reports depth range as 100-300 m. The findings of a Caribbean study indicate that it is most abundant at depths of 60-100 m off Jamaica (Thompson and Munro 1974a).

***Life History***

Maximum reported size is 65 cm TL (male). Maximum reported weight is 3,170 g (Allen 1985 in Froese and Pauly 2002). Size at maturity and age at first maturity estimated in Froese and Pauly (2002) are 34.9 cm TL and 1 year, respectively. Observed maximum fork lengths of catches taken in a Jamaican study were 56 cm FL and 54 cm FL for males and females, respectively; estimated mean sizes of maturity, 43-45 cm FL and 39-41 cm FL for males and females, respectively (Thompson and Munro 1974a). Approximate life span is 4.4 years; natural mortality rate, 0.30 (Ault et al. 1998). Large catches occasionally obtained over a short period of time suggest a schooling habit for this species (Thompson and Munro 1974a).

### *Diet*

Prey includes fishes and benthic organisms, including cephalopods, tunicates (Allen 1985 in Froese and Pauly 2002), and crustaceans (Thompson and Munro 1974a). Halstead (1970), in Froese and Pauly (2002), report that it can be ciguatoxic.

### *Reproduction and Spawning*

Aida Rosario (unpublished data; personal communication) reports that females with ripe gonads were collected from December to May and from August to September, and were collected with the highest frequency in March and September. In the northeastern Caribbean, individuals in spawning condition have been observed from February through April, and in September (Erdman 1976). Thompson and Munro (1974a) reports that, off Jamaica, the greatest proportions of ripe fishes were found in JanuaryApril and September-November (Thompson and Munro 1974a).

## Blackfin snapper, *Lutjanus buccanella*

### *Distribution and Habitat*

Blackfin snapper occurs in the Western Atlantic, as far north as North Carolina (USA) and Bermuda, south to Trinidad and northern Brazil, including the Gulf of Mexico and Caribbean Sea (Allen 1985 in Froese and Pauly 2002). This species is very common in the Caribbean, particularly in the Antilles. The blackfin snapper is a demersal species, found from 20-200 m depth. Adults inhabit deeper waters over sandy or rocky bottoms, and near drop-offs and ledges. Juveniles occur in shallower waters, often between about 35 and 50 m (Allen 1985 in Froese and Pauly 2002), and sometimes in small schools (Thompson and Munro 1974a). Suitable bottom type is probably more important than depth in influencing the distribution of this species. Most fish taken in fish traps during a 1978 survey off Puerto Rico were captured at 75-110 m depth (Boardman and Weiler 1979).

### *Life History*

This species is moderately resilient, with a minimum population doubling time of 1.4-4.4 years (K = 0.10 - 0.70). Maximum reported size is 75 cm TL (male); maximum weight, 14 kg (Allen 1985 in Froese and Pauly 2002). The modal lengths for male and female blackfins taken in the Puerto Rican survey were 26 cm FL and 23 cm FL, respectively. Maximum size was 47 cm FL. Estimated lengths of maturity for females and males were 20 cm FL and 38 cm FL, respectively (Boardman and Weiler 1979). Size at maturity and age at first maturity are estimated in Froese and Pauly (2002) as 34 cm TL and 1.9 years, respectively. Approximate life span is 8.2 years; natural mortality rate, 0.23 (Ault et al. 1998).

### *Diet*

Allen (1985), in Froese and Pauly (2002) identify fishes as the primary prey. Thompson and Munro (1974a) report that the main items in the stomachs of this species taken at the Virgin Islands were isopods (37.5%) and fish (33.3%), with shrimps, spiny lobsters, crabs, octopus and squid making up the rest of the diet. Tunicates have been found in the stomachs of some adults (Thompson and Munro 1974a). It can be ciguatoxic (Allen 1985 in Froese and Pauly 2002).

### *Reproduction and Spawning*

The findings of Boardman and Weiler (1979) indicate that spawning occurs year-round in the U.S. Caribbean, in relatively large numbers. In the northeastern Caribbean, individuals in spawning condition have been observed in February, April, and September (Erdman 1976). Ripe fishes have been observed in Jamaican waters in February-May and in August-November, with maxima in April and September (Thompson and Munro 1974a).

## Silk snapper, Lutjanus vivanus

### *Distribution and Habitat*

Silk snapper are found in western Atlantic waters, as far north as Cape Hatteras, North Carolina and Bermuda and as far south as Brazil (Bohlke and Chaplin 1967, Froese and Pauly 2011, Figure 2.8.1). They are also found in the Gulf of Mexico along the continental shelf (Bohlke and Chaplin 1967, Boardman and Weiler 1980, Sylvester et al. 1980). The reported depth range for silk snapper is 64m – 300m (Sylvester et al. 1980, Parker and Mays 1998, Cummings 2003). Depth distribution and ontogenetic stage are positively correlated, where younger, smaller fish are generally found in shallower depths than older and larger individuals (Boardman and Weiler 1980). The silk snapper occurs in the Western Atlantic, as far north as Bermuda and North Carolina (USA), southward to central Brazil. It is most abundant around the Antilles and the Bahamas. The silk snapper is mainly found from 90-140 m depth, commonly near the edge of the continental and island shelves, but also beyond the shelf edge to depths of 300 m. Adults are generally distributed further offshore than juveniles (SAFMC 1999), and usually ascend to shallow water at night (Allen 1985 in Froese and Pauly 2002). Suitable bottom type is probably more important than depth in influencing the distribution of this species. According to Rivas (1970), silk snapper are the only deep water snappers found over mud substrate in the Western Atlantic. Most fish taken in fish traps during a 1978 survey off Puerto Rico were captured at 112-165 m depth. Silk snapper have been reported to school in size groups (Dammann et al. 1970). Boardman and Weiler (1979) suggest that silk snapper are commonly associated with blackfin snapper and vermillion snapper, though silk snapper are usually found at a slightly deeper depth.

### *Life History*

This species is of low resilience, with a minimum population doubling time of 4.5 - 14 years (K = 0.09-0.32; tm = 5). Maximum reported size is 83 cm TL (male); maximum weight, 8,320 g

(Allen 1985 in Froese and Pauly 2002). The predominant lengths for males and females surveyed with trap gear in Puerto Rican waters were 29 cm FL and 26 cm FL, respectively, as determined from length-frequency curves. But trap-caught silk snapper tend to be smaller than those caught by hook and line gear. The maximum size of fish taken in that study was 71 cm FL. Females and males appeared to mature at 50 cm FL and 38 cm FL, respectively (Boardman and Weiler 1979). Size at maturity and age at first maturity are estimated in Froese and Pauly (2002) as 43.4 cm TL and 6.3 years, respectively. A Jamaican study estimates mean sizes of maturity as 55-60 cm FL (males) and 50-55 cm FL (females) (Thompson and Munro 1974a). The approximate life span of this fish is 28.7 years; natural mortality rate, 0.23 (Ault et al. 1998). However, Tabash and Sierra (1996) suggested a maximum life span of seven years and estimated an M using Ralston's (1987) method to be 0.86, which was also advocated by the SEDAR process.

The range of published natural mortality estimates was large, ranging from 0.19 and 0.86 per year. Martinez-Andrade (2003) estimated natural mortality to be between 0.54 and 0.56 per year using the equation published in the FishBase manual (Froese and Pauly 2011). The reported ranges for Linf, K, and t0 were 600 -1170 mm total length (TL), 0.051-0.32 per year, and - 2.309 - -0.04 years, respectively. The reported range for the allometric growth parameter, b, was 2.86 - 3.1 and the range for the scaling parameter, a, was 1e-5 - 0.117. Estimates of length-at-maturity, Lmat, from the literature varied. The lowest estimates of Lmat were 296mm fork length (FL) and 267mm FL for males and females, respectively (Rosario et al. 2006). The remaining estimates ranged between 340mm TL and 600mm TL. Lmat was generally determined by macroscopic inspection of the gonads. Rosario et al. (2006), however, conducted a histological investigation, which may more accurately represent Lmat. Estimates of age-at-maturity, tmat, were also discussed. The range for tmat was between two and six years.

***Diet***

Prey items include mainly fishes, shrimps, crabs, gastropods, cephalopods, tunicates and some pelagic items, including urochordates (Allen 1985 in Froese and Pauly 2002). The main items in the stomachs of fishes captured off the Virgin Islands consisted of fish (50.1%), shrimp (17.8%), and crabs (11%), with isopods and other invertebrate groups completing the diet (Thompson and Munro 1974a). It can be ciguatoxic (Allen 1985 in Froese and Pauly 2002).

***Reproduction and Spawning***

Silk snapper are gonochronistic (i.e., sexes are distinct; Sylvester et al. 1980). Silk are thought to spawn year round (Sylvester et al. 1980). Peak spawning months for silk in the USVI are April-June and October-December (Sylvester 1974). Parker and Mays (1998) have suggested that peak spawning months in the southeast USA are July-September and again in October-December. The findings of Boardman and Weiler (1979) indicate that this species spawns year-round in the U.S. Caribbean, in low percentages. But the small number of ripe fish observed in that study

may have been due to the majority of the catch being smaller than estimated size at maturity. Apparent peaks in spawning in July-September and October-December were probably due to chance collection of spawning groups of a few large fishes (Boardman and Weiler 1979). In the northeastern Caribbean, individuals in spawning condition have been observed from February through April, and in September and November (Erdman 1976). Ripe fishes have been observed off the coast of Jamaica in March-May and August, September and November (Thompson and Munro 1974a).

## Vermilion snapper, Rhomboplites aurorubens

### *Distribution and Habitat*

Vermilion snapper occur in the Western Atlantic from Bermuda and North Carolina (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea (Allen 1985 in Froese and Pauly 2002). Vermilion snapper are demersal, commonly found over rock, gravel, or sand bottoms near the edge of the continental and island shelves (Allen 1985 in Froese and Pauly 2002). Suitable bottom type is probably more important than depth in influencing the distribution of this species (Boardman and Weiler 1979). According to Allen (1985), in Froese and Pauly (2002), this fish is found in moderately deep waters from 180-300 m. But most fish taken in fish traps during a 1978 survey off Puerto Rico were captured at 75-110 m depth (Boardman and Weiler 1979). Vermilions often form large schools; particularly the young, which generally occur at shallower depths (Allen 1985 in Froese and Pauly 2002).

### *Life History*

This fish is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K = 0.20; tm = 3; tmax = 10) (Allen 1985 in Froese and Pauly 2002). Maximum size and weight reported by Allen (1985), in Froese and Pauly (2002), is 60 cm TL (male) and 3,170 g, respectively. The modal length of both males and females collected in a three-year fish trap survey in Puerto Rican waters was 23 cm FL; maximum size, 38 cm. Size at maturity was 14 cm FL (males) and 20 cm FL (females) (Boardman and Weiler 1979). Size at maturity and age at first maturity for this species are estimated in Froese and Pauly (2002) as 34.5 cm TL and 3.3 years, respectively. Maximum reported age is 10 years (Allen 1985 in Froese and Pauly 2002); natural mortality rate, 0.23 (Ault et al. 1998).

### *Diet*

Prey items include fishes, shrimps, crabs, polychaetes, other benthic invertebrates, cephalopods, and planktonic organisms (Allen 1985 in Froese and Pauly 2002).

### *Reproduction and Spawning*

According to Boardman and Weiler (1979), this fish spawns year-round in the U.S. Caribbean and in relatively large numbers. Erdman (1976) reports that the majority of fishes collected off the south coast of Puerto Rico in February, March, April, and June had sub-ripe or ripe gonads. A study off Jamaica captured one active male during May, and one ripe and three active females during October (Thompson and Munro 1974a).

## Wenchman, Pristipomoides aquilonaris

### *Distribution and Habitat*

Wenchman snapper occur in the Western Atlantic from North Carolina (USA) to Guiana, including the Caribbean Sea. Wenchman are demersal, found from 24-370 m depth.

### *Life History*

Maximum reported size is 56 cm TL (male); maximum weight, 1,990 g (Allen 1985 in Froese and Pauly 2002). Size at maturity is estimated as 32.1 cm TL; natural mortality rate, 0.44 (Froese and Pauly 2002).

### *Diet*

Its diet is composed primarily of small fishes (Allen 1985 in Froese and Pauly 2002). Olsen et al. (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

### *Reproduction and Spawning*

## Cardinal snapper, Pristipomoides macrophtlamus

### *Distribution and Habitat*

Cardinal snapper have been recorded to occur in the Western Central Atlantic, Straits of Florida, Bahamas, Greater Antilles, and the Caribbean coast of Nicaragua and Panama. This fish in benthopelagic and occurs at depths ranging from 110 – 550 m (361-1,804 ft; Allen 1985). Most commonly found in deeper waters of the shelf near the edge of the continental slope.

### *Life History*

Males have been recorded to reach a length of 50 cm (20 inches) TL with average lengths around 30 cm (12 inches) TL. The estimate of size at first maturity is 18 cm (7 inches) TL.

### *Diet*

Feeds on small fishes and larger planktonic animals.

### *Reproduction and Spawning*

## Queen snapper, *Etelis oculatus*

### *Distribution and Habitat*

Queen snapper occur in the Western Atlantic from Bermuda and North Carolina (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. It is commonly found near oceanic islands, and is particularly abundant in the Bahamas and the Antilles. Queen snapper are bathydemersal (Allen 1985 in Froese and Pauly 2002) and move offshore to deep-water reefs and rocky ledges as they grow and mature (SAFMC 1999). Allen (1985), in Froese and Pauly (2002) indicate queen snapper are primarily found over rocky bottom habitats, in depths of 100-450 m. Gobert et al. (2005) fished for and found queen snapper at depths between 100m and 500m. This was the widest depth distribution found reported in the literature, however, video taken during recent surveys in deep water habitats observed a queen snapper at 539 m.

### *Life History*

This fish is a moderately resilient species, with a minimum population doubling time 1.4-4.4 years (K = 0.29 - 0.61). Maximum reported size is 100 cm TL (male). Maximum reported weight is 5,300 g (Allen 1985 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 53.6 cm TL and 1 year, respectively. Approximate life span is 4.7 years; natural mortality rate, 0.76 (Froese and Pauly 2002). The reported estimates for Linf and K, were 1020 mm TL and 1030 mm TL, and 0.29-0.621 per year, respectively (Murray and Moore 1992, Murray et al. 1992, Murray and Neilson 2000). The reported range for the allometric growth parameter was 2.55-2.908 and the range for the scaling parameter was 0.012-0.0632 (Bohnsack and Harper 1988, Murray and Moore 1992, Rosario et al. 2006). Estimates of Lmat from the literature ranged from 230mm and 536mm. Rosario et al. (2006) provided lower estimates, which were measured in millimeters fork length, than Martinez-Andrade (2003). Estimates of age-at-maturity ranged between one and two years.

### *Diet*

Primary prey items include small fishes and squids (Allen 1985 in Froese and Pauly 2002).

### *Reproduction and Spawning*

Queen snapper are gonochronistic (i.e., sexes are distinct) and thought to spawn year round (Rosario et al. 2006). Spawning is thought to peak during October and November in Puerto Rico (Rosario et al. 2006).

## Lane snapper, Lutjanus synagris

### *Distribution and Habitat*

Lane snapper occur in the Western Atlantic from Bermuda and North Carolina (USA) to southeastern Brazil, including the Gulf of Mexico and Caribbean Sea. It is most common around the Antilles, on the Campeche Bank, off Panama, and the northern coast of South America. Lane snapper are found over all bottom types, but are usually encountered around coral reefs and on vegetated sandy areas, in turbid as well as clear water, from 10-400 m depth (Allen 1985 in Froese and Pauly 2002).

***Life History***

This species is moderately resilient, with a minimum population doubling time of 1.4-4.4 years (K = 0.13-0.26; tm = 2; tmax = 10). Maximum reported size is 60 cm TL (male); maximum weight, 3,530 g (Allen 1985 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated in Froese and Pauly (2002) as 26.9 cm TL and 3 years, respectively. Figuerola and Torres (1997) estimate size at 50% maturity as 14.7 cm FL (males) and 18.5 cm FL (females) based on fishery dependent and independent data collected in the U.S. Caribbean. Allen (1985), in Froese and Pauly (2002), report maximum age as 10 years. Studies from northeast Brazil and Cuba used otoliths to estimate ages of this species up to 6 years (Thompson and Munro 1974a). Estimated natural mortality rate is 0.30 (Ault et al. 1998).

***Diet***

This species feeds at night on small fishes, bottom-living crabs, shrimps, worms, gastropods and cephalopods (Allen 1985 in Froese and Pauly 2002). According to Olsen et al. (1984), in Froese and Pauly (2002), it can be ciguatoxic.

***Reproduction and Spawning***

This fish often forms large aggregations, especially during the spawning season (Allen 1985 in Froese and Pauly 2002). Spawning season is protracted, with some degree of reproductive activity occurring practically year-round (Figuerola and Torres 1997). Most spawning occurs from March to September in the U.S. Caribbean (Erdman 1976; Figuerola and Torres 1997) and, with greater intensity, between April and July. Spawning is believed to peak in June and July around the full moon (Figuerola and Torres 1997). Fecundity ranged from 347,000 to 995,000 eggs per fish in a study of six individuals captured off Cuba (Thompson and Munro 1974a).

## Mutton snapper, *Lutjanus analis*

***Distribution and Habitat***

Mutton snapper occur in the Western Atlantic as far north as Massachusetts (USA), southward to southeastern Brazil, including the Caribbean Sea and the Gulf of Mexico. It is most abundant around the Antilles, the Bahamas, and off southern Florida (USA). According to Allen (1985), in Froese and Pauly (2002), mutton snapper can be found in both brackish and marine waters

from 25-95 m depth. Thompson and Munro (1974a) report that this species was captured on mud slopes off the southeast coast of Jamaica at depths of 100-120 m (Thompson and Munro 1974a). Juveniles generally occur closer to shore, over sandy, vegetated (usually Thalassia) bottom habitats, while large adults are commonly found offshore among rocks and coral habitat (Allen 1985 in Froese and Pauly 2002).

***Life History***

This fish is of low resilience, with a minimum population doubling time of 4.5-14 years (K = 0.13-0.25) (Allen 1985 in Froese and Pauly 2002). Allen (1985), in Froese and Pauly (2002), reports maximum size as 94 cm TL (male); maximum weight, 15.6 kg (Allen 1985 in Froese and Pauly 2002). The largest male and female observed in a study conducted in Puerto Rico between February 2000 and May 2001 measured 70 cm FL and 69 cm FL, respectively (Figuerola and Torres 2001). Approximate life span is 14 years (Allen 1985 in Froese and Pauly 2002); natural mortality rate, 0.214 (Ault et al. 1998). Maximum reported age is 17 years (Figuerola and Torres 2001). Size at maturity and age at first maturity are estimated in Froese and Pauly (2002) as 47.3 cm TL and 3.1 years, respectively. Figuerola and Torres (2001) estimate size at 50% maturity as 33 cm FL and 41.4 cm FL for males and females, respectively, based on the Puerto Rican survey. They indicate that all males and females are probably mature at 43.1 cm FL and 45 cm FL, respectively. That study, which was based on fishery dependent data, notes that 53% of males and 72% of females were taken prior to achieving sexual maturity. One study estimated that the ovary of an individual fish contained about 1,355,000 eggs (Thompson and Munro 1974a).

***Diet***

It feeds both day and night on fishes, shrimps, crabs, cephalopods, and gastropods (Allen 1985 in Froese and Pauly 2002). According to Olsen et al. (1984), in Froese and Pauly (2002), it can be ciguatoxic.

***Reproduction and Spawning***

Spawning occurs in aggregations (Figuerola and Torres 2001). Erdman (1976) reports that individuals have been observed in spawning condition in the U.S. Caribbean from February through July (Erdman 1976). Figuerola and Torres (2001) report that some degree of reproduction occurs from February to June, but that spawning activity generally peaks during the week following the full moon in the months of April and May. Spawning aggregations are known to occur north of St. Thomas and south of St. Croix, USVI in March, April, and May (Rielinger 1999).

## Dog snapper, *Lutjanus jocu*

***Distribution and Habitat***

Dog snapper occur in the Western from Massachusetts (USA), southward to northern Brazil, including the Gulf of Mexico and Caribbean Sea. Dog snapper are found from 5-30 m depth. Adults are common around rocky or coral reefs. Young are found in estuaries, and occasionally enter rivers (Allen 1985 in Froese and Pauly 2002).

***Life History***

This species is of low resilience, with a minimum population doubling time of 4.5 - 14 years (K = 0.10; tm = 5.5). Maximum reported size is 128 cm TL (male); maximum weight, 28.6 kg (Allen 1985 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 47.6 cm TL and 6.2 years, respectively. Approximate life span is 28.7 years; natural mortality rate, 0.333 (Ault et al. 1998).

***Diet***

Dog snapper feed mainly on fishes and benthic invertebrates, including shrimps, crabs, gastropods and cephalopods (Allen 1985 in Froese and Pauly 2002). It can be ciguatoxic (Allen 1985 in Froese and Pauly 2002).

***Reproduction and Spawning***

Dog snapper are reported to spawn throughout the year off Cuba (Garcia-Cagide et al. 1999). A Caribbean study collected ripe females in February-March, and one ripe female and one spent male in November (Thompson and Munro 1974a). In the northeastern Caribbean, individuals in spawning condition have been observed in March (Erdman 1976).

## Schoolmaster snapper, *Lutjanus apodus*

***Distribution and Habitat***

Schoolmaster snapper occurs in the Western Atlantic as far north as Massachusetts (USA), southward to Trinidad and northern Brazil, including the Gulf of Mexico and Caribbean Sea. Schoolmaster snapper are found in shallow, clear, warm, coastal waters over coral reefs, from 2-63 m depth. Adults often seeks shelter near elkhorn corals and gorgonians. Juveniles are encountered over sand bottoms with or without seagrass (Thalassia), and over muddy bottoms of lagoons or mangrove areas. Young sometimes enter brackish waters (Allen 1985 in Froese and Pauly 2002).

***Life History***

Allen (1985), in Froese and Pauly (2002), reports maximum sizes as 67.2 cm TL and 75 cm FL for males and females, respectively. The maximum fork length of females captured in a Jamaican study was 57 cm (Thompson and Munro 1974a). Maximum reported weight is 10.8 kg

(Allen 1985 in Froese and Pauly 2002). Size at maturity is estimated as 37.7 cm TL; natural mortality rate, 0.25 (Ault et al. 1998).

***Diet***

Prey items include fishes, shrimps, crabs, worms, gastropods and cephalopods (Allen 1985 in Froese and Pauly 2002). Dammann (1969), in Froese and Pauly (2002), report that it can be ciguatoxic.

***Reproduction and Spawning***

Ripe and/or recently spent fishes have been collected in nearshore and oceanic habitats off Jamaica in February-June and August-November (Thompson and Munro 1974a). Erdman (1976) reports the occurrence of ripe males and females in September. Schoolmaster are reported to spawn during April-June off Cuba (Garcia-Cagide et al. 1994).

## Yellowtail snapper, *Ocyurus chrysurus*

***Distribution and Habitat***

Yellowtail snapper occur in the Western Atlantic from Massachusetts (USA) to southeastern Brazil, including the Gulf of Mexico and Caribbean Sea. This species is most common in the Bahamas, off south Florida, and throughout the Caribbean. Yellowtail snapper inhabit waters to 180 m depth, and usually occur well above the bottom (Allen 1985 in Froese and Pauly 2002). A Jamaican study reports this species was most abundant at depths of 20-40 m near the edges of shelves and banks (Thompson and Munro 1974a). Early juveniles are usually found over seagrass beds (Allen 1985 in Froese and Pauly 2002; Thompson and Munro 1974a). Later juveniles inhabit shallow reef areas. Adults are found on deeper reefs (Thompson and Munro 1974a). This fish wanders a bit more than other snapper species (SAFMC 1999). But the extent of its movement is unknown. It also exhibits schooling behavior (Thompson and Munro 1974a).

***Life History***

This species is of low resilience, with a minimum population doubling time of 4.5-14 years (K = 0.10-0.16; tm = 2; tmax = 14). Maximum reported size is 86.3 cm TL (male); maximum weight, 4,070 g (Allen 1985 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated in Froese and Pauly (2002) as 42.5 cm TL and 4 years, respectively. Figuerola and Torres (1997) estimate size at 50% maturity as 22.4 cm FL (males) and 24.8 cm FL (females), based on fishery independent and dependent data collected off Puerto Rico. Maximum reported age is 14 years (Allen 1985 in Froese and Pauly 2002); estimated natural mortality rate, 0.21 (Ault et al. 2002).

***Diet***

Juvenile yellowtail snappers feed primarily on plankton (Allen 1985 in Froese and Pauly 2002; Thompson and Munro 1974a). Adults feed mainly at night on a combination of planktonic (Allen 1985 in Froese and Pauly 2002), pelagic (Thompson and Munro 1974a), and benthic organisms, including fishes, crustaceans, worms, gastropods and cephalopods (Allen 1985 in Froese and Pauly 2002). Dammann (1969), in Froese and Pauly (2002), reports that it can be ciguatoxic.

***Reproduction and Spawning***

Spawning extends over a protracted period (Allen 1985 in Froese and Pauly 2002; Figuerola and Torres 1997), peaking at different times in different areas (Allen 1985 in Froese and Pauly 2002). Figuerola and Torres (1997) report that, in the U.S. Caribbean, the reproductive season of this fish extends from February to October, with a peak from April to July. Erdman (1976) reports that 80% of adult yellowtails captured off San Juan from March through May, and over Silver Bank in early September, had ripe or sub-ripe gonads. Evidence indicates that spawning occurs in offshore waters (Figuerola and Torres 1997; Thompson and Munro 1974a) and during the new moon (Figuerola and Torres 1997). Fecundity ranged from 100,000 to 1,473,000 eggs per fish in four individuals captured off Cuba (Thompson and Munro 1974a).

## Cubera snapper, Lutjanus cyanopterus

***Distribution and Habitat***

Cubera snapper is distributed in the western Atlantic from Nova Scotia (Canada) 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. Its depth range is one meter to at least 85 m (Lindeman et al. 2000).

***Life History***

***Diet***

***Reproduction and Spawning***

**Groupers, Serranidae**

Groupers are long-lived, slow growing fish. Thirteen groupers are managed as two individual stocks (Nassau grouper and goliath grouper) and four stock complexes in the in the Puerto Rico FMP.

## Nassau grouper, Epinephelus striatus

### *Distribution and Habitat*

Nassau grouper occur in the tropical Western Atlantic, ranging from Bermuda, the Bahamas, and Florida (USA) to southern Brazil. Take and possession of Nassau grouper is prohibited in federal waters and Puerto Rico implemented new regulations on March 12, 2004, to prohibit the possession or sale of Nassau grouper. The Nassau grouper occurs from the shoreline to at least 90 m depth. It is a sedentary, and reef associated species, usually encountered close to caves; although juveniles are common in seagrass beds (Heemstra and Randall 1993 in Froese and Pauly 2002).

### *Life History*

This fish is of low resilience, with a minimum population doubling time of 4.5 - 14 years (Musick et al. 2000 in Froese and Pauly 2002). Maximum reported size is 122 cm TL (male); maximum weight, 25 kg (Heemstra and Randall 1993 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 47.5 cm TL and 6.9 years, respectively. Approximate life span is 31.9 years (Froese and Pauly 2002); maximum reported age, 16 years (Heemstra and Randall 1993 in Froese and Pauly 2002). Ault et al. (1998) estimate natural mortality rate to be 0.18.

### *Diet*

Nassau grouper are top-level predators. Juveniles feed mostly on crustaceans, while adults (>30 cm) forage alone, mainly on fish (NMFS 2001b), but also on crabs and, to a lesser extent, other crustaceans and mollusks (Heemstra and Randall 1993 in Froese and Pauly 2002). Olsen et al. (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

### *Reproduction and Spawning*

This fish was initially characterized as a protogynous hermaphrodite, but recent investigations of histological and demographic data, and the nature of the mating system, indicates that Nassau grouper may not be strictly protogynous. Thus, it has been characterized as gonochoristic (separate sexes), with a potential for sex change (NMFS 2001b). One study reported 785,101 eggs for a specimen of 35.8 cm SL (Thompson and Munro 1974b). Nassau grouper aggregate to spawn at specific times and locations each year (Coleman et al. 2000; Sadovy et al. 1994), reportedly at some of the same sites utilized by the tiger, yellowfin, and black groupers (Sadovy et al. 1994). Concentrated aggregations of a few dozen (NMFS 2001b) up to 30,000 Nassau groupers have been reported from the Bahamas, Jamaica, Cayman Islands, Belize, and the Virgin Islands (Heemstra and Randall 1993 in Froese and Pauly 2002). Spawning aggregations composed of about 2000 individuals have been documented north and south of St. Thomas,

USVI, at 10-40 m depth, from December through February, around the time of the full moon (Rielinger 1999).

According to NMFS (2001b), spawning aggregations occur in depths of 20-40 m at specific locations of the outer reef shelf edge always in December and January around the time of the full moon in waters 25-26 degrees Celsius. Thompson and Munro (1974b) indicate that the spawning season probably extends from January to April in Jamaican waters. They report that spawning aggregations lasting up to two weeks have been encountered annually during late January to early February around the Cayman Islands (Thompson and Munro 1974b). In the northeastern Caribbean, individuals in spawning condition have been observed in March (Erdman 1976).

## Goliath grouper, *Epinephelus itajara*

### *Distribution and Habitat*

Goliath grouper, occur in the Western and Eastern Atlantic, and in the Eastern Pacific Ocean. In the Western Atlantic, its range extends from Florida (USA) to southern Brazil, including the Gulf of Mexico and the Caribbean Sea. Take and possession of Goliath grouper is prohibited in both federal and Puerto Rico implemented new regulations on March 12, 2004, to prohibit the possession or sale of Goliath grouper. A solitary species, Goliath grouper inhabit rock, coral, and mud bottom habitats, from shallow, inshore areas to depths of 100 m (Heemstra and Randall 1993 in Froese and Pauly 2002) or 150 m (NMFS 2001a). Juveniles are generally found in mangrove areas and brackish estuaries. Large adults also may be found in estuaries. T hey appear to occupy limited home ranges with little inter-reef movement (Heemstra and Randall 1993 in Froese and Pauly 2002).

### *Life History*

This species is of low resilience, with a minimum population doubling time of 4.5 - 14 years (K=0.13; tm=5.5-6.5). Maximum reported size is 250 cm TL (male); maximum weight, 455 kg (Heemstra and Randall 1993 in Froese and Pauly 2002). NMFS (2001a) reports that males generally range in size between 80-210 cm TL; females, from 30-220 cm. Estimated size at maturity and age at first maturity are 98 cm TL and 4.3 years, respectively (Froese and Pauly 2002). In the eastern Gulf of Mexico, males were found to mature at 110-115 cm TL, and females at 120-135 cm TL (Bullock et al., 1992), at approximately 6 years of age. Ault et al. (2002) estimate natural mortality rate to be 0.13. Fish taken from exploited populations range to 37 years of age. But it is likely that this species could live much longer than 40 years if left unexploited (NMFS 2001a).

### *Diet*

This fish feeds primarily on crustaceans, particularly spiny lobsters, as well as turtles and fishes, including stingrays.

***Reproduction and Spawning***

This species exhibits definite or strongly suggestive indications of sex reversal (protogynous hermaphrodite) (Thompson and Munro 1974b). It forms consistent aggregations (always containing the largest, oldest individuals in the population), but only during the spawning season (Coleman et al. 2000). Aggregations off Florida declined in the 1980s from 50-100 fish to less than 10 per site. Since the harvest prohibition, aggregations have rebounded somewhat to 20-40 fish per site. Spawning in that area occurs in July through September over full moon phases. Fish may move up to 100 km from inshore reefs to the offshore spawning aggregations in numbers of up to 100 or more on ship wrecks, rock ledges, and isolated patch reefs along the southwest coast (NMFS 2001a). In the northeastern Caribbean, individuals in spawning condition have been observed in July and August (Erdman 1976). Bullock et al. (1992) reported that goliath grouper spawn during June through December with a peak in July to September in the eastern Gulf of Mexico.

## Coney, Epinephelus fulvus

***Distribution and Habitat***

Coney occur in the Western Atlantic, ranging from South Carolina (USA) and Bermuda to southern Brazil, including Atol das Rocas. Wary, but approachable, this species is taken in commercial fisheries and also is utilized in the aquarium trade (Heemstra and Randall 1993 in Froese and Pauly 2002). Coney are sedentary and prefer coral reefs and clear water. They can be found to depths of 150 m.

***Life History***

This fish is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.14-0.63; Fec=67,000). Maximum reported size is 41 cm TL (male). It is a protogynous hermaphrodite (Heemstra and Randall 1993 in Froese and Pauly 2002). Size at maturity and age at first maturity estimated in Froese and Pauly (2002) is 19.8 cm TL and 1.1 years, respectively. Size at 50% maturity for female coneys sampled off the west coast of Puerto Rico is 13 cm FL (Figuerola and Torres 2000). Heemstra and Randall (1993), in Froese and Pauly (2002), report that females mature at 16 cm TL and transform to males at about 20 cm TL. The approximate life span of this fish is 4.5 years; natural mortality rate, 0.18 (Ault et al. 1998).

***Diet***

The diet of this fish is composed primarily of small fishes and crustaceans. It may follow morays and snake eels to feed on flushed preys (Heemstra and Randall 1993 in Froese and Pauly 2002). Olsen et al. (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

***Reproduction and Spawning***

Several studies have indicated that coney do not form spawning aggregations. Spawning occurs in pairs within small groups composed of one male and multiple females. Although ripe ovaries are found from November to March off the west coast of Puerto Rico, spawning activity appears to be limited to several days around the last quarter and new moon phases during January and February (Figuerola and Torres 2000).

## Graysby, Epinephelus cruentatus

***Distribution and Habitat***

Graysby occur in the Western Central Atlantic, from North Carolina to southern Florida (USA), off Bermuda, and in the Gulf of Mexico and Caribbean Sea. Its small size generally makes it of minor importance to commercial fisheries (Heemstra and Randall 1993 in Froese and Pauly 2002). The graysby inhabits seagrass (Thalassia) beds and coral reefs, and can be found to 170 m depth.

***Life History***

This fish is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.34-0.35; tm=3.5-5.5; tmax=9; Fec=260,000). Maximum reported size is 42.6 cm TL (male); maximum weight, 1,130 g. The graysby is hermaphroditic (Heemstra and Randall 1993 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 19.8 cm TL and 2 years, respectively (Froese and Pauly 2002). Approximate life span is 8.1 years; natural mortality rate, 0.20 (Ault et al. 1998).

***Diet***

The brown chromis, has been identified as a preferred food item (Heemstra and Randall 1993 in Froese and Pauly 2002). ). Juveniles feed on shrimp; adults, primarily on fishes. Olsen et al. (1984), in Froese and Pauly (2002), reports that it can be ciguatoxic.

***Reproduction and Spawning***

Graysby are sedentary, solitary, and secretive, usually hiding during the day, and feeding at night. In the northeastern Caribbean, individuals in spawning condition have been observed in March, and in May through July (Erdman 1976). Nagelkerken (1979) determined that graysby collected in the Caribbean were in spawning condition from July through October.

## Black grouper, Mycteroperca bonaci

***Distribution and Habitat***

***Life History***

***Diet***

***Reproduction and Spawning***

## Red grouper, Epinephelus morio

***Distribution and Habitat***

Red grouper occur in the Western Atlantic, ranging as far north as Massachusetts (USA) to southern Brazil, including the Gulf of Mexico and Caribbean Sea. A sedentary species, red grouper are usually found resting on rocky and muddy bottoms, from 5-300 m depth. It is uncommon around coral reefs. Juveniles can be found in shallow water, but adults are usually taken in waters deeper than 60 m.

***Life History***

This fish is of low resilience, with a minimum population doubling time of 4.5 - 14 years (K=0.1-0.18; tm=4-6; tmax=25; Fec=1.4 million). Maximum reported size is 125 cm TL (male); maximum weight, 23 kg. The world record for hook and line is 17.7 lbs, from Cape Canaveral, Florida (Heemstra and Randall 1993 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 47.1 cm TL and 5.2 years, respectively (Froese and Pauly 2002). Maximum reported age is 25 years (Heemstra and Randall 1993 in Froese and Pauly 2002). Estimated natural mortality rate is 0.18 (Ault et al. 1998).

***Diet***

It feeds on a wide variety of fishes and invertebrates (Heemstra and Randall 1993 in Froese and Pauly 2002).

***Reproduction and Spawning***

Red grouper are protogynous hermaphrodites. Most females transform to males between ages 7 to 14. In the northeastern Caribbean, individuals in spawning condition have been observed from February through May (Erdman 1976).

## Tiger grouper, Mycteroperca tigris

***Distribution and Habitat***

Tiger grouper occur in the Western Atlantic, ranging from Bermuda and south Florida (USA) to Venezuela and, possibly, Brazil, including the Gulf of Mexico and Caribbean Sea. A solitary species, the tiger grouper inhabits coral reefs and rocky areas, from 10-40 m depth.

***Life History***

This fish is of low resilience, with a minimum population doubling time of 4.5 - 14 years (K=0.11; tm=6.5-9.5). Maximum reported size is 101 cm TL (male); maximum weight, 10,000 g (Heemstra and Randall 1993 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 39.9 cm TL and 5.8 years, respectively. Approximate life span is 26 years; natural mortality rate, 0.116 (Ault et al. 2002).

***Diet***

The tiger grouper ambushes a variety of fish species, and frequents cleaning stations (Heemstra and Randall 1993 in Froese and Pauly 2002). Off the island of Vieques, predation on tiger groupers by sharks at the time of capture is high (one for every six tiger grouper caught during the seasons of 1997 and 1998), and should be considered in the estimation of the number of fish that are being removed, directly or indirectly, from the fishery (Matos and Posada 1998). Dammann (1969), in Froese and Pauly (2002), reports that it can be ciguatoxic.

***Reproduction and Spawning***

The size-sex ratios described in a Bermuda study indicate this fish is probably a protogynous hermaphrodite (Heemstra and Randall 1993 in Froese and Pauly 2002). It forms aggregations at specific times and locations each year, but only during the spawning season (Coleman et al. 2000; Matos and Posada 1998). A presumptive courting group of three tiger groups also has been observed off the Bahamas, indicating that courtship also may occur in small groups (Sadovy et al. 1994). One known aggregation site in the U.S. Caribbean is a well-defined promontory of deep reef known as "El Seco," which is located about 4.7 nm east of Vieques Island, Puerto Rico. This site was discovered in the early 1980s by a local diver-fisher who also encountered large numbers of yellowfin grouper at the site. The site differs from other aggregation sites described for western Atlantic groupers in that it is relatively level, rather than near a distinct shelf-edge break. Other aggregation sites also have been reported, but not confirmed, including one site north of Vieques Island and another off St. Thomas, USVI. Apparently, both of those sites are used by the yellowfin grouper as well. Aggregating tiger and yellowfin grouper were observed at a site off Guanaja Island, Honduras, that is also used by aggregating Nassau and black grouper (Sadovy et al. 1994).

The "El Seco" tiger grouper aggregation is routinely targeted by fishermen using spear guns and hook and line gear. This fish is only infrequently taken outside of the aggregation season and is not taken by fish traps in the area (Matos and Posada 1998; Sadovy et al. 1994). The aggregation begins about two days after the full moons of February and March and last for about 5-6 days

(Matos and Posada 1998). Females taken from the "El Seco" aggregation in 1997 and 1998 averaged 46.2 cm TL and 48.2 cm TL, respectively; males averaged 53.4 cm TL and 54.0 cm TL, respectively. The female to male ratio was 1:6.4 in 1997 and 1:12.0 in 1998 (Matos and Posada 1998). White et al. (2002) reported that spawning aggregations of tiger grouper occur one week following the full moon during January through April off Puerto Rico.

## Yellowfin grouper, Mycteroperca venenosa

### *Distribution and Habitat*

Yellowfin grouper occur in the Western Atlantic, ranging from Bermuda to Brazil and Guianas, including the Gulf of Mexico and Caribbean Sea. Yellowfin grouper inhabit waters from 2-137 m depth. Juveniles are commonly found in shallow turtle grass beds; adults, on rocky and coral reefs.

### *Life History*

This fish is of low resilience, with a minimum population doubling time of 4.5 - 14 years (K=0.09-0.17; tmax=15; Fec=400,000). Maximum reported size is 100 cm TL (male); maximum weight, 18.5 kg (Heemstra and Randall 1993 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 45.6 cm TL and 3.7 years, respectively. Approximate life span is 16.9 years; natural mortality rate, 0.18 (Ault et al. 1998).

### *Diet*

It feeds mainly on fishes (mostly on coral reef species) and squids (Heemstra and Randall 1993 in Froese and Pauly 2002).

### *Reproduction and Spawning*

This fish is believed to be a protogynous hermaphrodite. One studied specimen contained a total of 1,425,443 eggs (Thompson and Munro 1974b). Yellowfin grouper reportedly aggregate at some of the same sites utilized by the tiger, Nassau, and black groupers (Sadovy et al. 1994). Three spawning aggregation sites have been documented off the USVI. Sites located north and south of St. Thomas are utilized from February through April. A third site located in the USVI National Park off St. John, USVI, is utilized year-round. Individuals aggregating at that site number about 200 (Rielinger 1999). Spawning has been observed in Puerto Rican waters in March. Most spawning appears to occur in Jamaican waters between February and April (Thompson and Munro 1974b).

## Yellowedge grouper, Epinephelus flavolimbatus

### *Distribution and Habitat*

Yellowedge grouper occur in the Western Atlantic, ranging from North Carolina (USA) to southern Brazil, including the Gulf of Mexico and the Caribbean Sea. A solitary and demersal species, yellowedge grouper occur in rocky areas and on sand mud bottom, ranging from 64-275 m (210-892 ft) depth. On soft bottoms, yellowedge grouper are often seen in or near trenches or burrow-like excavations.

***Life History***

This fish is of low resilience in rebuilding from low abundance, with a minimum population doubling time of 4.5 - 14 years (K= 0.10; tmax=35). Maximum reported size is 115 cm (45 inches) TL (male); maximum weight, 18.6 kg (41 pounds; Heemstra and Randall 1993). Estimated size at maturity and age at first maturity are 50.5 cm (20 inches) TL and 6.2 years, respectively (Froese and Pauly 2002). Maximum reported age is 32 years (Heemstra and Randall 1993). Natural mortality rate is estimated at 0.20 (Ault et al.2002).

*Epinephelus flavolimbatus* is listed as "vulnerable" by Ferreira and Peres (2008) owing to an overall 30 percent decline from fisheries catch data throughout much of its range, although catch data suggests much higher declines in some areas. Generation length has been assumed during the assessment as 10 yrs (most certainly an underestimate) and the general biological characteristics of the species, including longevity, formation of aggregations for spawning, and its high desirability in regional fisheries, combined with a lack of effective management of multi-species fisheries in much of the region and pressure on such stocks predicted to increase, make this a vulnerable species. The yellowedge grouper has been managed under a seasonal closure (spawning months) in federal waters since 2005 and in the USVI since 2006 (February through April). Puerto Rico has not implemented a seasonal closure for the species.

***Diet***

It feeds on a wide variety of invertebrates (mainly brachyuran crabs) and fishes (Heemstra and Randall 1993).

***Reproduction and Spawning***

In the northeastern Caribbean, individuals in spawning condition have been observed in April (Erdman 1976). Spawning is reported to occur during April through October in the South Atlantic (Keener 1984) and May through September in the Gulf of Mexico (Bullock et al. 1996).

## Misty grouper, Epinephelus mystacinus

***Distribution and Habitat***

Misty grouper occur in Western Atlantic from Bermuda and North Carolina (USA) to Mexico, including the Gulf of Mexico and Caribbean Sea. The misty grouper is a solitary,

bathydemersal, deep-water species, ranging from 30-400 m depth. Juveniles occur in shallower waters.

***Life History***

Virtually nothing is known about the age, growth, and reproduction of this species. Maximum reported sizes are 160 cm TL and 100 cm TL for males and females, respectively. Maximum reported weight is 107 kg (Heemstra and Randall 1993 in Froese and Pauly 2002). Estimated size at maturity is 81.1 cm TL; natural mortality rate, 0.14 (Froese and Pauly 2002).

***Diet***

Prey items include fishes, crustaceans, and squids (Heemstra and Randall 1993 in Froese and Pauly 2002).

***Reproduction and Spawning***

In the northeastern Caribbean, individuals in spawning condition have been observed in January, April, August, and November (Erdman 1976).

## Yellowmouth grouper, Mycteroperca interstitialis

***Distribution and Habitat***

The yellowmouth grouper is a reef-associated species inhabiting rocky and coral areas in depths from shallow water (mangrove lagoons, Craig et al., 2011) to about 150 m (Heemstra and Randall 1993). Juveniles are present at Bajo de Sico (Sharer et al 2015) in Western Puerto Rico.

***Life History***

***Diet***

***Reproduction and Spawning***

## Red hind, Epinephelus guttatus

***Distribution and Habitat***

Red hind occur in the Western Atlantic, ranging from North Carolina (USA) to Venezuela, including the Caribbean Sea. Red hind are found in shallow reefs and rocky bottoms, from 2-100 m depth. They are usually solitary and territorial.

***Life History***

This species is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.12-0.24; tm=3; tmax=17; Fec=96,000). Maximum reported size is 76 cm TL (male); maximum weight, 25 kg (Heemstra and Randall 1993 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated in Froese and Pauly (2002) as 31.4 cm TL and 5.5 years, respectively. Figuerola and Torres (2000) estimate size at maturity as 21.7 cm FL based on data collected in a study conducted off the west coast of Puerto Rico. The approximate life span of this fish is 23.8 years; natural mortality rate, 0.18 (Ault et al. 1998).

***Diet***

Red hind feed mainly on crabs and other crustaceans, fishes, such as labrids and haemulids, and octopus (Heemstra and Randall 1993 in Froese and Pauly 2002). Halstead (1970), in Froese and Pauly (2002), reports that it can be ciguatoxic.

***Reproduction and Spawning***

Red hind are protogynous hermaphrodites and mean size at sex reversal appears to be in the region of 38 cm TL (Thompson and Munro 1974b). But, according to Heemstra and Randall (1993), in Froese and Pauly (2002), some individuals have been observed to undergo sexual inversion at just 28 cm TL. CFMC (1985) reports size at sex reversal as 35 cm TL. Most fish larger than 40 cm are males, which is important in terms of numbers caught and total weight of landings in the Caribbean (Heemstra and Randall 1993 in Froese and Pauly 2002). One study showed 233,273 eggs for a specimen of 35.8 cm SL (Thompson and Munro 1974b).

This species aggregates in large numbers during the spawning season (Coleman et al. 2000; Sadovy et al. 1994). A number of spawning aggregation sites have been documented in the U.S. Caribbean. Three sites are located off the western coast of Puerto Rico. A fourth site is located near the shelf edge off the southwest coast of Puerto Rico, El Hoyo and La Laja, and is utilized by as many as 3,000 individuals at 20-30 m depth. A fifth site is located on the Lang Bank, north-northeast of St. Croix, and is characterized by aggregations from 38-48 m depth. Finally, a sixth site is located south of St. Thomas, USVI. That aggregation also generally occurs at 38-48 m depth. The timing of aggregations is somewhat variable. Aggregations off Puerto Rico generally occur from January through March in association with the full moon, while those off the USVI generally occur from December through March in association with the full moon (Rielinger 1999).

## Rock hind, Epinephelus adscensionis

***Distribution and Habitat***

Rock hind occur in the Western Atlantic from Massachusetts (USA) to southern Brazil, including the Gulf of Mexico and Caribbean Sea. Rock hind are demersal, inhabiting rocky reef habitats to depths of 120 m.

### *Life History*

This fish is of low resilience, with a minimum population doubling time of 4.5 - 14 years (K=0.11). Maximum reported size is 61 cm TL (male); maximum weight, 4,080 g (Heemstra and Randall 1993 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 28 cm TL and 6.1 years, respectively. Approximate life span is 25.9 years; natural mortality rate, 0.25 (Ault et al. 1998).

### *Diet*

Crabs comprise the majority of its diet, but it also has been observed to feed on fishes and young sea turtles (Heemstra and Randall 1993 in Froese and Pauly 2002). Halstead (1970), in Froese and Pauly (2002), reports that it can be ciguatoxic.

### *Reproduction and Spawning*

This fish has been observed to spawn in aggregations near the shelf edge off the southwest coast of Puerto Rico, at 20-30 m depth, in the month of January (Rielinger 1999). Off Cuba, rock hind have been reported to spawn during January through March (Garcia-Cagide et al. 1994).

## Parrotfishes, Scaridae

Parrotfishes are tropical shallow-water fishes, which commonly occur on or adjacent to coral reef habitat, but also can be found over rocky shores and substrates. These fish are herbivores, and most species feed on algae scraped from dead coral substrates. The common practice of consuming and crushing bits of rock along with the algae to aid in the digestive process make these fishes some of the most important producers of sand on coral reefs (Nelson 1994 in Froese and Pauly 2002). Six parrotfish species are managed in two stock complexes in the Puerto Rico FMP.

# Blue parrotfish, *Scarus coeruleus*

### *Distribution and Habitat*

Blue parrotfish occur in the Western Atlantic, ranging from Maryland (USA) and Bermuda to Brazil, including the Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002). Blue parrotfish inhabit coral reef habitat, occurring from 3-25 m depth. Juveniles are found on seagrass (Thalassia) beds.

### *Life History*

Maximum reported size is 120 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Estimated size at maturity is 62.9 cm TL; natural mortality rate, 0.43 (Froese and Pauly 2002).

### *Diet*

Dietary items include benthic plants and small organisms in the sand (Robins and Ray 1986 in Froese and Pauly 2002).

### *Reproduction and Spawning*

This fish is known to form large spawning aggregations (Robins and Ray 1986 in Froese and Pauly 2002). In Jamaican waters, the highest proportion of active and ripe fishes occurs between January and May (Reeson 1975b).

## Midnight parrotfish, Scarus coelestinus

### *Distribution and Habitat*

Midnight parrotfish occur in the Western Atlantic, ranging from Bermuda to Brazil, including the Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002). Midnight parrotfish occur from rocky coastal reefs to seaward reefs, in depths of 5-75 m.

### *Life History*

Maximum reported size is 77 cm TL (male); maximum weight, 7,000 g (Robins and Ray 1986 in Froese and Pauly 2002).

### *Diet*

It is often encountered in schools, feeding on algae along with surgeonfishes.

### *Reproduction and Spawning*

The midnight parrotfish has been observed to spawn in pairs. A Jamaican study reported that the highest proportion of active and ripe fishes was confined to the period between January and May. Spawning seems to be confined to the warmer months of the year in Bermuda (Reeson 1975b).

## Rainbow parrotfish, Scarus guacamaia

### *Distribution and Habitat*

Rainbow parrotfish occurs in the Western Atlantic, ranging from Bermuda to Argentina, including the Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002). Rainbow parrotfish are found from 3-25 m depth. Juveniles are commonly encountered in mangrove areas.

### *Life History*

Maximum reported size is 120 cm TL (male); maximum weight, 20 kg (Robins and Ray 1986 in Froese and Pauly 2002). Estimated size at maturity is 62.9 cm TL; natural mortality rate, 0.43 (Froese and Pauly 2002).

***Diet***

This fish feeds primarily on benthic algae (Robins and Ray 1986 in Froese and Pauly 2002).

***Reproduction and Spawning***

In Jamaican waters, the highest proportion of active and ripe fishes appear to be confined to the period between January and May (Reeson 1975b). In the northeastern Caribbean, individuals in spawning condition have been observed in June and July (Erdman 1976).

## Princess parrotfish, Scarus taeniopterus

***Distribution and Habitat***

Princess parrotfish occur in the Western Atlantic, ranging from Bermuda to Brazil, and throughout the Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002). Princess parrotfish are found on coral or rock bottoms, from 2-25 m depth. Juveniles often occur in association with seagrass(Thalassia).

***Life History***

Maximum reported size is 35 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 21.2 cm TL; natural mortality rate, 0.88 (Froese and Pauly 2002).

***Diet***

It feeds on plants in large aggregations, and sleeps in a mucus cocoon (Robins and Ray 1986 in Froese and Pauly 2002).

***Reproduction and Spawning***

This species appears to spawn throughout the year in Jamaican waters, with the highest proportion of ripe fishes occurring in December and January (Reeson 1975b).

## Queen parrotfish, Scarus vetula

***Distribution and Habitat***

Queen parrotfish occur in the Western Central Atlantic, ranging from Bermuda to northern South America, and throughout the Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002). Queen parrotfish inhabit coral reefs and adjacent habitats, from 3-25 m depth.

### *Life History*

Maximum reported size is 61 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 30.6 cm TL and 1.1 years, respectively. Approximate life span is 4.8 years; natural mortality rate, 1.05 (Froese and Pauly 2002).

### *Diet*

Qqueen parrotfish feed on algae and sleeps in a mucus cocoon (Robins and Ray 1986 in Froese and Pauly 2002).

### *Reproduction and Spawning*

It is often observed in groups of one supermale with several young adults, most of which are believed to be females. In the northeastern Caribbean, individuals in spawning condition have been observed in January, February, May, June, and August (Erdman 1976). Spawning pairs have been observed in August and January off the Virgin Islands and Puerto Rico, respectively (Reeson 1975b).

## Redtail parrotfish, Sparisoma chrysopterum

### *Distribution and Habitat*

Redtail parrotfish occur in the Western Atlantic, ranging from southern Florida (USA) to Brazil, and throughout the Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002). Redtail occur in coral reefs and adjacent habitats to depths of 15 m. Juveniles most commonly inhabit seagrass beds.

### *Life History*

Maximum reported size is 46 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated in Froese and Pauly (2002) as 23.9 cm FL and 0.9 years, respectively; approximate life span, 3.6 years. Estimated size at 50% maturity based on fishery independent and dependent data collected from Puerto Rican waters is 23.5 cm FL (females). Transitional fish ranged from 20.1 cm FL to 24.8 cm FL (Figuerola and Torres 1997).

### *Diet*

Redtail parrotfish feed on benthic algae and seagrasses (Robins and Ray 1986 in Froese and Pauly 2002).

### *Reproduction and Spawning*

Spawning period is protracted. According to Figuerola and Torres (1997), no peaks are apparent in the U.S. Caribbean, but spawning activity appears to decrease during the summer (May through August). Data from a Jamaican study indicate that the highest proportion of active and ripe fishes occurs between January and May (Reeson 1975b).

## Stoplight parrotfish, Sparisoma viride

### *Distribution and Habitat*

The stoplight parrotfish occurs in the Western Atlantic, ranging from southern Florida (USA) to Brazil, and throughout the Caribbean Sea (Cervigón et al. 1992 in Froese and Pauly 2002). Stoplight parrotfish inhabit clear water coral reefs, occurring from 3-49 m depth. Juveniles may be found in seagrass beds and other heavily vegetated bottoms. This species is strictly diurnal, and spends the night resting on the sea bottom. It occurs singly or in small groups.

### *Life History*

Maximum reported size is 64 cm TL (male); maximum weight, 1,600 g. Size at maturity is estimated in Froese and Pauly (2002) as 36.1 cm TL; natural mortality rate, 0.66. Size at 50% maturity estimated from a survey conducted off Puerto Rico is 20.5 cm FL (females) (Figuerola and Torres 1997) . A Bermuda study reports that males mature at 16-20 cm SL and females at 16.3 cm SL (Reeson 1975b).

### *Diet*

This fish feeds primarily on soft algae, but also has been observed to graze on live corals, such as Montastrea annularis. It produces a significant amount of sediment through bioerosion using its strong beak-like jaws and constantly regrowing teeth (Cervigón et al. 1992 in Froese and Pauly 2002).

### *Reproduction and Spawning*

This fish is a protogynous hermaphrodite, functioning first as a female and, later, as a male (Cervigón et al. 1992 in Froese and Pauly 2002). Spawning period is protracted. According to Figuerola and Torres (1997), no peaks are apparent in the U.S. Caribbean, but spawning activity appears to decrease during the summer (May through August). Paired spawning has been observed in May off the Virgin Islands (Reeson 1975b).

## Redband parrotfish, Sparisoma aurofrenatum

### *Distribution and Habitat*

Redband parrotfish occur in the Western Atlantic, ranging from Bermuda to Brazil, and throughout the Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002). Redband

parrotfish inhabit coral reefs, occurring from 2-20 m depth. Juveniles are usually found in adjacent seagrass beds. It is often observed resting on the sea bottom, either solitary or in small groups.

***Life History***

This species is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.20). Maximum reported size is 28 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 17.4 cm TL; natural mortality rate, 1.14 (Froese and Pauly 2002).

***Diet***

It feeds on plants (Robins and Ray 1986 in Froese and Pauly 2002).

***Reproduction and Spawning***

Reeson (1975b) reports that spawning has been observed to occur off the Virgin Islands in the months of March, April, June, and August. Erdman (1976) reports that individuals also have been observed in spawning condition in the northeastern Caribbean in February and December (Erdman 1976). Ripe fishes have been caught in both the nearshore and offshore environment. Paired spawning has been observed (Reeson 1975b).

## Striped parrotfish, Scarus croicensis

***Distribution and Habitat***

Striped parrotfish occurs in the Western Atlantic, ranging from Bermuda to northern South America (and possibly Brazil), including the Gulf of Mexico and Caribbean Sea (Böhlke and Chaplin 1993). Striped parrotfish is found over shallow, clear waters, from 3-25 m depth. It is a schooling species, and generally occurs over seagrass (Thalassia) beds, but also is found in rocky or coral areas.

***Life History***

Maximum reported size is 35 cm TL (male) (Böhlke and Chaplin 1993). Size at maturity is estimated in Froese and Pauly (2002) as 21.2 cm TL; natural mortality rate, 0.61. A study conducted in Bermuda reports that males mature at 11-13 cm SL and females, at 9-10 cm SL (Reeson 1975b).

***Diet***

It feeds on plants (Böhlke and Chaplin 1993).

***Reproduction and Spawning***

Supermales spawn individually with striped females, while sexually mature males in the striped phase spawn in aggregations (Böhlke and Chaplin 1993) of up to 400 individuals (Reeson 1975b). One spawning aggregation site has been documented off the southwest coast of Puerto Rico. Striped parrotfish have been observed to spawn at that site in winter months at about 20-30 m depth (Rielinger 1999). This species has been observed to spawn in the Virgin Islands in February, March, April, June, and August. Deeper reef fronts (15- 20 m) appear to be the focal points for spawning groups. It has been observed to migrate daily among specific routes (Reeson 1975b).

**Surgeonfishes, Acanthuridae**

Surgeonfish are commonly found in small groups, or larger aggregations, usually in association with coral reef habitat. Almost entirely herbivorous, they compete with parrotfishes, various damselfishes, filefishes, and others for algae and plants. Three surgeonfish species are managed as one stock complex in the Puerto Rico FMP.

## Blue tang, Acanthurus coeruleus

***Distribution and Habitat***

In the Western Atlantic, blue tang range from New York (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. Blue tang are generally encountered in coral reef, or inshore grassy or rocky habitats, from 2-40 m depth (Robins and Ray 1986 in Froese and Pauly 2002). Characterized as a suprabenthic nomad, this species is generally solitary in the evening hours (Reeson 1975a), but also has been observed in small and large groups.

***Life History***

This fish is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.11-0.50). Maximum reported size is 39 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Length and age at first maturity is estimated as 23.3 cm TL and 6.3 years, respectively. Approximate life span is 25.8 years; natural mortality rate, 0.32 (Froese and Pauly 2002).

***Diet***

Blue tang feed almost entirely on algae (Robins and Ray 1986 in Froese and Pauly 2002), but also consumes organic detritus and seagrasses (Reeson 1975a).

***Reproduction and Spawning***

A study conducted in Jamaican waters reported the occurrence of high proportions of active and/or ripe fishes during most months of the year on the oceanic banks, and few fishes with active gonads in the nearshore environment (Reeson 1975a). Rielinger (1999) describes one

aggregation site documented off Puerto Rico, which is located south of Salinas de Ensenada & Guanica. About 6000-7000 individuals reportedly spawn at that site in association with the full to new moon. These aggregations occur at 10-30 m depth (Rielinger 1999). Studies in the Bahamas also have observed what appeared to be pre-spawning aggregations late in the day (Reeson 1975a).

## Ocean surgeonfish, Acanthurus bahianus

### *Distribution and Habitat*

In the Western Atlantic, ocean surgeonfish range from Massachusetts (USA), southward to Brazil, including the Gulf of Mexico and Caribbean Sea. Ocean surgeonfish inhabit shallow bottom habitats with coral or rocky formations, in depths from 2-40 m (Robins and Ray 1986 in Froese and Pauly 2002). It also may be encountered over algal plains and seagrass beds that lie adjacent to reef habitats. Characterized as a benthic resident (Reeson 1975a), this species usually occurs in groups of five or more individuals (Robins and Ray 1986 in Froese and Pauly 2002), and commonly schools with the doctorfish, Acanthurus chirurgus (Reeson 1975a).

### *Life History*

Maximum reported size is 38.1 cm SL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at first maturity is estimated in Froese and Pauly (2002) as 22.8 cm SL. But Reeson (1975b) provides a smaller estimate of 11 cm FL based on a study conducted in Jamaican waters.

### *Diet*

This fish feeds primarily on algae and seagrasses, but also consumes a great deal of inorganic material (e.g., sand, small shells, etc.), which is believed to aid in the digestive process. It also has been observed to feed on dead fish both in traps and in fish pens (Reeson 1975a).

### *Reproduction and Spawning*

Breeding is believed to occur year round off Jamaica, with peak spawning activity occurring from January to February and from August to September (Reeson 1975a). In the northeastern Caribbean, individuals in spawning condition have been observed in February, April, and November (Erdman 1976). One spawning aggregation composed of about 20,000 individuals has been documented south of Salinas de Ensenada and Guanica, Puerto Rico, at 15-18 m depth, from November through April (Rielinger 1999).

## Doctorfish, Acanthurus chirurgus

### *Distribution and Habitat*

In the Western Atlantic, doctorfish range from Massachusetts (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. Doctorfish are generally found in loose aggregations from depths of 2-24 m in shallow reefs or rocky areas (Robins and Ray 1986 in Froese and Pauly 2002), but may also be encountered over adjacent algal plains and seagrass beds (Reeson 1975a). It is characterized as a suprabenthic nomad, and commonly schools with the ocean surgeonfish, Acanthurus bahianus (Reeson 1975a).

***Life History***

This fish is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.25-0.50). Maximum reported size is 35 cm TL (male); maximum weight, 5,100 g (Robins and Ray 1986 in Froese and Pauly 2002). Length and age at first maturity is estimated as 19.4 cm TL and 2.7 years, respectively (Froese and Pauly 2002). The approximate life span of the doctorfish is 10.9 years. Estimated natural mortality rate is 0.64 (Froese and Pauly 2002).

***Diet***

It feeds primarily on algae but, like the ocean surgeonfish, ingests inorganic material in the process (Reeson 1975a; Robins and Ray 1986 in Froese and Pauly 2002).

***Reproduction and Spawning***

A study conducted in Jamaican waters observed the occurrence of ripe individuals in catches taken from September to November, and the highest proportions of active fish from January to May (Reeson 1975a). In the northeastern Caribbean, individuals in spawning condition have been observed in January, February, and June (Erdman 1976).

**Triggerfish, Balistidae**

Triggerfish are a popular target of subsistence fishing on many islands. Three triggerfish species are managed as one stock complex in the Puerto Rico FMP.

## Queen triggerfish, Balistes vetula

***Distribution and Habitat***

Queen triggerfish occur in the Western Atlantic from Massachusetts (USA) to southeastern Brazil, including the Gulf of Mexico and Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002). Erdman (1976) reported that this species is commonly caught in fish pots in the northeastern Caribbean. Queen triggerfish are generally found over rocky or coral areas, from depths of 2-275 m. It also has been observed over sand and grassy areas (Robins and Ray 1986 in Froese and Pauly 2002). There is some evidence that juveniles tend to inhabit shallower

waters, then move into deeper water as they mature (Aiken 1975b). This fish may school, but also has been observed alone and in small groups (Aiken 1975b; Robins and Ray 1986 in Froese and Pauly 2002).

***Life History***

The queen triggerfish is reportedly moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.15-0.57). Maximum reported size is 60 cm TL (male); maximum weight is 5,440 g (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity, and age at first maturity, are estimated in Froese and Pauly (2002) as 40.8 cm TL and 2.8 years, respectively. Aiken (1975b) estimates mean size at maturity as 26.5 cm fork length (FL) and 23.5 cm for males and females, respectively, collected in a Jamaican study. Fecundity measured in 3 individuals averaged 73 eggs per gram body weight. Approximate life span is 12.5 years. Estimated natural mortality rate is 0.48 (Froese and Pauly 2002).

***Diet***

Approximate life span is 12.5 years. Estimated natural mortality rate is 0.48 (Froese and Pauly 2002). It is considered to be an excellent food fish, but its liver is poisonous (Robins and Ray 1986 in Froese and Pauly 2002).

***Reproduction and Spawning***

Peak spawning occurred from January to February and from August to October (Aiken 1975b). In the northeastern Caribbean, individuals in spawning condition have been observed from February through June (Erdman 1976). This fish primarily feeds on benthic invertebrates, such as sea urchins (Robins and Ray 1986 in Froese and Pauly 2002).

## Ocean triggerfish, Canthidermis sufflamen

***Distribution and Habitat***

Ocean triggerfish occur in the Western Atlantic from Massachusetts (USA) to South America, including the Gulf of Mexico and Caribbean Sea. Ocean triggerfish occur from 5-60 m depth (Robins and Ray 1986 in Froese and Pauly 2002), usually in mid-water or at the surface (Aiken 1975b), and is often associated with Sargassum. Adults are commonly encountered near dropoffs of seaward reefs, but occasionally occur in shallow waters as well (Robins and Ray 1986 in Froese and Pauly 2002). This fish is sometimes solitary, but also is known to form small groups in open water (Aiken 1975b; Robins and Ray 1986 in Froese and Pauly 2002). It has also been observed to form schools of well over 50 individuals.

***Life History***

Maximum reported size is 65 cm TL (male); maximum weight, 6,120 g (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 36.6 cm TL (Froese and Pauly 2002). The fecundity of four individuals taken from Jamaican waters averaged 217 eggs per gram body weight. Estimated natural mortality rate is 0.57 (Froese and Pauly 2002).

***Diet***

This species feeds primarily on large zooplankton (Robins and Ray 1986 in Froese and Pauly 2002), but also has been observed to consume benthic invertebrates (Aiken 1975b).

***Reproduction and Spawning***

Ripe fishes have been observed off Jamaica in January, May, August, September and December, with a maximum in September (Aiken 1975b). In the northeastern Caribbean, individuals in spawning condition have been observed in April (Erdman 1976).

## Gray Triggerfish, Balistes capriscus

***Distribution and Habitat***

Depth range from 0 - 100 m.

***Life History***

***Diet***

***Reproduction and Spawning***

**Wrasses, Labridae**

Three wrasses are managed in the Puerto Rico FMP as one stock (hogfish) and one stock complex (puddingwife and Spanish hogfish).

## Hogfish, Lachnolaimus maximus

***Distribution and Habitat***

Hogfish occur in the Western Atlantic from Nova Scotia (Canada) to northern South America, including the Gulf of Mexico and Caribbean Sea (Robins and Ray 1986 in Froese and Pauly 2002). Hogfish are found from 3-30 m depth, over open bottoms or coral reef habitats. It is often encountered where gorgonians are abundant.

***Life History***

This species is of low resilience, with a minimum population doubling time 4.5 - 14 years (K=0.09; Fec=100,00). Maximum reported size is 91 cm TL (male); maximum weight, 10,000 g (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 46.1 cm FL and 6.9 years. Approximate life span is 31.9 years (Froese and Pauly 2002). Natural mortality rate is estimated at 0.25 (Ault et al. 1998).

***Diet***

Mollusks constitute the primary prey item, but this species also feeds on crabs and sea urchins (Robins and Ray 1986 in Froese and Pauly 2002). It can be ciguatoxic (Robins and Ray 1986 in Froese and Pauly 2002).

***Reproduction and Spawning***

Spawning aggregations have been documented to occur at 16+ m depth off La Parguera, Puerto Rico from December through April (Rielinger 1999). Garcia-Cagide et al. (1994) reported that hogfish spawn off Cuba during May through July. Colin (1982) found that peak spawning of hogfish off Puerto Rico is during December through April.

## Spanish hogfish, Bodianus rufus

***Distribution and Habitat***

Spanish hogfish occur in the Western Atlantic from Bermuda and southern Florida (USA) to southern Brazil, including the Gulf of Mexico and Caribbean Sea. Spanish hogfish are found to 70 m depth over rocky or coral reefs.

***Life History***

Maximum reported size is 40 cm TL (male); maximum weight, 1,020 g (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity is estimated as 23.8 cm TL; natural mortality rate, 0.80 (Froese and Pauly 2002).

***Diet***

This fish feeds on brittle stars, crustaceans, mollusks, and sea urchins. Juveniles actively pick parasites from larger fishes (Robins and Ray 1986 in Froese and Pauly 2002). Dammann (1969), in Froese and Pauly (2002), report that it can be ciguatoxic.

***Reproduction and Spawning***

In the northeastern Caribbean, individuals in spawning condition have been observed in February (Erdman 1976).

## Puddingwife, Halichoeres radiates

### *Distribution and Habitat*

Puddingwife occur in the Western Atlantic from Bermuda and North Carolina (USA) to Brazil, including the Gulf of Mexico (Robins and Ray 1986 in Froese and Pauly 2002) and Caribbean Sea. Adult puddingwife wrasses are found on shallow patch or seaward reefs down to 55 m. Juveniles usually occur in shallower (1-5 m) coral reefs.

### *Life History*

Maximum reported size is 51 cm TL (male) (Robins and Ray 1986 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated as 25.5 cm TL and 1.2 years, respectively. Approximate life span is 4.8 years; natural mortality rate, 1.09 (Froese and Pauly 2002).

### *Diet*

Prey items include mollusks, sea urchins, crustaceans, and brittle stars (Robins and Ray 1986 in Froese and Pauly 2002). Olsen et al. (1984), in Froese and Pauly (2002), report that it can be ciguatoxic.

### *Reproduction and Spawning*

In the northeastern Caribbean, individuals in spawning condition have been observed in March, April, and December (Erdman 1976).

**Angelfishes, Pomacanthidae**

Angelfish are large, flat, disk-shaped reef fish that are usually easily identifiable by their brightly colored or boldly striped bodies. Three angelfish are managed in the Puerto Rico FMP in one stocks complex.

## Queen angelfish, Holacanthus ciliaris

### *Distribution and Habitat*

The queen angelfish occurs in both the Western and Eastern Central Atlantic Oceans. In the

Western Atlantic, its range extends from Florida (USA) and the Bahamas to Brazil, including the Gulf of Mexico and Caribbean Sea. Queen angelfish are found on coral reefs primarily in shallow waters, but have been observed at depths of 80 m (Humann and DeLoach 2014). Juveniles are solitary and live primarily in and around colonies of finger sponges and coral (Feddern 1968).

### *Life History*

Maximum reported size for the queen angelfish is 45 cm (18 in) (Humann and DeLoach 2014) and common length is 30 cm (12 in) TL (Carpenter 2002). Maximum weight reported is 1,600 g (Claro 1994 in Froese and Pauly 2017). Estimated size at maturity is 26.5 cm TL; natural mortality rate, 0.4; approximate life span 13 years (Froese and Pauly 2011). Based on empirical models, Froese and Pauly (2011) estimate the queen angelfish to be a medium resilience fish, with a minimum population doubling time of approximately 1.4 - 4.4 years.

***Diet***

The queen angelfish has been reported to prey almost exclusively on sponges, supplemented by small amounts of algae, tunicates, hydroids and bryozoans (Randall and Hartman 1968; Andrea et al. 2007). Juveniles eat algae until they reach sexual maturity (DeLoach 1999) and have been observed cleaning ectoparasites from other fishes (Randall 1967). This species poses a low risk for ciguatera poisoning (Olsen et al. 1984; Böhlke and Chaplin 1993) and recent surveys conducted in Puerto Rico do not list angelfish as fish species that induced ciguatera poisoning (Azziz-Baumgartner et al. 2012).

***Reproduction and Spawning***

Queen angelfish are protogynous hermaphrodites (Nottingham et al. 2003), meaning they are born male and at some point switch sexes to female. Their courtship structure consists of male-dominated harems, although spawning only occurs in pairs (Moyer et al. 1983) and no large spawning aggregations have been observed (Aiken 1975). Ripe queen angelfish were observed within one year from January to August with a peak in April (Munro et al. 1983) although Aiken (1975) observed over a 5-year period that the majority of ripe fish were observed in September-October and that all fish were inactive during November-December. Spawning occurs at sunset, and throughout the lunar cycle (DeLoach 1999; Moyer er al. 1983) and in Puerto Rico, spawning activity has been observed near the shelf edge (Moyer et al. 1983; Colin and Clavijo 1988). Queen Angelfish are pelagic spawners (Thresher 1984; Colin and Clavijo 1988), releasing their gametes into the water column. Larvae hatch after 15-20 hours and within three to four weeks the juveniles settle in the shallow water habitats (DeLoach 1999). Hybridization has been known to occur between *H. ciliaris* and *H. isabelita* (Feddern 1968).

## Gray angelfish, Pomacanthus arcuatus

***Distribution and Habitat***

The gray angelfish occurs in the Western Atlantic, ranging from New England (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. Gray angelfish swim about coral reefs, often in pairs, at depths ranging from 10 to 80 m and juveniles are usually found on shallow-water patch reef and grass flats (Humann and DeLoach 2014). Gray angelfish spend the day roaming their territories, with their mates at their side, and seldom take shelter (DeLoach 1999).

### *Life History and Biology*

Maximum reported size for the gray angelfish is 60 cm (24 in) TL (Humann and DeLoach 2014) and common length is 36 cm (14 in) TL (Carpenter 2002). Maximum weight reported is 2,550 g and a maximum observed age from otoliths was 24 years (Steward et al. 2009). Growth equations from that study indicated rapid growth during the first five years and estimated that females would reach their asymptotic length of 325mm TL at age six, and males would reach 388mm TL at age nine. Estimated size at maturity is 34.1 cm TL; natural mortality rate, 0.42 (Froese and Pauly 2002).

### *Diet*

Approximately 70% of gray angelfish diet is various species of sponges, followed by tunicates, algae, zoantharians, gorgonians, hydroids, byrozoans, and seagrasses (Randall and Hartman 1968). Visual feeding surveys reported gray angelfish eating small amounts of multiple sponges, moving to a new sponge after only 2.8 bites, notably selecting a different sponge species 92% of the time, indicating active diet diversification and suggesting that gray angelfish have the ability to distinguish sponge species from each other (Wulff 1994). Juveniles mostly eat algae, but they also act part-time as cleaner fish, picking ectoparasites off other reef fishes, until such a time that they reach three inches in length (DeLoach 1999). This species poses a low risk for ciguatera poisoning (Olsen et al. 1984; Böhlke and Chaplin 1993) and recent surveys conducted in Puerto Rico do not list angelfish as fish species that induced ciguatera poisoning (Azziz-Baumgartner et al. 2012).

### *Reproduction and Spawning Characteristics*

Gray angelfish are not believed to undergo any sex change during growth to maturity (DeLoach 1999). This species is generally observed in pairs, suggesting that they are monogamous (Thresher 1984), but polygamous activity has been reported by Moyer et al. (1983). Regardless of the reproductive orientation, spawning always occurs in pairs and at sunset (Moyer er al. 1983; Colin and Clavijo 1988; DeLoach 1999) and in Puerto Rico, spawning activity has been observed near the shelf edge (Moyer et al. 1983). Over the course of a year, ripe gray angelfish were observed in February through June with a peak in March (Munro et al. 1973). However, Aiken (1983) observed the greatest percentage of ripe gray angelfish in October and January.

Fecundity estimates for female gray angelfish range from 16,150 to 126,000 eggs per individual and 50 to 123 eggs per gram body weight (Aiken 1975).

## French angelfish, Pomacanthus paru

### *Distribution and Habitat*

The french angelfish occurs in both the Western and Eastern Atlantic. In the Western Atlantic, it ranges from Florida (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. Adult french angelfish swim about coral reefs, often in pairs, at depths ranging from 15 to 80 m and juveniles inhabit reefs and sandy bottoms, often near holes or protective hard bottom crevices (Humann and DeLoach 2014). French angelfish are similar to gray angelfish in their social, feeding and reproductive behaviors (DeLoach 1999) and large, intraspecifically exclusive home ranges with similar patterns of shallow, medium depth, and deep bands of contiguous home ranges up to 2,300 $m^2$ (Hourigan et al. 1989).

***Life History***

This fish is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.21). Maximum reported size is 41.1 cm TL (Allen 1985 in Froese and Pauly 2002). Estimated size at maturity and age at first maturity are 26.7 cm TL and 3.2 years, respectively. Approximate life span is 13.6 years; natural mortality rate, 0.50 (Froese and Pauly 2002). French angelfish size ranges from 10-14 inches, with a maximum observed size of 18 inches (Humann and DeLoach 2014).

***Diet***

This fish feeds on sponges, algae, bryozoans, zoantharians, gorgonians and tunicates. Juveniles tend cleaning stations, servicing jacks, snappers, morays, grunts, surgeonfishes, wrasses, and other reef fish (Allen 1985 in Froese and Pauly 2002). This species poses a low risk for ciguatera poisoning (Olsen et al. 1984; Böhlke and Chaplin 1993) and recent surveys conducted in Puerto Rico do not list angelfish as fish species that induced ciguatera poisoning (Azziz-Baumgartner et al. 2012).

***Reproduction and Spawning Characteristics***

In the northeastern Caribbean, individuals in spawning condition have been observed in March and May (Erdman 1976). Feitosa *et al*. (2015) detected no sign of hermaphroditism in French angelfish collected from fish traps in Brazil and classified the species as a gonochorist fish. French angelfish also form mated pairs but little is known about their actual spawning behavior.

**Grunts, Haemulidae**

Grunts are [DESCRIPTION]. The only species included for management in the Puerto Rico FMP is the white grunt.

## White grunt, Haemulon plumieri

***Distribution and Habitat***

Also known simply as, the "grunt," this species occurs in the Western Atlantic, ranging from Chesapeake Bay (USA) to Brazil, including the Gulf of Mexico and Caribbean Sea. White grunt are found from 3-40 m depth, in dense aggregations during the day on patch reefs, around coral formations, or on sandy bottoms. Juveniles commonly inhabit seagrass (Thalassia testudinum) beds.

***Life History***

This fish is moderately resilient, with a minimum population doubling time of 1.4 - 4.4 years (K=0.16-0.35; tm=2; tmax=13; Fec=64,000). Maximum reported size is 53 cm TL (male); maximum weight, 4,380 g (Courtenay and Sahlman 1978 in Froese and Pauly 2002). Size at maturity and age at first maturity are estimated in Froese and Pauly (2002) as 27.2 cm TL and 2.6 years, respectively. A study in Jamaican waters reported mean size at maturity as about 20 cm FL and 22 cm FL for males and females, respectively. Males and females appeared to be fully mature at 24-24.9 cm FL and 26-27.9 cm FL, respectively (Gaut and Munro 1974). Approximate life span is 11 years; natural mortality rate, 0.375 (Ault et al. 1998).

***Diet***

White grunt feed on crustaceans, small mollusks, and small fishes.

***Reproduction and Spawning***

Peak breeding season appears to be between January and April in Jamaican waters, with a secondary, minor peak in September-November (Gaut and Munro 1974). In the northeastern Caribbean, individuals in spawning condition have been observed from February through April, and in September and November (Erdman 1976). Frequently exhibits a territorial "kissing" display, in which two contenders push each other on the lips with their mouths wide open (Courtenay and Sahlman 1978 in Froese and Pauly 2002).

**Jacks, Carangidae**

Jacks are small to large sized fish with varying body shapes with two dorsal fins, and a forked caudal fin. Jacks are some of the most important tropical marine fishes for commercial, subsistence, and recreational fisheries (Nelson 1984 in Froese and Pauly 2002). Three jacks are managed as individual stocks in the Puerto Rico FMP.

## Crevalle jack, Caranx hippos

***Distribution and Habitat***

Crevalle jacks are found in the Western Atlantic from Nova Scotia (Canada) and northern Gulf of Mexico to Uruguay, including the Greater Antilles (Frose and Pauly). Depth range is depth range 1 - 350 m. Crevalle jacks are generally found in neritic waters over the continental shelf,

from the coastline, where it is common on shallow flats, to offshore waters. Juveniles are abundant in brackish estuaries with muddy bottoms, near sandy beaches and on seagrass beds, entering lagoons and lower courses of rivers. They form fast-moving schools, although larger fish may be solitary.

***Life History***

Maximum length is 124 cm TL and the maximum published weight is 32.0 kg (Frose and Pauly).

***Diet***

Crevalle jacks are known to feed on smaller fish, shrimp, and other invertebrates (Frose and Pauly).

***Reproduction and Spawning***

Eggs are pelagic (Frose and Pauly).

## African pompano, Alectis ciliaris

***Distribution and Habitat***

***Life History***

***Diet***

***Reproduction and Spawning***

## Rainbow runner, Elagatis bipinnulata

***Distribution and Habitat***

Rainbow runner are found in the Western Atlantic from Massachusetts (USA) and the northern Gulf of Mexico to Rio de Janeiro, Brazil. Their depth range is depth range 0 - 150 m (Frose and Pauly). Adults are found in oceanic and coastal waters, generally near the surface over reefs or sometimes far offshore around floating structures. They may form large schools.

***Life History***

Maximum length is 180 cm TL and the maximum published weight is 46.2 kg (Frose and Pauly). The maximum reported age is 6 years.

***Diet***

Rainbow runner feed on invertebrates, mainly on larger crustaceans of the zooplankton, and small fishes (Frose and Pauly).

### *Reproduction and Spawning*

Eggs are pelagic (Frose and Pauly).

## Barracuda

### *Distribution and Habitat*

Western Atlantic from Massachusetts (USA), Bermuda, and throughout the Caribbean Sea to Brazil. Found predominantly at or near the surface. Juvenile occurs among mangroves, estuaries and shallow sheltered inner reef areas; adult occurs in a wide range of habitats from murky inner harbors to open seas. Diurnal and solitary, but can also be found in small aggregations. Depth range 1 - 100 m. Adult barracudas are usually solitary being found in deeper water in and over the shelf edge both near the surface and benthos (personal observation).

Postlarval barracuda are collected near the surface far from shore. In south Florida, temperature evidently dictates the movement of both young and adults. During their first spring young barracuda move inshore and spend the summer in shallow grass beds or sandy areas where they find protection in floating weeds and detritus or among the blades of seagrass. At this stage they may form loose aggregations of 10 to 30 individuals. When they are about 7 inches long, they move into grass flats one or two fathoms deep. When they are 8-10 inches long, they are found in the mangrove habitat. Apparently, young barracuda have a greater tolerance to hyposaline conditions than adults and find some protection from their predators. In their second winter, at about 20 inches length, they enter the coral reef habitat and deeper grass beds. During the following spring they migrate into deeper water and return to the reefs the following fall. Adults often occupy the sandy interface between the turtle grass beds and the fringing reefs. Large solitary individuals are occasionally found out in open sea.

### *Life History*

Length at maturity 66 cm. Maximum length of 200 cm TL and maximum published weight of 50.0 kg.

### *Diet*

A change in type of food eaten by barracuda occurs with the change in habitat. Young barracuda eat primarily gobies, mojarras, atherinids, young parrotfish, and needlefish. Adults feed on grunts, puffers, jacks, seabasses, half-beaks, and mackerel. The adults eat the reef dwelling fish and fast swimming fish of the surface and mid-depths (DeSylva 1970). With the change in habitat and food comes the increased probability of ciguatera poisoning.

### *Reproduction and Spawning*

## Tripletail

***Distribution and Habitat***

Western Atlantic from New England and Bermuda southward to Argentina. Depth range 0 - 70 m. Adult inhabits bays, muddy estuaries and lower reaches of large rivers. A sluggish offshore fish that often floats on its side near the surface in the company of floating objects. Occasionally drifts over reefs. Juveniles may occur in floating Sargassum and mimic a floating leaf.

***Life History***

Maximum reported length of 110 cm TL and maximum reported weight of 19.2 kg.

***Diet***

Feeds on benthic crustaceans and small fish.

***Reproduction and Spawning***

## Dolphin

Distribution and Habitat

Life History

Diet

Reproduction and Spawning

## Pompano dolphin

Distribution and Habitat

Life History

Diet

Reproduction and Spawning

## Little tunny

Distribution and Habitat

Life History

Diet

Reproduction and Spawning

## Blackfin tuna

Distribution and Habitat

Life History

Diet

Reproduction and Spawning

## King Mackerel

Distribution and Habitat

Life History

Diet

Reproduction and Spawning

## Cero

Distribution and Habitat

Life History

Diet

Reproduction and Spawning

## Wahoo

***Distribution and Habitat***

***Life History***

***Diet***

***Reproduction and Spawning***

## Manta ray

***Distribution and Habitat***

The giant manta ray is found worldwide in tropical, subtropical, and temperate bodies of water and is commonly found offshore, in oceanic waters, and near productive coastlines.

***Life History***

***Diet***

***Reproduction and Spawning***

## Spotted eagle ray

***Distribution and Habitat***

***Life History***

***Diet***

***Reproduction and Spawning***

## Southern Stingray

***Distribution and Habitat***

***Life History***

***Diet***

***Reproduction and Spawning***

## Echinoderms

Echinoderms are a large group of marine invertebrates possessing an inner skeleton of calcareous plates and a water-vascular system of fluid-filled vessels and appendages. The body structure often consists of multiples of five in skeletal plates, spines, arms, etc. Tube feet, the tactile extensions of the water-vascular system, occur on the arms and body. Managed echinoderm stocks include all species of sea urchins and sea cucumbers within the Puerto Rico EEZ.

## Sea Urchins

Urchins, such as the long-spined urchin (*Diadema antillarum*) can play an important role on the reefs as herbivores. They are found in all habitats from 0 to 45 m of water, though they tend to hide in sheltered locations during the day, waiting to feed openly on algae after dark. Densities

of D. antillarum can be high on reefs, with as many as 13/$m^2$ having been reported (Colin 1978). Aside from grazing on reef algae, urchins can denude areas of seagrass beds as well. This grazing on the reefs is an important factor in coral reef health and stability. In some instances where D. antillarum was not present, algae were literally taking over the reef from the corals. At least 15 species of fishes are known to prey on D. antillarum. Some juvenile fishes and shrimp and known to utilize the long spines of this urchin species as shelter. D. antillarum are known to aggregate and spawn throughout the year in the Caribbean. The remaining species of urchin, such as Echinometra lucunter and Lytechinus variegatus, occur in shallower water than Diadema antillarum, generally from 0 to 20 m in depth, and do not play as critical a role as the latter species. The West Indian sea egg (Tripneustes ventricosus) also inhabits seagrass beds, but its numbers have been greatly reduced in some areas of the Caribbean due to harvest for its roe.

## Sea Cucumbers

There are about 25 species of sea cucumbers that occur in shallow Caribbean water. The donkey dung sea cucumber (*Holothuria mexicans*) is perhaps the most common. It inhabits seagrass beds and sandy areas around reefs from 3 to 20 m of water. Sea cucumbers feed by passing sediment through the gut and digesting any organic material contained in it, or by catching detritus or small planktonic organisms on mucous-covered tentacles centered around the mouth. The body wall of sea cucumbers often contain a toxin, called holothurin, which makes them distasteful to predators. The slender sea cucumber (H. impatiens) and the tiger tail cucumber (H. thomasi) occur on reefs are rubble areas from 7 to 45 m of water.

## Corals

### Hydrocorals, Class Hydrozoa

The Class Hydrozoa is divided into five orders, of which only three are of any significance on Atlantic reefs: Athecatae (hydroids), Milleporina (fire corals), and Stylasterina.

The Athecatae, which include most species of the Hydrozoa, are solitary or colonial with the polypoid generation much more extensively developed than the medusoid generation. The solitary hydroids are not important on Caribbean reefs, but the colonial species can be conspicuous members of the reef community (Colin 1978).

Milleporina species represented in the Coral FMP are the fire corals (Millepora spp.), which belong to the family Milleporidae. Their name derives from the powerful stinging cells they possess, which enable them to paralyze and capture prey. These colonial corals are found from deep fore reef areas to back reefs (Colin 1978), and are considered to play a significant role in coral reef construction, particularly in shallow windward substrates, where they have a buffering effect (Goenaga and Boulon 1992).

Three described species of western Atlantic Millepora exist: M. alcicornis, M. complanata, and M. squarrosa. They differ only in the morphology of the skeleton and are often considered ecological variants of a single species. The branched form, M. alcicornis, occurs somewhat deeper than the others, while M. squarrosa is found in heavy surf or in areas exposed to air in the troughs of waves. Under extreme wave conditions or when covering the remains of another organisms, Millepora can be encrusting. Colonies sometimes cover entire sea fans and may also grow on the outer portion of the stalks of dead gorgonians. Barnacles and serpulid worm tubes may occur on the sides of the blade-like forms of Millepora (Colin 1978).

Stylasterina species represented in the Coral FMP belong to the family Stylasteridae. These corals are also colonial but do not contain zooxanthallae. They have been used frequently as ornamental pieces (Goenaga and Boulon 1992). Only one species, the rose lace coral (Stylaster roseus) is represented in the Caribbean coral reef fishery management unit. S. roseus occur at depths of 6 m to at least 30 m. These small, fragile, fan-like colonies reach 10 cm in height. They commonly occur in caves or crevices, often growing on inverted surfaces and occasionally (as at Mona Island) on open vertical rock faces (Colin 1978).

**Anthozoans, Class Anthozoa**

The second class of Coelenterata in the management unit, anthozoans include black corals (Order Antipatharia), gorgonians, sea fans (Sub-class Octocoralia), sea anemones and other similar organisms (Orders Actinaria, Zoanthidea and Corallimorpha), as well as the true reef-building corals (Order Scleractinia) (CFMC 1994). Anthozoans has its life cycle restricted to the polyp phase exclusively, with no medusa stage occurring. They typically attach to a substrate and have the oral end expanded into a flattened oral disk. A calcareous skeleton may be constructed. Further, a planula larvae may be produced, which is capable of being transported some distance by ocean currents.

**Octocorals, Orders Alcyonacea and Gorgonacea**

Due to the large numbers of species in these two orders, please refer to Table 4 for a list of all managed species. The following discussion on octocoral biology is offered to represent the order.

These two orders consist of sea fans, sea whips and other gorgonian species. Alcyonacea, also known as soft corals, includes species with skeletons consisting of spicules but no axial skeleton (Goenaga and Boulon 1992). Gorgonacea is the more dominant group of Octocorallia, occurring in abundance on Caribbean reefs (Colin 1978). All gorgonian colonies possess an axial skeletal structure of either a horny or calcareous central cylinder or a zone of tightly bound spicules. Most species have an erect skeletal structure attached to a solid substrate by a holdfast, by a smaller number of species may occur as an encrusting mat (Colin 1978). Gorgonians may live for more than 20 years with annual growth rates ranging from 0.8 - 4.5 cm/yr for 13 species studied in southeastern Puerto Rico over a five-year period (CFMC 1994). At study sites on southeastern Puerto Rico, mortality was found to be higher in small colonies, as compared to

larger specimens, the major causes of death being damage to the colony base or detachment (CFMC 1994). Two species of sea whips, Ellisella barbadensis and E. elongata, reach sizes of nearly 2 m and can occur in dense stands on rocky, often vertical substrates at about 20 to at least 250 m. Three other smaller species may also occur within diving depths on deep reefs. Most species have wide geographic ranges, generally from southern Florida to the Caribbean.

The common sea fan, Gorgonia ventalina, has the widest distribution, both on the reef and geographically, of any gorgonian species. It can be found on nearly ever reef and is a characteristic part of reef environments in the Atlantic. It can occur near shore in areas of extreme wave action and on deeper outer reefs at 15 m or more in depth. It can reach a height of nearly 2 m and shows a somewhat "clumped" (non-random) distribution of individuals on a reef (Colin 1978). This species is known from Bermuda to Curacao, including the Florida Keys and western Caribbean.

The Venus sea fan, G. flabellum, is often restricted to shallow water with very strong wave action. It occurs in areas generally somewhat shallower and rougher than G. ventalina where the two occur in the same geographic area. It is seldom found below 10 m depth and can reach sizes near those of G. ventalina. Its known geographic distribution is somewhat odd. It is abundant and easily distinguished from G. ventalina in the Bahamas, but becomes scarce and less distinctive in Florida and the Lesser Antilles. It is common on the windward reef flats and back reef zones where fire corals are abundant. This species is known to fall prey to the flamingo tongue snail (Sefton and Webster 1986).

G. mariae, the wide-mesh sea fan, is the smallest of the sea fans, the fan-like form reaching only about 30 cm in height. There are two other growth forms of this species. One has short free branchlets form one or both faces, while the plumose form, which may reach 40 cm in height, has the inner and lower branches anastomosed, but the terminal branches free. This is generally a deeper water species than the G. ventalina and G. flabellum and has been encountered as deep as 47 m and as shallow as 5 m. Known from Cuba, Jamaica, Puerto Rico, the Virgin Islands, and the northern Lesser Antilles (Colin 1978).

There are several species of Pseudopterogorgia (sea plumes) on Caribbean reefs. Most are tall, plume-like colonies. On the leeward side of some islands in the Caribbean, a zone of dense growth of these species can occur at 7-10 m, with colonies reaching heights over 1.5 m. They are pinnately branched, with no interconnections between branches, and some are slimy to the touch with abundant mucus. Pseudopterogorgia spp. may be so common as to be the dominant feature of some reefs. Flamingo tongue snails are also common predators of sea plumes (Sefton and Webster 1986). The bipinnate plume produces planulae in Jamaica in late January an dearly February. Unlike stony coral planulae, those of the bipinnate plume do not contain zooxanthellae. In the laboratory, they settle 11 days after release and must acquire their initial zooxanthellae from the environment, as these plant cells are abundant in the adult colonies (Colin 1978).

The genus Eunicea (sea rods) is an important group of reef-dwelling alcyonarians. Most occur from a few meters depth to a maximum of about 30 m (Colin 1978). Eunicea spp. occur at shallow and moderate depths. These gorgonians have single-celled algae (zooxanthellae) in the tissues of the polyps, as do most other gorgonians, corals, and anemones of the reef community. These symbiotic algae aid in the nutrition of the host colony (Sefton and Webster 1986).

Muricea spp. are common at moderate depths, particularly in spur and groove systems of the reef. They may also be attached to coral rubble in sandy areas (Sefton and Webster 1986). Sea rods, Plexaura spp., occur to depths of 50 m. P. homomalla has recently been the subject of much study since it was discovered to contain high amounts of a type of chemical (prostaglandins) valuable in the pharmaceutical industry. Advances in chemical synthesis of prostaglandins have not made such considerations less important. This species is tan in color and can reach nearly 12 m in height. Trumpet fishes sometimes hide by aligning themselves with the branches of Plexaurella colonies (Sefton and Webster 1986). Most Plexaurella spp. in the Caribbean commonly occur from about 10 to 50 m depth.

Gorgonian life history is noted by low and variable recruitment of small specimens. Given this uncertain recruitment, the predictable survival of adults is critical to the persistence of gorgonian populations (CFMC 1994). Further, gorgonian species can play an important role as habitat for other managed species. Fire coral, Millepora spp., may encrust entire colonies, particularly the sea fans of the genus Gorgonia. Bivalve mollusks, sponges, and algae may grow upon dead sections of gorgonian skeletons; whether these organisms simply take advantage of already dead substrate or themselves kill a portion of the gorgonian is not known. The gastropod mollusk, Cyphoma gibbosum, feeds on gorgonian polyps by crawling slowly over the skeleton, grazing at will. Other organisms, such as basket starfishes and brittlestars, climb tall gorgonians to reach a position more advantageous for filter-feeding in reef areas (Colin 1978). These factors warrant the prohibition on their harvest.

**Hard or stony corals, Order Scleractinia**

Almost 50 species belonging to 12 different families are represented in the Caribbean coral reef fishery management unit.  Due to the numerous scleractinian species included in the coral reef fishery management unit, and that the ecological importance of corals is widely accepted and understood by the public, the following is only a survey of the major species and species groups.

Scleractinians are the principal reef builders. They are calcium secreting, anemone-like animals that can form colonies comprised of many physically and physiologically linked polyps or else can be solitary or consisting of one polyp. Tentacles occur in multiples of six and the digestive cavities are divided by partitions (sclerosepta and sarcosepta) that radiate from the center of the polyp. The polyps of stony corals are somewhat similar to those of sea anemones but produce a calcium carbonate cup (the corallite) and are usually colonial, producing a massive calcareous skeleton (the corallum) from the many corallites. In contrast to anemones they produce calcium

carbonate, aragonitic skeletons that can reach considerable sizes (e.g., over 5 m in diameter and height in individuals of Montastrea annularis). The skeleton is internal, in contrast to other skeleton forming cnidarians (Goenaga and Boulon 1992). Often scleractinians are considered in two informal groups, the hermatypic or reef-building corals (those making a significant contribution to reef structure) and ahermatypic or non-reef building corals (often small, solitary species without large skeletons) (Colin 1978).

Many stony corals, particularly those that are hermatypic, contain small unicellular plants called zooxanthellae (dinoflagellata) in their gastrodermis. These zooxanthellae are pigmented, giving corals most of their color, and play a role in the production of calcium carbonate by the coral polyp. The exact nature of their contribution is not known and seems to vary within species of corals. Generally, however, ahermatypic corals lack zooxanthellae while hermatypic species possess large numbers. The zooxanthellae can be expelled by a coral (usually termed bleaching) when under stress (Colin 1978).

It is believed that the requirement of light for the zooxanthellae is the reason why coral reefs are limited to fairly shallow waters. With increasing depth below about 30 m corals are generally less heavily calcified than in shallower water and the ability to form reef structures is much less than in shallow water. Reef corals may occur to depths approaching 90-100 m in extremely clear water, but below 45-50 m in their constructional abilities are severely limited and may be surpassed by those of other groups of organisms such as the sclerosponges (Colin 1978).

Within a colony, all reproduction is asexual. New polyps are budded from other polyps as the colony increases in diameter or length. The rate of growth is variable between species, with branched species generally growing faster than massive species, and is strongly influenced within each species by environmental conditions. Sexually produced larvae, termed planulae, result in the establishment of new colonies. Larvae may either swim (entering the plankton and covering large distances) or crawl (staying close to the parent) until they attach to the bottom to initiate a new colony (Colin 1978).

A number of organisms prey directly on corals. Certain fishes pick polyps from the surface of the colony (butterflyfishes) while others ingest or scrape portions of skeleton with their attached polyps (puffers, parrotfishes). Some gastropod mollusks feed on coral polyps by inserting their proboscis into the polyp, and a few polychaete worms feed on branched corals by engulfing the tip of a branch in their mouth (Colin 1978). Boring sponges and clams occur in the skeleton and weaken it by their mechanisms of removing calcareous material (Colin 1978).

Acropora cervicornis (staghorn coral), found throughout the Caribbean, is characteristic of seaward facing reefs, but generally occurs on reefs below 6 to 9 m depth. It occurs from low water to 50 m but is most common at 12 to 22 m. This is one of the most rapidly growing corals. Length increases of nearly 30 cm per year have been recorded for single branches under optimal conditions. This species can also occur in shallow, quiet back reef areas where the water is fairly

clear. Damselfishes frequently stake out their territories in staghorn, as well as elkhorn coral (Sefton and Webster 1986).

A. palmata (elkhorn coral) is also characteristic of seaward facing reefs. It is the most abundant stony coral in shallow water areas, often growing up to low water levels. The "A. palmata zone" is a characteristic component of most West Indian reefs, and it thrives where wave conditions are rough. Severe storms such as hurricanes can have disastrous effects on reefs comprised of this species. Entire reefs may be reduced to rubble, much of this transported over the reef crest or piled above low water levels. Large colonies may be overturned and often renew their growth in the inverted position. A. palmata is strictly a shallow-water coral. Seldom are colonies found below 15 m, and its greatest abundance is in the top 6 m of the water. It can occur in surprisingly turbid water, but may be limited in some areas by low winter temperatures. The fast-growing branching colonies of A. palmata are sometimes 4 m or more across. One of the dominant corals in the Caribbean, elkhorn coral competes by growing rapidly and by shading or over-topping its neighbors. Entire barrier reefs, with no adjacent reef flat, may be built of this coral. The famous barrier reef at Buck Island, St. Croix, is an excellent example of such a situation, but similar reefs are found in many areas of the Caribbean. Occasionally, the branches of A. palmata will have lumpy growths of polyps, termed "neoplasms," on the normally flattened branches. If any portion of the coral surface dies this provides a site of attachment for a wide variety of organisms, and branches of A. palmata with algae, hydroids, and actinians in sections have been observed. Certain crabs, such as Domecia acanthophora, form cavities in the junctions of branches by preventing the coral from growing in these areas (Colin 1978).

Corals of the genus Agaricia and Leptoseris, commonly known as the "lettuce corals," are among the most fragile corals occurring on reefs. However, they play an important role in reef construction, particularly in the deeper sections. Various species are also important elements of the shallow reef environment (Colin 1978). While Agaricia tenuifolia is generally restricted to depths shallower than 18 m, other species are found on reefs down to 80 m in depth.

Two species of Caryophyllidae are in the coral reef fishery management unit, Eusmilia fastigiata (flower coral) and Tubastrea aurea (cup coral). E. fastigiata colonies, found widely in the Caribbean, grow up to 50 cm in diameter. This species has a wide depth range from 1-65 m, but is most common at 3-30 m depth. It can occur in a variety of habitats from back reefs to fore reefs, and under overhanging sides of larger corals. Encrusting sponges, algae, and tubeworms often grow on the dead branches from which the polyps grow (Sefton and Webster 1986). T. aurea is non-reef building (ahermatypic) but is, on occasion, abundant on reefs in the proper habitat. It is not solitary, with clumps containing a few to hundreds of polyps occurring on undercut wave-swept rocks, on overhanging faces in deeper water and in fairly dimly lit caves.

One pier off western Puerto Rico has all the area available on the inside of the pilings, beneath a platform providing shade, completely covered by this coral to a depth of 1.5 m. This species lacks zooxanthellae.

*Diploria spp.* include *D. clivosa* (knobby brain coral), *D. labyrinthiformis* (grooved brain coral), and *D. strigosa* (symmetrical brain coral). In Bonaire, D. clivosa is one of the dominant corals on the leeward side of a fringing reef of Acropora palmata, but is not as significant a constructor on reefs as are the other two species of Diploria. It does not occur as deep as *D. strigosa,* with its maximum depth begin about 15 m and its distribution centered around 1 to 3 m. This species grows in shallow to moderately deep areas, often in quiet back reef and lagoon habitats. Where wave action is stronger, it exhibits a more plate-like growth and becomes an important structural element of the reef community in some locations (Sefton and Webster 1986). D. labyrinthiformis forms sizeable heads over 1 m in diameter. This species is a minor reef constructor on the seaward slope of reefs and is the most restricted species of Diploria in its distribution on reefs. It occurs as deep as 43 m, but is most common at 2-15 m depth. This common coral is found from shallow to deep locations, but is most abundant at moderate depths on windward reef terraces (Sefton and Webster 1986). D. strigosa can form immense heads well over 2 m across and is capable of making a significant contribution to reef structure. This species, like most brain corals, is slow growing, with an annual increase of size of a head estimated at up to 1 cm per year. This means specimen of 2 m in diameter would be at least 100 years old and probably several hundred with all factors considered. This species occurs from low water to at least 40 m but is most abundant above 10 m. It is perhaps the most widely distributed species of Diploria on the reef and has even been reported from muddy bays where few other corals grow. This species occurs at all scuba depths from shallow nearshore reefs to moderately deep fore reef slopes (Sefton and Webster 1986).

*Montrastrea annularis* (boulder star coral) and *M. cavernosa* (great star coral) are generally the most common species of coral on Atlantic reefs at moderate depths (Colin 1978). M. annularis forms massive boulders or heads reaching several meters across in shallow water (1-20 m) and flattened heads or plate-like colonies in deeper water (below 20 m). It reaches depths of at least 60 m (Colin 1978). There is great variation in this species, and much of it seems related to depth. This species is slow growing compared to branching corals such as A. cervicornis, but rates of 1.0-2.5 cm per year increase in height have been recorded. M. annularis is attached by a wide variety of organisms other than corals. Boring sponges are quite abundant in this species, gastropod mollusks of the genus Coralliophila feed either on the polyps or on plankton ingested by the polyps, and filamentous algae occur on areas where coral tissue was removed by mechanical action. This star coral often forms massive mounds that are important structural elements of buttresses and other fore reef elements at moderate depth. Colonies become more plate-like as depth increases. This is frequently the dominant reef-builder in buttresses and fore reef slopes (Sefton and Webster 1986).

In many localities at moderate depths, M. cavernosa is the predominant species of coral present. Either this species or M. annularis is generally the most common coral between 10-30 m in buttressed or sloping areas of Atlantic reefs lacking sizable thickets of A. cervicornis. Below 30 m, M. cavernosa clearly predominates over M. annularis, but increasing importance of agariciid

corals and sclerosponges in reef construction somewhat diminishes its contribution. M. cavernosa is one of the most effective zooplankton feeders among stony corals. It is one of the deepest occurring hermatypic corals, found at depths from only a few meters to at least 90 m (Colin 1978). M. cavernosa is somewhat less common than M. annualris but, nevertheless, is an important reef-builder in many areas (Sefton and Webster 1986).

Dendrogyra cylindricus (pillar coral) is one of the most spectacular stony corals found on West Indian reefs. Colonies may contain dozens of upright cylindrical branches and reach a total height of nearly 3 m. If a single one of the "pillars" is broken off and comes to rest in a position where it continues to live, the branch will give rise to several new pillars which again grow vertically. This species is unusual in that the polyps with their tentacles are expanded in the daytime unlike most other stony corals. Pillar coral varies considerably in abundance throughout its range and is a very minor constructor of reefs. It is found on flat or gently sloping reef bottoms between 1 and 20 m. Colonies form spires 3 m or more tall. Distribution is spotty throughout the Caribbean (Sefton and Webster 1986).

Four Poritidae species are represented in the management unit: Porites astreoides (Mustard hill coral); Porites branneri (Blue crust coral); Porites divaricata (Small finger coral); and Porites porites (Finger coral). P. asteroides can occur in a variety of growth forms. In shallow water it can be encrusting, while at deeper depths the colonies are either rounded or flattened with the surface facing towards the light. Fam worms often occur with P asteroides and the sponge Mycale laevis, which grows on the undersurfaces of certain corals, can also be associated with it. Asexual reproduction is accomplished either through extratentacular budding or intratentacular budding. P. asteroides occurs abundantly in nearly all reef zones to depths of over 50 m. P. branneri colonies are encrusting and found from 0.1-12 m of depth, generally associated with bank reef types. P. divaricata is a delicate species of Porites. The branches are about 6 mm in diameter and form, at most, a small clump with widely spaced branches. P. divaricata are typical of back reef areas in shallow water, but occur rarely as deep as 15 m (Colin 1978). P. porites have thick branches, often 25 mm in diameter, that resemble stubby fingers, hence the name. P. porites can occur in many reef situations including back and clear water fore reef areas, It common throughout the Caribbean, but is rare below 20 m (Colin 1978).

**Black corals, Order Antipatharia**

Entire colonies are harvested for artisanal purposes in some regions of the Caribbean. In 1970, the local precious coral jewelry industry (black and pink coral) was estimated to have a retail value of more than 4 million dollars. Their axial skeleton is polished and attains considerable thickness in some species, rendering them commercially valuable in the jewelry trade to humans. Species that do not branch are bent for making necklaces. In Puerto Rico and the Virgin Islands, commercial harvesting is apparently uncommon but is known to occur (Goenaga and Boulon 1992).

The ecology and life history of these organisms is, for the most part, unknown. Taxonomy, to a large extent, is also unknown. Two genera are represented in the Caribbean coral reef fishery management unit: Antipathes spp. (bush black corals) and Stichopathes spp. (wire corals) (Goenaga and Boulon 1992). Black corals are typically deep sea, slow growing colonial anthozoans usually occurring under ledges, possibly because their larvae is negatively phototactic. The axial skeleton is black, spiny and scleroproteinaceous, and is secreted in concentric layers around a hollow core. The polyps overlay the horny skeleton, are interconnected and possess six non-retractile, unbranched tentacles. They usually contain a diverse array of internal and external unstudied commensal organisms that include palaemonid crustaceans, lichomolgid copepods, and pilargiid polychaetes. Available evidence suggests that recruitment is infrequent.

Thick stemmed, branched, and large (i.e., potentially important economically) bush black corals occur in water depths below 50 m in La Parguera, Puerto Rico. Unbranched, thin stemmed wire corals are present at depths of 20 m. Both genera can also occur sparsely in very shallow, turbid waters off Mayaguez, western Puerto Rico and in La Parguera, southwestern Puerto Rico. Individual Antipathes spp. have been observed above depths of 8 m south of Arrecife La Gata, La Parguera, indicating that adult colonies of these species do not require deep waters. In the Virgin Islands, these species are most common at depths exceeding 30 m but can be found on the north shore of St. Croix and north of St. John (e.g., Haulover Bay) at depths of less than 20 m. Some of these colonies have been observed to have been harvested over a several year period which would indicate either cautious harvesting (some of these areas being within the VI National Park) or personal collecting for low level jewelry production (Goenaga and Boulon 1992).

**False corals, Order Corallimorpharia**

The corallimorpharians are a small order of Hexacorallia. They lack a skeleton but they form sheet-like colonies or can occur singularly. While they occur on Carribean reefs, they are of minor importance (Colin 1978).

Discosoma spp. are often found in groups on rocky substrates, and they may reach 10 cm in diameter. Generally occurring in shallow waters 2 to 30 m in depth, it can be found growing on vertical shaded areas, on dead branches of coral, and symbiotically growing on sponges (Colin 1978). The Florida false coral, Ricordia florida, covers large areas of rocky substrates on the back and fore reef from 0 to 20 m of water, and can consist of hundreds of polyps. Individual specimens of R. florida are no large than 5 cm in diameter, and has short, rounded tentacles.

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# Appendix K. Endangered Species Act (ESA) Consultations

The Puerto Rico Fishery Management Plan (PRFMP) will subsume some of the activities currently managed under the Reef Fish Fishery Management Plan (RFFMP) of Puerto Rico and the U.S. Virgin Islands (USVI) and the Spiny Lobster Fishery Management Plan (SLFMP) of Puerto Rico and the USVI. Activities under these FMPs have been determined to potentially affect ESA species and ESA Section 7 consultations have been done for them in the past. The following summarizes the consultation history for each of the two FMPs.

Reef Fish

The National Marine Fisheries Service (NMFS), Caribbean Fishery Management Council (Council) and the U.S. Fish and Wildlife Service completed an informal Section 7 consultation on the original Reef Fish FMP that was implemented in 1985. The consultation included the following species: sei whale (*Balaenoptera borealis*; endangered); humpback whale (*Megaptera novaeangliae*; endangered); sperm whale (*Physeter catodon*; endangered); West Indian manatee (*Trichechus manatus*; threatened); and leatherback sea turtle (*Dermochelys coriacea;* endangered); and critical habitat for the leatherback sea turtle in St. Croix, USVI. The Council prepared a biological assessment of the potential effects of the proposed management system on the above-listed species. The consultation concluded that based on the best available information, populations of endangered and threatened species and their critical habitat would not be adversely affected by the Reef Fish FMP.

On April 28, 1989, NMFS conducted a Section 7 consultation on the effects of all commercial fishing activities in the Southeast Region. The resulting opinion concluded that commercial fishing activities in the Southeast Region were not likely to jeopardize the continued existence of any threatened or endangered species.

Amendment 1 to the Reef Fish FMP, implemented in December 1990, proposed no changes to the manner in which species listed under the Endangered Species Act were affected by fishing managed under the Reef Fish FMP. NMFS concluded its proposed actions would have no anticipated impact on threatened or endangered species.

An informal ESA Section 7 consultation was conducted on Amendment 2 to the Reef Fish FMP in August 1992. NMFS concluded that neither the directed fisheries nor the management measures proposed in Amendment 2 would jeopardize endangered or threatened species, or adversely impact their critical habitat.

An informal ESA Section 7 consultation was conducted on a regulatory amendment to the Reef Fish FMP in October 1996. NMFS concluded that the regulatory amendment and the operation of the U.S. Caribbean reef fish fishery, in accordance with the amendment, were not likely to adversely affect endangered or threatened species under NMFS' jurisdiction.

An informal ESA Section 7 consultation was conducted on the Generic Essential Fish Habitat (EFH) Amendment in 1998. NMFS concluded that the amendment would not adversely affect the recovery of endangered or threatened species, or their critical habitat. NMFS only partially approved the Generic EFH Amendment in March 1999, finding that it did not evaluate all managed species or all fishing gears with the potential to damage fish habitat.

An informal ESA Section 7 consultation was conducted on the Comprehensive Amendment to FMPs of the U.S. Caribbean in August 2001. NMFS concluded the management measures proposed in the amendment were not likely to adversely affect any listed species under the ESA. The Comprehensive Amendment was ultimately disapproved by NMFS in May 2002.

Effects of the reef fish fishery managed under the Reef Fish FMP were analyzed in a formal consultation for the first time as part of a May 19, 2005, opinion (NMFS 2005a; hereafter referred to as the 2005 Caribbean opinion or NMFS [2005a]), which evaluated the effects of all Caribbean fisheries in the exclusive economic zone (EEZ) on listed species and designated critical habitat. NMFS (2005a) concluded the continued authorization of all Caribbean fisheries in the EEZ (including the reef fish fishery) was not likely to jeopardize the continued existence of green, hawksbill, leatherback, or loggerhead sea turtles. An incidental take statement was issued specifying the amount and extent of anticipated take of these species, along with reasonable and prudent measures and associated terms and conditions deemed necessary and appropriate to minimize the impact of these takes; the reef fish fishery was allotted take. Other listed species (olive ridley sea turtles and listed marine mammals) and designated critical habitat for sea turtles in the action area were determined not likely to be adversely affected by the continued authorization of any Caribbean EEZ fisheries.

On October 4, 2011, NMFS completed its most recent biological opinion evaluating the effects of the continued authorization of the U.S. Caribbean reef fish fishery, managed under the Reef Fish FMP, on ESA-listed species and designated critical habitat. In the opinion, NMFS concluded that its continued authorization is not likely to jeopardize the continued existence of green, hawksbill, or leatherback sea turtles, or elkhorn or staghorn corals, or destroy or adversely modify *Acropora* critical habitat. The opinion also concluded that the continued authorization of the U.S. Caribbean reef fish fishery is not likely to adversely affect ESA-listed whales or Northwest Atlantic loggerhead sea turtles, or the critical habitat for green, hawksbill or leatherback sea turtles. No longer believed to be present and thus unaffected, olive ridley sea turtles were not discussed in the opinion.

Spiny Lobster

An informal Section 7 consultation was completed on the original Spiny Lobster FMP in July 1980. The consultation concluded that based on the best available information, populations of endangered and threatened species and their critical habitat would not be adversely affected by the continued authorization of the fishery.

On April 28, 1989, NMFS conducted a Section 7 consultation on the effects of all commercial fishing activities in the Southeast Region. The resulting opinion concluded that commercial fishing activities in the Southeast Region were not likely to jeopardize the continued existence of any threatened or endangered species.

Amendment 1 of the Spiny Lobster FMP, implemented in December 1990, proposed no changes to the manner in which species listed under the Endangered Species Act were affected by fishing managed under the Spiny Lobster FMP. NMFS concluded its proposed actions would have no anticipated impact on threatened or endangered species.

A formal consultation was conducted on Amendment 2 to the Spiny Lobster FMP in 2005. Amendment 2 was part of the Comprehensive Amendment to all the FMPs of the U.S. Caribbean to address required provisions of the Magnuson-Stevens Fishery Conservation and Management Act. The effects of the spiny lobster fishery were analyzed as part of a May 19, 2005, opinion (NMFS 2005a), which evaluated the effects of all Caribbean fisheries in the EEZ on listed species and designated critical habitat. NMFS (2005a) concluded the continued authorization of all Caribbean fisheries in the EEZ was not likely to jeopardize the continued existence of green, hawksbill, leatherback, or loggerhead sea turtles. The spiny lobster fishery was determined to be likely to adversely affect only green, hawksbill, and leatherback sea turtles. An incidental take statement was issued specifying the amount and extent of anticipated take of these species, along with reasonable and prudent measures and associated terms and conditions deemed necessary and appropriate to minimize the impact of these takes; both the reef fish and spiny lobster fisheries were separately allotted take. Other listed species (olive ridley sea turtles and listed marine mammals) and designated critical habitat for sea turtles in the action area were determined not likely to be adversely affected by the continued authorization of any Caribbean EEZ fisheries.

On October 8, 2008, F/SER2 requested reinitiation of Section 7 consultation for Amendment 4 to the Spiny Lobster FMP specifically to address adverse effects to elkhorn (*Acropora palmata*) and staghorn (*Acropora cervicornis*) corals, which were listed subsequent to completion of the 2005 Caribbean opinion. Additionally, on November 26, 2008, NMFS designed critical habitat for these species. Both of these listed species and their critical habitats overlap in some areas

where fishing managed by the Spiny Lobster FMP is authorized; thus, they may be adversely affected by this fishery.

On January 27, 2011, NMFS published a Notice of Intent that it was developing Amendment 5 to the Caribbean Spiny Lobster FMP. On July 21, 2011, the Caribbean Fisheries Management Council (CFMC) selected the preferred alternatives for Amendment 5. Formal consultation was initiated on November 12, 2011. NMFS proposed to continue authorizing the federal Caribbean spiny lobster fishery as managed under the Spiny Lobster FMP, including proposed Amendment 5. Amendment 5 was prepared by the Council and NMFS Southeast Regional Office (SERO) and was designed to bring the Caribbean spiny lobster fishery into compliance with the 2007 revisions to the MSA. An Opinion concluded on December 12, 2011, that the proposed action was not likely to destroy or adversely modify *Acropora* critical habitat in the U.S. Caribbean. It also concluded that the action was not likely to jeopardize the continued existence of staghorn corals, or green, hawksbill, or leatherback sea turtles.

Reinitiation of Consultation (Reef Fish and Spiny Lobster)

As provided in 50 CFR 402.16, reinitiation of formal consultation is required if discretionary federal action agency involvement or control over the action has been retained, or is authorized by law, and, if among other things, a new species is listed or critical habitat designated that may be affected by the action.

On July 3, 2014 (79 FR 38214) NMFS listed the Central and Southwest Atlantic Distinct Population Segment (DPS) of scalloped hammerhead sharks. The NMFS SERO Sustainable Fisheries Division (SFD) determined the continued authorization of the subject fisheries of this Opinion may adversely affect this DPS and believed it should be included in the reinitiation of ESA Section 7 consultation to evaluate these fisheries' potential impacts.

On September 10, 2014, NMFS listed 20 new coral species under the ESA. Five of those new species (rough cactus coral [*Mycetophyllia ferox*], pillar coral [*Dendrogyra cylindrus*], lobed star coral [*Orbicella annularis*], mountainous star coral [*Orbicella faveolata*], and boulder star coral [*Orbicella franksi*]) occur in the Caribbean and all are listed as threatened. The two previously listed coral species (elkhorn coral [*Acropora palmata*] and staghorn coral [*Acropora cervicornis*]) remain listed as threatened. In a September 26, 2014, memorandum, NMFS Sustainable Fisheries Division determined that the continued authorization of the Caribbean reef fish and spiny lobster fisheries may affect these five newly-listed species and requested reinitiation of ESA Section 7 consultation to evaluate these fisheries' potential impacts on them.

Since requesting reinitiation on the five recently listed coral species, NMFS has published five final rules listing a total of six additional species that may be affected by the continued authorization of the reef fish and spiny lobster fisheries under the Reef Fish FMP and Spiny

Lobster FMP in the U.S. Caribbean and, has expanded the ongoing reinitiation to consult on the effect to these species. These listings include the following:

- On July 3, 2014, NMFS published a final rule listing the Central and Southwest Atlantic DPS of scalloped hammerhead shark (*Sphyrna lewini*) as threatened under the ESA (79 FR 38213). This DPS occurs in the Caribbean;
- On April 6, 2016, NMFS and the U.S. Fish and Wildlife Service published a final rule removing the range-wide and breeding population ESA listings of the green sea turtle (*Chelonia mydas*), and in their place, listing eight DPSs of green sea turtle as threatened and three DPSs as endangered (81 FR 20058). Two of the green sea turtle DPSs, the North Atlantic DPS and the South Atlantic DPS, occur in the U.S. Caribbean and are listed as threatened;
- On June 29, 2016, NMFS published a final rule listing the Nassau grouper (*Epinephelus striatus*) as threatened (81 FR 42268);
- On January 22, 2018, NMFS published a final rule listing the giant manta ray (*Manta birostris*) as threatened (83 FR 2916);
- On January 30, 2018, NMFS published a final rule listing the oceanic whitetip shark (*Carcharhinus longimanus*) as threatened (83 FR 4153).

In memoranda dated January 19, 2016, October 24, 2016, and March 31, 2017, NMFS determined that allowing the continued authorization of fishing under the Reef Fish FMP and Spiny Lobster FMP would not violate Section 7(a)(2) or 7(d) of the ESA during the reinitiation period, which, under those memoranda, extended until July 31, 2017. These determinations were based on NMFS' analyses of the effects of the continued operation of the reef fish and spiny lobster fisheries during the reinitiation period on the five most recently listed coral species, two new green sea turtle DPSs, and Nassau grouper. In particular, NMFS determined that continued operation of these fisheries during the reinitiation period would not jeopardize the continued existence of these species or destroy or adversely modify critical habitat, and thus would not violate Section 7(a)(2). NMFS also determined that there had not been any irreversible or irretrievable commitment of resources that would prevent implementation of any reasonable and prudent alternatives that might be provided at the conclusion of the consultation. Thus, NMFS determined that continued operation of the fisheries during the reinitiation period would not violate Section 7(d). In addition, in a memorandum dated August 29, 2017, NMFS considered whether the continued authorization of fishing managed under the Reef Fish FMP, while reinitiating consultation to consider the effects on the Central and Southwest Atlantic DPS of scalloped hammerhead shark, would violate Sections 7(a)(2) or 7(d) of the ESA, and concluded it would not.

The listing of the additional corals, the green sea turtle DPSs, and Nassau grouper triggered reinitiation of consultation on numerous federal fisheries in the Southeast region, resulting in

significant Section 7 workload. In a March 31, 2017, memorandum, it was expected the consultations on the reef fish and spiny lobster fisheries in the U.S. Caribbean would be completed by the end of July 2017.

In an October 31, 2018 memorandum updating ESA Section 7(a)(2) and Section 7(d) determinations for allowing the continued authorization of fishing managed by the U.S. Caribbean Reef Fish and Spiny Lobster FMPs during reinitiation of ESA consultation on these fisheries anticipated that the reinitiation period on these fisheries to extend through December 2019.. That memorandum addressed all listed species for which one or more reinitiation triggers for these FMPs have been met and provided analysis of effects of these ongoing fisheries during the reinitiation period on the recently listed giant manta ray and oceanic whitetip shark listings for the first time. NMFS also reviewed analysis from previous findings relative to Nassau grouper, the North Atlantic and South Atlantic DPSs of green sea turtle, the Central and Southwest Atlantic DPS of scalloped hammerhead shark, and the five corals listed in 2014 to ensure that those findings still apply.

# Appendix L. Bycatch in Puerto Rico Fisheries

## Introduction

The Council is required by the Magnuson-Stevens Fishery Conservation and Management (Magnuson-Stevens) Act §303(a)(11) to establish a standardized bycatch reporting methodology to assess the amount and type of bycatch occurring in the fishery and to include in its FMPs conservation and management measures that, to the extent practicable and in the following order, (A) minimize bycatch and (B) minimize the mortality of bycatch that cannot be avoided. The Magnuson-Stevens Act defines bycatch as "fish which are harvested in a fishery, but which are not sold or kept for personal use, and includes economic discards and regulatory discards. Such term does not include fish released alive under a recreational catch-and-release fishery management program" (Magnuson-Stevens Act §3(2)). Economic discards are fish that are discarded because they are undesirable to the harvester. This category of discards generally includes certain species, sizes, and/or sexes with low or no market value. Regulatory discards are fish that are required by regulation to be discarded, but also include fish that may be retained but not sold. NMFS outlines at 50 CFR §600.350(d)(3)(i) ten factors that should be considered in determining whether a management measure minimizes bycatch or bycatch mortality to the extent practicable, including:

A. Population effects for the bycatch species;

B. Ecological effects due to changes in the bycatch of that species (effects on other species in the ecosystem);

C. Changes in the bycatch of other species of fish and the resulting population and ecosystem effects;

D. Effects on marine mammals and birds;

E. Changes in fishing, processing, disposal, and marketing costs;

F. Changes in fishing practices and behavior of fishermen;

G. Changes in research, administration, and enforcement costs and management effectiveness;

H. Changes in the economic, social, or cultural value of fishing activities and non-consumptive uses of fishery resources;

I. Changes in the distribution of benefits and costs; and,

J. Social effects.

Agency guidance provided at 50 CFR §600.350(d)(3)(ii) advises the Councils adhere to the precautionary approach found in the Food and Agriculture Organization of the United Nations (FAO) Code of Conduct for Responsible Fisheries (Article 6.5) when faced with uncertainty

concerning these ten practicability factors. According to Article 6.5 of the FAO Code of Conduct for Responsible Fisheries, using the absence of adequate scientific information as a reason for postponing or failing to take measures to conserve target species, associated or dependent species, and non-target species and their environment, would not be consistent with a precautionary approach.

## Bycatch Practicability Analysis

### Background

A bycatch practicability analysis (BPA) was first addressed in the 2005 Caribbean Sustainable Fisheries Act Amendment/Final Environmental Impact Statement (Caribbean SFA Amendment [CFMC 2005]), which was approved by the agency on September 13, 2005 and the final rule published in the *Federal Register* on October 28, 2005, effective November 28, 2005 (70 FR 62073). The Caribbean SFA Amendment BPA evaluated the biological, ecological, social, economic, and administrative impacts associated with a wide range of alternatives including those required for achieving the bycatch mandates of the Magnuson-Stevens Act. In summary, four alternatives including a "No Action" alternative were presented, and impacts were described regarding bycatch reporting. Those alternatives are included herein by reference and summarized below. Those alternatives, in addition to the no action alternative, would to a greater or lesser degree: Develop a federal permit system for commercial and charter boat fishermen participating in Council-managed fisheries, with an associated mandatory monthly reporting requirement; utilize the Marine Recreational Fisheries Statistics Survey database to provide additional bycatch information on the recreational and subsistence sectors; and, consult with Puerto Rico in an effort to modify the trip ticket system currently in place in the U.S. Caribbean to require standardized collection of bycatch data.

Additional measures were included in the Caribbean SFA Amendment to minimize bycatch and bycatch mortality to the extent practicable. The analysis of the practicability of those measures can be found in Section 6.6.2 of that amendment and is included by reference and summarized as follows: Four alternatives, including a "No Action" alternative, were presented and are included herein by reference. Impacts were described regarding minimizing bycatch and bycatch mortality. Those alternatives proposed to: Increase the minimum allowable mesh size for fish traps; establish a minimum mesh size of two inches and a maximum mesh size of six inches, stretched mesh, for gill and trammel nets; gill and trammel nets must be tended at all times; and, amend current requirements for trap construction such that only one escape panel is required, which could be the door.

The BPA in the Caribbean SFA Amendment discussed that beach seines, the gear with the highest rate of discard mortality, are not used in the EEZ. Trammel nets, which were banned

from the EEZ in 2005 (CFMC 2005), were reported to produce little bycatch although supporting data are very limited.

Anecdotal information suggests that the vast majority of fish harvested in the U.S. Caribbean are retained for the market or for personal use – including species with low market value. With the exception of species that are commonly believed to be ciguatoxic, economic discards in this region appear to be minimal.

Species identified as potential regulatory discards in the 2005 Caribbean SFA Amendment BPA, and the rational for inclusion, included:

- Nassau grouper: Federal, state, and territorial laws require that Nassau grouper landed in the U.S. Caribbean be returned unharmed to the water;
- Goliath grouper: Federal, state, and territorial laws require that Goliath grouper landed in the U.S. Caribbean be returned unharmed to the water;
- Butterflyfish: The harvest of some species of butterfly fish (*Chaetodon spp.*) is not prohibited in federal waters (CFMC 2005) but it is prohibited in the state waters of Puerto Rico;
- Juvenile yellowtail snapper: Federal law requires that catches of yellowtail snapper under 12 inches (30.5 cm) in total length be returned to the water (the minimum size in Puerto Rico waters is 10.5 inches (26.7 cm) fork length, about the same as in federal waters);
- Juvenile and berried spiny lobster: Federal and Commonwealth laws prohibit the harvest of spiny lobster under 3.5 inches (8.9 cm) in carapace length and berried spiny lobsters (this size limit also applies to *Panulirus argus* imports into the U.S. Caribbean (CFMC 2008); and,
- Red hind grouper, coney, rock hind, graysby; yellowfin, red, tiger, and black groupers; silk, black, blackfin, and vermilion snappers: Federal law prohibits fishing for and possession of these species during their respective EEZ closed seasons. Puerto Rico Commonwealth law also prohibits fishing for and possession of these species during the state closed seasons, which may not coincide with the EEZ closed seasons. Depending on the species and depth of the fishing activity, bycatch mortality could be high.

The Caribbean SFA Amendment BPA noted that the extent of those regulatory discards has not been quantified. In the past, the regulatory requirements forcing fishermen to discard these species were difficult to enforce because regulations were generally less restrictive in state waters. The mortality rates associated with commercial and recreational bycatch also have not been quantified, but generally increase with depth (e.g., finfish taken from deeper water generally have a lower survival rate when returned to the water).

The BPA concluded that, due to the nature of U.S. Caribbean fisheries, it was unlikely that any of the alternatives proposed in the Caribbean SFA Amendment would significantly reduce bycatch. Most Caribbean fishermen utilize all they catch, and those fisheries that are noted for producing large amounts of bycatch (e.g., trawling) are essentially absent from the U.S. Caribbean. Thus, bycatch is not as significant an issue in the U.S. Caribbean compared to other regions. What little bycatch occurs is generally confined to regulatory discards, which would be minimally affected by the gear restriction alternatives evaluated in the BPA. The BPA also concluded that the direct effects to the biological environment from any of those proposed alternatives would be minimal. Additionally, one or more alternatives may result in a direct, but relatively minor, effect to the socioeconomic and administrative environment, due to the required modifications of fishing gear. In contrast, anecdotal information suggests that the only reason for large-mesh net fisheries is to illegally fish for turtles. Similarly, most trap fishermen already employ only one escape panel. Regardless, the Council also opted to prohibit the use of gill and trammel nets in the U.S. Caribbean EEZ (excluding some bait and species not managed by the FMP), primarily to reduce fishing mortality, though it will also have ancillary benefits in the reduction of bycatch. The effects of the management regime implemented in 2005 have not been fully assessed to determine the impact of bycatch. The alternatives implemented for the U.S. Caribbean EEZ in 2005 were to varying degrees also implemented in Puerto Rico state waters in the U.S. Caribbean. Moreover, Puerto Rico implemented additional regulations for the commercial and recreational harvest. Puerto Rico, in cooperation with the fishermen, SEFSC, SERO, and the Council, is actively involved in the development of new data collection forms and improving the quality of the catch reports and trip interview programs. To date, the Council has not implemented a federal permit system for commercial and charter boat fishermen participating in the harvest of Council managed species, as proposed in the Caribbean SFA Amendment. The catch report forms in Puerto Rico do not collect information on bycatch during a fishing trip.

A BPA was also included in the 2010 Caribbean ACL Amendment (CFMC 2011a) and supplemented in the 2011 Caribbean ACL Amendment (CFMC 2011b) (2010/2011 BPA). The 2010/2011 BPA is herein included by reference and summarized below. Bycatch considerations for measures evaluated in that BPA that are consider to still be valid and applicable in this FMP also are noted below.

In the 2010/2011 BPA and in the Puerto Rico FMP, bycatch in commercial and/or recreational fisheries may be affected through alternatives presented and described to revise or establish management reference points and status determination criteria, revise or establish ACLs and AMs, allocate resources (based on stock complexes, recreational and commercial sectors, and geographic criteria), establish species-specific management measures (e.g., parrotfish measures in the 2010 ACL Amendment), and establish harvest limits (e.g., establishment of recreational bag limits in the 2010 and 2011 ACL Amendments). The Council considered the list of 10

factors (50 CFR §600.350(d)(3)(i)) discussed in Section 3.5.1 above to gage if their management measures minimize bycatch or bycatch mortality. Their findings are summarized below.

A. Population effects for the bycatch species: the 2010/2011 BPA discussed that management measures may have an indirect but slight impact on minimizing bycatch. If those measures redefining management reference points result in more conservative estimates of MSY and OY along with, conservative establishment of OFLs and ACLs, and if with these measures there is a high compliance to regulations, fishing effort would be expected to be reduced in proportion to the more conservative catch allowances, resulting in a reduction in bycatch and bycatch mortality. The findings of the 2010/2011 BPA would also be applicable to the Puerto Rico FMP, as actions included in this FMP and analyzed in the DEIS included in this document also redefine and/or establish management refence points, and redefine or establish ACLs.

B. Ecological effects due to changes in the bycatch of a stock (effects on other species in the ecosystem): the 2010/11 BPA discussed that if management develops conservative measures as cited in (A) above, less bycatch and bycatch mortality would be expected, although natural variation may mask such a result. Theoretically, in response to such conservative management, the coral reef ecosystem would become better balanced as a result of more intact trophic and predatory interactions due to fewer non-target individuals being extracted or dying from the impacts of capture and release. This determination would continue to apply in the Puerto Rico FMP.

C. Changes in the bycatch of other species of fish and the resulting population and ecosystem effects: Same as (B) above. This determination would continue to apply in the Puerto Rico FMP.

D. Effects on marine mammals and birds: The 2010/2011 BPA discussed that, because fishermen in the U.S. Caribbean region traditionally utilize most resources harvested, the amounts of bycatch resulting from proposals included in the 2010 and 2011 ACL Amendments were not expected to change, so little to no affect to mammals or birds was expected. This determination can also be applied to actions in the Puerto Rico FMP and remains valid.

E. Changes in fishing, processing, disposal, and marketing costs: The 2010/2011 BPA noted that, if management chooses the most conservative and restrictive proposals in the respective amendments, one might expect changes to fishing in that more fishing effort might take place after implementation of each amendment to hedge against closure once limits are reached. Such a change may result in a proportionate change in bycatch or bycatch mortality. If that were to occur, AMs would be triggered to reduce the length of

the fishing season in subsequent fishing years, thereby minimizing bycatch. This determination is also applicable to measures implemented in the Puerto Rico FMP.

F. Changes in fishing practices and behavior of fishermen: The 2010/2011 BPA discussed that, regardless of the conservative degree management takes in responding to the proposals of that amendment, changes to fishing practices were not expected to result in greater or lesser degrees of bycatch. The BPA noted that fish traps, hook-and-line, and spearfishing have been the most successful fishing practices and these practices were not expected to change without further regulations. Bycatch was not expected to change from its current level. In the Puerto Rico FMP, changes to fishing practices also are not expected to result in greater or lesser degrees of bycatch as fishing methods would not change in the regulations implementing this FMP.

G. Changes in research, administration, and enforcement costs and management effectiveness: The 2010/2011 BPA discussed that research and monitoring is needed to understand the effectiveness of proposed management measures in reducing bycatch. Additional work is needed to determine the effectiveness of measures being developed in those amendments and by future actions being considered by the Council to reduce bycatch. A Data Collection Improvement Program is being developed in the region in cooperation with local governments and NMFS, which if funded should begin accumulation of information needed to assess bycatch questions. Additional administrative and enforcement efforts will be needed to implement and enforce these regulations.

H. Changes in the economic, social, or cultural value of fishing activities and non-consumptive uses of fishery resources: The 2010/2011 BPA noted that proposed management measures, including those that are likely to increase or decrease discards, could result in social and/or economic impacts and that those are discussed in Chapter 4 of each one of the 2010 and 2011 Caribbean ACL Amendments. In the Puerto Rico FMP, socio-economic impacts of measures that would be likely to increase or decrease discards are discussed in Sections 4.5.3, 4.5.4, 5.5.3, 5.5.4, 5.10.3, 5.10.4, 6.5.3, 6.5.4, 6.11.3, 6.11.4, 7.5.3, 7.5.4, 8.5.3, and 8.5.4.

I. Changes in the distribution of benefits and costs: The 2010/2011 BPA noted that attempts were made to ensure reductions provided by proposed management measures were equal in the commercial and recreational sectors. The extent to which those management measures would increase or decrease the magnitudes of discards was not clear. Potential increases in dead discards were taken into consideration in bag and size limits, setting commercial quotas, and determining the effectiveness of a seasonal closure. It is unlikely

that the magnitude of discards will be the same in the commercial and recreational sectors.

J. Social effects: In the 2010 and 2011 Caribbean ACL Amendments, the social effects of all the management measures, including those most likely to reduce bycatch, were described in Chapter 6 of each amendment. In the Puerto Rico FMP, social effects are described in Sections 4.5.4, 5.5.4, 5.10.4, 6.5.4, 6.11.4, 7.5.4, and 8.5.4.

Commercial and Recreational Bycatch

Puerto Rico does not include bycatch reporting on their commercial trip tickets, thus the actual amount of bycatch occurring in this sector is unknown. The amount of recreational bycatch including catch and release is also unknown. However, as mentioned in the Caribbean SFA Amendment BPA, anecdotal information suggests that the vast majority of fish harvested in Puerto Rico are retained for the market or for personal use – including species with low market value. Those fisheries that are noted for producing large amounts of bycatch (e.g., trawling) are essentially absent from the U.S. Caribbean. Thus, bycatch is not as significant an issue in the U.S. Caribbean, including Puerto Rico, compared to other regions. With the exception of species that are commonly believed to be ciguatoxic, economic discards in this region appear to be minimal. What little bycatch occurs is generally confined to regulatory discards. Current regulatory discards from both the recreational and commercial sectors may potentially include:

- Nassau grouper: federal and Puerto Rico state laws require that Nassau grouper caught must be released immediately with a minimum of harm;
- Goliath grouper: federal and Puerto Rico state laws require that goliath grouper caught must be released immediately with a minimum of harm;
- Midnight, rainbow, and blue parrotfish: federal laws prohibit the harvest and possession of these species in federal waters off Puerto Rico and the U.S. Caribbean and any fish caught must be released immediately with a minimum of harm;
- Juvenile yellowtail snapper: federal law requires that catches of yellowtail snapper under 12 inches (30.5 cm) in total length be released immediately with a minimum of harm (the minimum size in Puerto Rico waters is 10.5 inches (26.7 cm) fork length, about the same as in federal waters);
- Juvenile and berried spiny lobster: Federal and Puerto Rico state laws prohibit the harvest of spiny lobster under 3.5 inches (8.9 cm) in carapace length and berried spiny lobsters (this size limit also applies to *Panulirus argus* imports into the U.S. Caribbean (CFMC 2008);
- Red hind grouper, red, black, tiger, yellowfin or yellowedge groupers; vermilion, black, silk, black, and blackfin snappers; lane and mutton snappers: Federal law prohibits fishing for and possession of these species during their respective closed seasons or area closures, as applicable. Puerto Rico state laws also prohibit fishing for and possession of

some of these species during the closed seasons to varying degrees (See Puerto Rico Fishing Regulations 7949). Depending on the species and depth of the fishing activity, there might be high bycatch mortality;

- Bajo de Sico area closure: fishing for any Council-managed reef fish is prohibited during the seasonal area closure, thus any Council-managed reef fish species caught while fishing for other species should be returned to the water;
- Reef fish with recreational bag limits: any Council-managed reef fish that is harvested over their specified bag limit, should be returned to the water;
- Spiny lobster with recreational bag limits: any spiny lobster that is harvested over its specified bag limit, should be returned to the water;
- Stocks for which AMs apply: any stocks for which AMs are applied should not be retained.

## Interactions with Protected Species

Protected species and critical habitat located within the Puerto Rico management area (See Section 2.3.2) would be potentially affected by activities authorized under the Puerto Rico FMP.

All protected species under the Endangered Species Act (ESA) are potentially subject to effects from boating activities occurring in the management area, including vessel strikes (e.g., turtles), contaminants/pollution from boating activities, and damage through anchoring (e.g., benthic habitats).

Listed turtle and fish species are potentially subject to effects from fishing activities that would occur under the Puerto Rico FMP, most notably hooked as bycatch. Listed turtles and mammals could be entangled in line, trap, and net fishing gear. Corals are potentially physically impacted by fishing gear/activities, for example through crushing (by gear or vessel anchors), abrasion (by gear/anchor line or trap gear), and snagging (breaking of coral by gear/anchor). Additionally, Nassau grouper could potentially be caught in traps or speared by fishermen. Several fishing related activities could potentially startle turtles, fish, and marine mammals.

Additionally, the harvest of herbivorous fish or invertebrates (e.g., sea urchins) would be expected to indirectly affect both *Acropora* critical habitat and listed coral species through impacts to the grazing and the related control of algae.

Since this is a new, island-based FMP, specific numbers of protected species bycatch for the fishery as it would be promulgated are not available. However, bycatch estimates from the previous Reef Fish FMP and Spiny Lobster FMP biological opinions are available (NMFS 2011a and NMFS 2011b, respectively). While they do not represent the exact numbers expected to be taken during fishing activities authorized under in this new Puerto Rico FMP (since fishing effort is not expected to be identical under the new FMP), they are presented here to provide context to

the approximate magnitude of bycatch that could occur. The actual bycatch expected to occur would be estimated and analyzed as part of the ongoing ESA Section 7 consultation. The most recent biological opinion for the Reef Fish FMP (NMFS 2011a) stated that up to 75 green, 48 hawksbill, and 18 leatherback sea turtles could be taken lethally over three year periods. Take of *Acropora* (staghorn and elkhorn, combined) coral was calculated for three one-year periods at 0.0041 square miles. Indirect effects to *Acropora* coral via reduced sexual/asexual reproductive success were noted also. The most recent biological opinion for the Spiny Lobster FMP (NMFS 2011b) stated that up to 12 green, 12 hawksbill, and nine leatherback sea turtles could be taken lethally over three one-year periods. Take of staghorn coral was calculated for three one-year periods at 93 square feet.

Recently listed species (*i.e.*, rough cactus coral, pillar coral, lobed star coral, mountainous coral, boulder star coral, scalloped hammerhead shark Central DPS, Nassau grouper, oceanic whitetip shark, and giant manta ray) could also be taken under activities authorized under the Puerto Rico FMP, however previous calculations of take for these species under the Reef Fish or Spiny Lobster FMPs do not exist (they would be estimated in the ongoing Section 7 consultation).

Previous analyses of effects to ESA-listed species are summarized in Section 7 consultations for the Reef Fish and Spiny Lobster FMPs (see Appendix D) and were determined for each fishing sector (*i.e.*, Puerto Rico commercial, Puerto Rico recreational, St. Thomas/St. John, and St. Croix). It would be expected that those determinations accurately reflect known effects to listed marine mammals, sea turtles, and corals in the Puerto Rico management area. Similarly, NMFS' effects analyses for Nassau grouper, scalloped hammerhead shark Central and Southwest Atlantic DPS, giant manta ray, and oceanic whitetip shark described in NMFS' October 31, 2018 memorandum, should accurately reflect potential effects to these species through the extended reinitiation period of December 2019.

A formal consultation is currently in process to comprehensively package all analyses for all actions under the Puerto Rico FMP into one document (*i.e.*, biological opinion) and update information/analyses as appropriate. This biological opinion would also outline any expected take, and its effect to populations, and determine whether the FMP jeopardizes the continued existence of any ESA-listed species, or destroys or adversely modifies designated critical habitat.

## Summary

This section evaluates the need and efficacy of taking additional action to minimize bycatch and bycatch mortality in the fisheries that comprise the Puerto Rico FMP using the ten factors provided at 50 CFR 600.350(d)(3)(i). Management measures mentioned above, as well as past measures implemented by the Council to reduce fishing mortality that were migrated to this FMP as a result from Action 1, indirectly minimize bycatch in Puerto Rico fisheries. Fish traps, hook-and-line, and spearfishing have been the most successful fishing practices and these practices are

not expected to change without further regulations. Changes to those gear types or their operations are not considered in this FMP, thus bycatch is not expected to change from its current level. These measures continue to be applicable to fishery management in the Puerto Rico EEZ. It is likely that management measures such as redefined ACLs and AMs could increase the number of discards. However, this depends primarily on how well the reference points and particularly the ACLs reflect actual fishing activity, and secondarily on if fishermen shift effort to other species, seasons, or fisheries and if effort decreases in response to more restrictive management measures. The extent to which community structure and age/size composition respond to ending overfishing also will influence bycatch. Bycatch minimizing measures taken in previous Council actions (e.g., 2010 and 2011 Caribbean ACL Amendments) as discussed above, which would still be applicable in the Puerto Rico FMP, took into consideration potential increases in dead discards when setting bag and size limits, commercial quotas, and when determining the effectiveness of a seasonal closure. In addition, the effect that overlapping seasonal closures could have on reducing bycatch and fishing mortality of many co-occurring species is also expected to continue in the Puerto Rico FMP. New species groupings based on biological, geographic, economic, taxonomic, technical, social, and/or ecological factors proposed in this FMP could also reduce bycatch of co-occurring species.

Finally, the relative abundance, size structure, and age structure of other species in reef communities could be expected to change in response to reduced fishing pressure, for example as a result of changing predator/prey relationships or habitat characteristics. Such ecological changes could occur in the community structure of reef ecosystems through actions that would end overfishing. These ecological changes could affect the nature and magnitude of future patterns of bycatch. As appropriate and necessary, the Puerto Rico FMP could be amended to further reduce bycatch as additional information becomes available.

# Appendix M. Fisheries Data Requirements

## M.1. Introduction

Management of fisheries and living marine resources depends on careful interpretation and analysis of reliable and comprehensive information (e.g., life history, landings data). The more information managers have available, the greater the likelihood that resource management goals will be achieved and the less uncertainty will be inherent in that effort. National Standard (NS) 1 of the Magnuson-Stevens Act provides information on what the Councils must include in their FMPs or associated public documents with respect to data, such as a description of general data collection methods as well as any specific data collection methods used for all stocks in the fishery and ecosystem component species (§ 600.310 (i)(1)-(3). These include:

(1) Source of fishing mortality (both landed and discarded), including commercial and recreational catch and bycatch in other fisheries;

(2) Description of the data collection and estimation methods used to quantify total catch mortality in each fishery, including information on the management tools used (i.e., logbooks, vessel monitoring systems, observer programs, landings reports, fish tickets, processor reports, dealer reports, recreational angler surveys, or other methods); the frequency with which data are collected and updated; and the scope of sampling coverage for each fishery; and

(3) Description of the methods used to compile catch data from various catch data collection methods and how those data are used to determine the relationship between total catch at a given point in time and the annual catch limit (ACL) for stocks and stock complexes that are part of a fishery.

In addition, NS2 of the Magnuson-Stevens Act states that an FMP should identify scientific information needed from other sources to improve understanding and management of the resource, marine ecosystem, and the fishery (including fishing communities) (§ 600.315).

Management of federal fisheries in the U.S. Caribbean relies almost exclusively on landings data derived from the commercial and (presently in Puerto Rico only) recreational sectors. Currently in the U.S. Caribbean, additional parameters used in fisheries management (e.g., species age, length, growth rate, and reproductive patterns) are lacking or not consistently available. Landings data are of considerable value for delineating long-term harvest patterns and for detecting substantial changes in those patterns. However, landings data are not suited to address all federal fisheries management issues, both because of limited temporal and spatial resolution of the landings data and because landings data alone cannot answer important management questions pertaining to year-class strength, recruitment patterns, and other essential measures of population health.

Limited temporal and spatial resolution hinders the ability to accurately determine changes in the fishery through time or among sites. As an example of the former case, commercial fisheries landings reports, until recently, did not include information on fishing location except to the coarsest degree (i.e., closer or farther than 10 miles from the coastline). A breakpoint at 10 miles from the coastline does not provide a clear indication of where the fishermen were harvesting the species with regard to state or federal waters, since the boundary between state and federal waters off Puerto Rico is nine nautical miles (nm).

Federal fishery management obligations have increased in the past several years resulting from the Congressional mandate to end overfishing of managed species, as defined in the 2007 revision of the Magnuson-Stevens Act. In particular, the Magnuson-Stevens Act requires as a statutory provision that ACLs be established, with few exceptions, for all federally managed species. These ACLs define the maximum allowable annual harvest for each stock (or stock complex) included in a federal FMP. Accountability measures (AMs) are corollary to the ACLs and function to either prevent an ACL from being exceeded (generally via in-season response) or to ensure that management actions are taken to prevent an overage from occurring again (generally via a post-season response). More information on how AMs and ACLs are applied to the Puerto Rico EEZ can be found in Sections 6.7 and 6.8 of this FMP/DEIS.

It is essential that scientists and managers have available to them, in a timely manner and with the necessary level of temporal and spatial resolution, data suitable to meet these federal management obligations. Ideally, those data would be available on a monthly or more frequent basis, thereby allowing for in-season management, but so far that has not been the case. Instead, essential landings data are typically not available until at least a year following the end of the applicable fishing season. This delay in data availability results in a management approach dependent on post-season responses, and those responses may not be in place until 18 to 24 months following the event.

Appendix M.2 (Data Needs for Management) below, lists and discusses the minimum data requirements for effective management of Puerto Rico EEZ fisheries and its shortfalls; and Appendix M.3 (Data Sources) discusses where current data comes from and how it is being collected to address management data needs.

## M.2 Data Needs for Management

With respect to effective management of marine fisheries in the U.S. Caribbean EEZ, particularly in the Puerto Rico EEZ, there exists a set of minimum data requirements necessary to maintain sustainable harvest (Table M.1). Note that additional data would be required to

address economic and social issues associated with the fishery. Those economic and social issues may play an essential role in fishery and ecosystem health.

**Table M.1.** Status of data components recommended for enhancing federal fisheries management in the U.S. Caribbean. (Y= program available, N= program not available).

| Program | Puerto Rico | St. Thomas/St. John | St. Croix |
|---|---|---|---|
| Commercial Landings Data | Y | Y | Y |
| Trip Intercept Program | Y | Y | Y |
| Marine Recreational Information Program | Y* | N | N |
| Fishery Independent Data | Y | Y | Y |
| Ecosystem Response Indicators | N | N | N |

* Since late 2017, NMFS Statistics and Technology Office is no longer conducting any Access Point Angler Intercept Surveys (APAIS) sampling in Puerto Rico. MRIP, ST1 will be working with the regional partners to identify administrative body/group/agency to better define data needs and possible data collection projects to be considered for funding and testing by MRIP.

- Commercial landings data: Commercial landings data are necessary to monitor trends in harvest, particularly with respect to changes in those trends, and to identify species that may be appropriate for inclusion in the list of federally managed species. Included in these landings reports is information on fishing effort and location. Commercial landings data are being acquired, but with limitations including a lack of specific information on harvest location, effort expended, and in many cases, species-level descriptions of the catch. Furthermore, it is important to note that some portion of the commercial catch does not enter the market, but instead is kept by the fishermen for personal use. The extent of this subsistence catch, the degree to which it is included in landings reports, and its influence on the achievement of federal management goals is not well understood in the U.S. Caribbean. More information about sources of commercial landings data can be found in Section E3.1.

- Trip intercept program (TIP) data: TIP data provides information on the basic biology of the catch, including size and sex distribution, species composition, and information on fishing locations and effort. These data are derived from surveys of the catch during dockside interviews with the fishermen. More information about the TIP can be found in Section E3.1).

- Recreational Data: The Marine Recreational Information Program (MRIP), formerly known as the Marine Recreational Fisheries Statistics Survey or MRFSS (see Table E3.1), conducts vessel intercepts, direct and indirect (e.g., telephone) interviews, and other activities to gauge the composition, extent, and variability of harvest by the recreational sector. Additional information about sources for recreational data can be found in Section E3.1.

- Fishery-independent data: Fishery information collected by sampling methods independent of the commercial and recreational sectors provides data complementary to that collected by fishery-dependent means. Fisheries-independent data will help determine the health of the fishery to the extent to which those fishery resources can be sustainably harvested. For example, in the U.S. Caribbean stock assessments rely on fisheries-dependent data sources to use data-limited approaches for determining stock status and sustainability levels. Given that data from fishery-independent surveys can provide an unbiased estimate of abundance with which to calibrate stock assessments, its use is preferable. Using good and reliable fishery-independent data can reduce dependence on fisheries-dependent data (Cass-Calay et al. 2016). Specific information about fishery-independent data sources in Puerto Rico can be found in Section M3.2.

  Fishery-independent data are collected under the auspices of several organizations and programs in the U.S. Caribbean and include a variety of methods such as diver-based surveys, visual census (underwater transects and point surveys), hook-and-line surveys, trap surveys, hydroacoustics, underwater video, and more, many with a limited spatial scale. However, often times these surveys do not take into account existing fishery knowledge or management needs. The results of these surveys require considerable effort to integrate into existing fishery data analysis. In addition, the survey designs are not necessarily appropriate for application to fishery management questions, nor are they repeated with any level of adequate consistency. A recent NOAA-sponsored workshop conducted in the U.S. Caribbean did a comprehensive review of the existing fishery-independent survey programs (Report of the U.S. Caribbean Fishery-Independent Survey Workshop 2016). Methods, statistical designs, and objectives differ among programs, and the workshop found that the majority of those objectives may not necessarily be directly related to stock assessments (i.e., information collected (abundance, density, size structure) was for particular species in localized areas). A general recommendation from the workshop was to develop comprehensive new surveys and/or improve the temporal and spatial scale of existing efforts to improve data collection activities so that stock assessments in the U.S. Caribbean can be better supported. Substantial funding is expended on these surveys, so it is essential that they be conducted in a manner that provides maximum applicability of the resultant data. This can be accomplished by close coordination among the various management agencies and organizations particularly with the involvement of local experts. Some of the recommendations from the 2016 U.S. Caribbean Fishery-Independent Survey Workshop for the development of new surveys and/or adaptation of existing surveys in the Caribbean include:

  1) Identify species of interest in the U.S. Caribbean to allow optimization of survey design.

2) Consult experts in survey design, statistics, and stock assessment prior to modifications/expansion/development of surveys.
3) Use similar methods across platforms to ensure adequate spatial coverage.
4) When using different gears, overlap spatially and temporally to allow calibration of methods.
5) Use cooperative research programs when fiseable (i.e., include fishing community).
6) Develop/enhance capacity to process and analyze age, reproductive information, etc.
7) Conduct a regional workshop to identify gaps in stock demographic data.
8) Focus on filling spatial gaps to achievea "representative fraction of the populations"
9) Enhance data mining and recovery – scour and captura as much regional data as possible.
10) Expand habitat mapping, including high resolution bathymetry.
11) Collect information to facilitate Ecosystem-based Fishery Management (EBFM) and next-generation stock assessment.

(Source: Report of the U.S. Caribbean Fishery-Independent Survey Workshop 2016)

- Ecosystem response indicators: The U.S. Caribbean reef fish fishery is by definition inherently intertwined with its habitat. Fishing is consistently mentioned as one of the top three impacts to coral reef health (NOS n.d.). Yet, fishery and coral reef managers are not relating changes in management regime to ecosystem responses. Parrotfish are an excellent example. Allowable take in the U.S. Caribbean EEZ has been substantially reduced but there is no monitoring program in place that would allow managers to quantify the response, if any, to the harvest reduction. The expected response to the reduction in parrotfish harvest would be an increase or decrease in the availability of critical *Acropora* settlement substrate. Many ecosystem indicators are monitored, but few, if any, allow managers to relate fisheries management decisions to habitat responses despite the high ranking of fishery impacts to ecosystem health.

## M.3 Data Sources

### M.3.1 Fishery-Dependent Data (Commercial and Recreational)

Fisheries managers utilize fishery-dependent catch statistics in the U.S. Caribbean to inform regulation of harvest levels (including ACLs) and implementation of management measures. The NOAA Fisheries Glossary (http://www.st.nmfs.noaa.gov/st4/documents/FishGlossary.pdf) defines fishery-dependent data as data collected directly on a fish or fishery from the commercial or sport fishermen and seafood dealers. Common methods of collecting fishery-dependent data include logbooks, trip tickets, creel sampling, fishery observers, and phone surveys. In the U.S. Caribbean, such data does not currently capture the full extent to which species under federal management are being extracted from the rest of the population. At the present time, two

fishery-dependent datasets are available for use in determining the quantity harvested of each stock or stock complex in Puerto Rico. The two data sets are:

- Puerto Rico DNER commercial trip ticket data
- Recreational landings data through MRIP

As mentioned above, a commercial TIP also exists in Puerto Rico and it involves information collected by port samplers mainly on fishing effort. TIP is further discussed below. Recent Southeast Data Assessment Review Data (SEDAR)-sponsored stock assessments have primarily utilized commercial landings data obtained from catch reports or the trip tickets, with little reliance on data obtained from TIP sampling (SEDAR 2009). SEDAR is a regional cooperative fishery management council process initiated in 2002 to improve the quality and reliability of fishery stock assessments in the South Atlantic, Gulf of Mexico, and the U.S. Caribbean.

### M.3.1.1 Commercial Landings Data

**Commercial Trip Ticket Data**

With such a high reliance on commercial catch reports, it is important to obtain credible data through such means. Fishery managers are currently working in identifying ways in which the commercial data collection can be enhanced to get a better perspective of the status of the fisheries in Puerto Rico.

In Puerto Rico, landings data are available by species in electronic form beginning in 1983 (SEDAR 2009). Commercial landings information in Puerto Rico is obtained through trip tickets submitted by fishermen, fishing associations, and dealers directly to the Puerto Rico DNER. Between 1968 and 1998, the commercial sector in Puerto Rico voluntarily reported landings data. The Puerto Rico Public Law 278 of 1998 (i.e., Puerto Rico Fisheries Law) required the commercial sector to submit their landings reports to the PR DNER (Matos 2008). However, the same law established that the local government had to create fishing regulations before mandatory reporting be required. The fishing regulations were not approved until 2004. Since 2005, the Puerto Rico DNER has been enforcing the monthly reporting of landings statistics by the commercial sector. In 2010, a moratorium was put in place to allow fishermen to submit their catch after the 60-day deadline. That moratorium was lifted in 2013 and fishermen need to report their catch within the 60-day timeframe. Currently, fishery landings data includes data on catch, effort, length, and frequency. Other information gathered in the catch report form includes fisher's license number, depth where most of the fishing took place, area of capture (by using numbers in a grid), HMS permit number (if applicable), if harvest was made in federal or state waters, if fishing with traps, what was the soaking time, etc. The Puerto Rico DNER enforces lack of monthly reporting through fines or by revoking fishing licenses (DNER 2010).

**Commercial Trip Intercept Program Data**

The TIP data collection in the U.S. Caribbean has historically focused on the commercial sector trips in both Puerto Rico and USVI. These data are obtained by port samplers who interview fishermen and gather information on fish length and numbers of each species or species group landed, gear used, and information on the fishing trip (e.g., trip duration, fishing locations). Port samplers also collect a variety of information on fishing effort, including, but not limited to, trap soak time and number of traps. Included in the information collected are at least two matrices (length frequency and species composition) that could be viewed as some of the most valuable information from this data set.

#### M.3.1.2 Recreational Landings Data

Although recreational and sportfishing activities in Puerto Rico are prominent, data on the recreational catch and effort, species composition of the catch, and biological data on the species targeted and harvested are mostly lacking (CFMC 2011a), as noted in Section 3.2 (Fisher and Stakeholder Concerns). In 2000, NMFS, in collaboration with a private contractor and the local government, initiated the Marine Recreational Fisheries Statistics Survey (MRFSS) (later redesigned as MRIP) program in Puerto Rico. Recreational fisheries monitoring through the MRFSS/MRIP follows the same methodology as on the continental U.S. In Puerto Rico, the MRFSS/MRIP program has been conducted through the Puerto Rico DNER, who generally has provided the intercept and interview personnel although occasionally contracting consultants to carry out the survey (CFMC 2011a). The program collected data on recreational catch and effort targeting finfish and on coastal and highly migratory species, but did not include information on two of the most important commercially and recreationally important invertebrates: conch and lobster. MRFSS/MRIP samplings in Puerto Rico have continued since 2000 (SEDAR 2009). Table E3.1 below lists the differences between the MRFSS and MRIP.

Table M3.1. Differences between the original MRFSS and the new MRIP.

| Subject/Theme | MRFSS | MRIP |
|---|---|---|
| **How phone surveys are conducted** | Phone surveys were conducted using random digit dialing of coastal households only. Lots of calls were made to non-anglers, and never called anglers who don't live on the coast. | The new National Saltwater Angler Registry will serve as a national "phone book" of fishermen, significantly increasing the ability to target anglers directly. |
| **Timeliness of data** | All data has been delivered to managers every two months. | Currently developing survey designs that could be modified to provide more frequent updates in response to management needs[1]. |

| | | |
|---|---|---|
| **How we measure catch per trip** | Assumed that catch sampled during peak times could accurately estimate catch across an entire 24-hour period. | Will sample sites during four specified six-hour blocks. Sampling during both peak and non-peak times will enable us to more accurately estimate catch across a whole day. |
| **How samplers gather information** | Samplers had some discretion in which sites to go to and in what order. | Samplers will conduct interviews at a specific cluster of sites in a specific randomized order, ensuring more structured sampling and less sampler discretion. |
| **Where samplers interview** | Samplers were directed to maximize the number of angler interviews, potentially creating a bias toward peak times and popular areas. | Samplers will now be directed to maximize the number of sites visited – including continuing to visit sites where there is no or low fishing activity – to ensure a more representative look at fishing activity across a geographic area. |
| **When samplers conduct interviews** | Little or no sampling was done late at night. | Samplers will now work during all day parts, including at night, because the number of people fishing and what they're catching can vary greatly during different times of the day. |

[1] Starting in 2017, the MRIP in Puerto Rico has been put on hold.

The Coastal Household Telephone Survey (CHTS) is a random digit telephone survey designed to identify and interview households and household members within the designated survey area to determine if they participated in recreational saltwater fishing during the designated period. Surveys are limited to full-time occupied housing units and exclude institutional housing, seasonal residences, businesses, mobile phones, and pay phones. The CHTS questionnaire includes a household screening to identify eligible fishing households and an angler questionnaire to collect detailed information about recent saltwater fishing trips. An interview consists of a successful contact with a household resident and enumeration of the number of household members (including zero) that participated in recreational saltwater fishing during the designated period. Anglers are asked to recall all recreational, saltwater fishing trips taken in the last two months (from date of interview). Respondents are asked for details on each trip, including trip dates, fishing modes, location of the fishing access site, and general area of fishing including river and estuarine saltwater cutoff points.

The Puerto Rico angler intercept survey follows the design and management of the U.S. coastal state MRIP Access Point Angler Intercept Surveys (APAIS), with the exceptions of no registry of for-hire vessels and that no head boats presently operate in Puerto Rico. Interviews are conducted year-round at various sites across the main island of Puerto Rico. Survey site and time intervals are pre-determined based on a NOAA draw with sites chosen from a fishing

location register. Angler interviews are the primary goal but are not always possible, in which case confirmed trip counts suffice. As of 2016, all anglers are intercepted at each site, regardless of fishing mode, and are pre-screened for eligibility prior to initiating the interview. Table E3.2 provides a summary of data collected from each intercept.

Table M3.2. Access Point Angler Intercept Survey data collected from private vessel, for-hire, and shoreline modes in the ongoing Puerto Rico MRIP data collection program. Data are collected in 2-month waves every 12-months. Reports are due 21 days after each wave.

| Survey Component | Variables Collected | Other Resolution | Data |
|---|---|---|---|
| **Effort** | (By angler): Boat hours (boat modes only), Fishing days in past 2 months/12 months, Gear soak hours, Home city/state/zip | Area fished, Gear type, Target | Effort, CPUE for landings |
| **Unavailable Catch** | (To lowest taxonomy): Number, Disposition | Area fished, Gear type, Target | Landings (number), Discards |
| **Sampled Catch** | (by species): Length, Individual weight, Number, Disposition | Area fished, Gear type, Target | Landings (number and weight), Discards |

More information can be found in the MRIP handbook: https://www.st.nmfs.noaa.gov/recreational-fisheries/MRIP-Handbook/MRIP_handbook.pdf

### M.3.1.3 Landings Data Transmission and Reporting

A historic problem with fishery dependent data reporting in the U.S. Caribbean has been the lengthy delay between the day species are harvested and the transmission of that harvest information to fishery managers. Currently, there may be as much as a two-year lag between the time landings are recorded and the time data are released for fishery management applications (CFMC 2011). This lag time reduces fishery managers' ability to adjust fishery management measures in a timely fashion. Ideally, landings data would be available to managers on a monthly basis within the fishing season (i.e., in Puerto Rico, from January to December), allowing for in-season adjustment of harvest rates to ensure that harvest limits are met but not exceeded. Currently, federal and territorial fishery agencies are working together to find ways to reduce the time lag and allow for a faster delivery of landings data.

The unavailability of landings data on time is problematic for ACL monitoring. For example, to determine if a sector ACL has been exceeded, NMFS compares the average of the most recent three years of available landings to the sector ACL for each stock or stock complex. Because each year's landings data do not become available until the following year, and there is a substantial time lag between data availability and implementation of a closure rule, effecting an

AM-based fishing season reduction in response to a sector ACL overage generally does not occur until two years following the most recent year of available landings.

MRAG Americas Inc. (2009) proposed a reporting scheme in which fishermen on Puerto Rico and the USVI would report on a weekly basis as a solution to the time lag issue. This scheme could speed up the process by reducing the delay with data reporting by using an electronic logbook system. The concern, however, is the time burden on fishermen, which could affect cooperation and compliance. To offset these concerns, a number of options could be offered, including self-addressed stamped envelopes, drop boxes in centralized locations, drop-offs in person at the agency office, and even call-ins (in special circumstances). Under this reporting scheme, receipts would be given to fisherman for all reports received. However there are limitations with this scheme, for example in Puerto Rico, agents cannot pick up landing reports and fishermen cannot drop them off at a centralized location because of the receipt requirement. Under the electronic logbook system, computers could be placed in government-sponsored fishing associations or in fishermen's associations with the associated training workshops. Fishermen, however, have made counter-proposals in which the MRAG timeline can be phased in on a slower timeframe. They would like to maintain the monthly reporting schedule, and phase in shorter reporting timeframes as the catch is approaching the quota limit (MRAG 2009).

Electronic reporting could aid in the timely submission of data and subsequent analysis to meet Magnuson-Stevents Act requirements in the U.S. Caribbean. Fisheries that may be suitable for electronic reporting include deep-water snapper grouper complex, for-hire boats and some of the key species of small scale fisheries, such as lobster, snappers, groupers, queen conch, among others.

Recently a grant was awarded to The Nature Conservancy to develop, improve and expand the adaptive electronic reporting system for up to 100 vessels in Puerto Rico Fisheries. The project would result in a fully functional electronic reporting system in Puerto Rico's commercial fisheries which will improve catch accountability, monitor annual catch limits, promote productive and sustainable fisheries, and improve Puerto Rico's fisheries statistics collection and management (NFWF 2018).

#### M.3.1.4 Non-Reporting and Misreporting

Another integral step in enhancing fishery dependent data is identifying and accurately measuring non-reporting and misreporting. An important component of fishery management is accounting for uncertainty. Uncertainty results from both non- and misreporting. There are two types of non-reporting. The first type is the catch that simply goes unreported, either by the fishermen or the fish house. The second, a smaller portion of the catch is never accounted for because it is sold on the dock en-route to the fish house where the rest of the catch is reported.

In Puerto Rico, the level of misreporting is a concern. Misreporting is the level of under or over reporting by a fisher. Misreporting needs to be corrected in order to more accurately and precisely know the level of species harvest. Better understanding of the temporal and seasonal changes in non-reporting and misreporting would allow for a better overall estimate of the expansion factor to be applied to the reported landings data (MRAG 2009). Expansions factors are used in Puerto Rico to calculate total landings from partial landings statistics and address the non- and misreporting issues. In Puerto Rico, expansion factors have been used to account for non-reporting fishermen and also to adjust for missing reports by fishermen who reported for part of the year. There is a need for expansion factors to be developed with the same timeliness as the reporting and they need to be specific to the reporting year.

A report published by MRAG Americas Inc[83] in 2009 proposed modifications to the present survey design to address these shortcomings. The proposed survey design would use the most recent census data to count the number of unlicensed fishermen by port and fishing center. Port samplers would then be able to refine the list based on their knowledge and experience with the local fishermen. Third, samplers would then conduct follow-up visits to each site confirming their estimates via interviews with the fishermen. Managers would use the information on the number of non-reporters by site to quantify the spatial and temporal variability in the ratio of reporters to non-reporters. From that information, managers can evaluate a design that obtains data from more sites at more times over the entire island, but a shorter sampling duration at each site. Port samplers should repeat this intense survey approximately every five years, and then over the longer term, managers would use the data to determine seasonality for sampling and intensities.

### M.3.2 Fishery Independent Data

The NOAA Fisheries Glossary defines fishery-independent data as characteristic of information (e.g., stock abundance index) or an activity (e.g., research vessel survey) obtained or undertaken independently of the activity of the fishing sector. Fishery-independent data intends to avoid the biases (e.g., non-reporting and misreporting) inherent to fishery-related data or fishery-dependent data. There are fishery-independent data collection initiatives such as the **Southeast Area Monitoring and Assessment Program (SEAMAP)** and SEDAR currently underway in the U.S. Caribbean. SEAMAP is state/federal program designed to collect, manage and disseminate fishery-independent data in the southeastern United States.

[83] MRAG Americas Inc. is a company comprised of scientists and specialists with expertise in fisheries and aquatic resource science, management, and monitoring; fisheries observer programs; ecosystem and protected area management; government liaison and relations; stakeholder engagement and outreach; and international conservation and management agreements.

In addition to the SEDAR and SEAMAP initiatives, these are also sporadic fishery independent surveys carried out in the U.S. Caribbean by other NOAA programs (Table E.3.3), academia, and other federal agencies. Increase coordination and prioritization between fishery managers, and these numerous fishery independent surveys will enhance fishery management in the U.S. Caribbean. An initiative to coordinate the numerous fishery independent projects would be labor intensive but would yield important results, and possibly fill the existing data gaps in the region. Thus, early collaboration within the NOAA programs working in the region is very important in setting a priority and avoiding duplication of effort.

As mentioned in Section E.2 (Data Needs for Management) there are many fishery-independent survey programs in the U.S. Caribbean and adjacent waters that serve as data sources for different objectives. Table E3.3 lists NOAA Inititiatives that collect fishery-independent data, particularly in Puerto Rico. Table E3.4 lists a representation of ongoing or recent fishery-independent sampling activities conducted by federal agencies, NGOs, states and territories, and academic partners as discussed in the NOAA sponsored U.S. Caribbean Fishery-Independent Survey Workshop (2016).

Table M3.3. List of NOAA initiatives that collect fishery-independent data in the U.S. Caribbean, particularly in Puerto Rico. (Source:

| NOAA Initiatives that Collect Fisheries-Independent Data |
|---|
| Caribbean Coral Reef Ecosystem Monitoring Project |
| Baseline Assessment of Guánica Bay, Puerto Rico in Support of Watershed Restoration |
| Seafloor Characterization of the U.S. Caribbean |
| Comprehensive U.S. Caribbean Coral Reef Ecosystem Monitoring Project (C-CCREMP) |
| Conservation Effects Assessment Project (CEAP): Jobos Bay, Puerto Rico Special Emphasis Watershed Partnership |
| Acoustic Tracking of Fish Movements in Coral Reef Ecosystems |
| An Ecological Characterization of the Marine Resources of Vieques, Puerto Rico |
| Coral Reef Ecosystem Studies (CRES) – U.S .Caribbean Component |
| Development of Reef Fish Monitoring Protocols to Support the National Park Service Inventory and Monitoring Program |

**Table M3.4.** Ongoing or recent fishery-independent sampling activities.

| **Fishery-Independent Sampling/Research Projects** | | |
|---|---|---|
| ***Survey*** | ***Description*** | ***Entity in charge*** |
| Biogeography Diver Based Suerveys (historical) and National Coral Reef Monitoring Program (NCRMP) | Surveys covering benthos, fish, people, and climate.<br>Not designed for stock assessment purposes. | Fish and benthos: NOS Biogeography Program, NMFS Southeast Fisheries Science Center |

| | | |
|---|---|---|
| Reef Visual Cencus (RVC) Surveys | Provides info not provided by fishery-dependent fara such info on al species, sizes, on appropriate spatial scales within the context of movements and haitats. | J. Ault; Steve Smith; Jim Bonsack |
| Caribbean Reef Fish Video Survey | Provide fishery-independent estimates of reef fish stocks in the U.S. Caribbean and collect biological samples for age and reproductive information. | Southeast Fisheries Science CEnter |
| SEAMAP-C in Puerto Rico | SEveral projects to mainly collect, manage and disseminate fishery-independent data on the species in territorial and EEZ waters; enable Puerto Rico to identify, complement and measure effectiveness of management measures. Projects include: Reef fish, queen conch, lobster, parrotfish, yellowtail snapper, lane snapper, and deep-water snapper surveys, and anhydroacoustic survey. | Collaboration among Puerto Rico DNER, Puerto Rico Sea Grant, Council, U.S. Fish and Wildlife Service, USVI DPNR, NMFS |
| Fish Spawning Aggregation Surveys in Puerto Rico | Monitor spawning aggregations using acoustic techniques focused on west coast areas Abrir La Sierra, Bajo de Sico, and Tourmaline Bank. Characterixe remnant Nassau grouper spawning aggregation and use visual survey results to validate acoustic monitoring work. | M. Scharer-Umpierre |
| Mesophotic Surveys | Characterize reef fish population in these ecosystems (30m-70m) | R. Appeldoorn; university partnerships |
| Survey of commercially exploited fish and shellfish populations from mesophotic reefs within the Puerto Rico EEZ | Characterize main species assemblagesof commercially important fish and shellfish in each of benthic habitats and dpeht surveyed (30-50m) within Abrir La Sierra, Bajo de Sico, Tourmaline Bank.; provide inferences of seasonal variations by species in Abrir La Sierra, particularly queen conch; produce rough population estimates for target species; provide preliminary analysis of status of commercially important fish and shellfish within mesophotic habitats based on the length frequency data. | J. García-Sais |

*Information about early NOAA surveys in the U.S. Caribbean dating back to1959 can be found in here http://sero.nmfs.noaa.gov/sustainable_fisheries/caribbean/fish_indep_wkshp/documents/pdfs/presentations/ingram_early_fi_caribbean_surveys.pdf.

### M3.2.1 Socio-economic Data

In 2018, the NMFS proposed to conduct a census of small-scale fishermen operating in the U.S. Caribbean. The data collection would apply only to Puerto Rico as data collection was complete

The extension for the data collection applies only to the Commonwealth of Puerto Rico because the data collection was completed in the USVI. The proposed socio-economic study will collect information on demographics, capital investment in fishing gear and vessels, fishing and marketing practices, economic performance, and miscellaneous attitudinal questions. The data gathered will be used for the development of amendments to FMPs, which require descriptions of the human and economic environment and socio-economic analyses of regulatory proposals. The information collected will also be used to strengthen fishery management decision-making and satisfy various legal mandates under the Magnuson-Stevens Act (U.S.C. 1801 et seq.), Executive Order 12866, Regulatory Flexibility Act, Endangered Species Act, and National Environmental Policy Act, and other pertinent statues. The information will be collected through in-person, telephone and mail surveys.

### M3.2.2 Southeast Data, Assessment, and Review (SEDAR)

The Southeast Data, Assessment, and Review is a cooperative fishery management council process initiated in 2002 to improve the quality and reliability of fishery stock assessments in the South Atlantic, Gulf of Mexico, and U.S. Caribbean. SEDAR is managed by the Caribbean, Gulf of Mexico, and South Atlantic Regional Fishery Management Councils in coordination with NMFS and the Atlantic and Gulf States Marine Fisheries Commissions. SEDAR seeks improvements in the scientific quality of stock assessments and greater relevance of quantities information available to address existing and emerging fishery management issues. SEDAR emphasizes constituent and stakeholder participation in assessment development, transparency in the assessment process, and a rigorous and independent scientific review of completed stock assessments. SEDAR is organized around three workshops. The first is a data workshop where datasets are documented, analyzed, and reviewed and data for conducting assessment analyses are compiled. The second is an assessment workshop where quantitative population analyses are developed and refined and population parameters are estimated. The third and final is a review workshop where a panel of independent experts reviews the data and assessment and recommends the most appropriate values of critical population and management quantities.

All SEDAR workshops are open to the public. Public testimony is accepted in accordance with each Council's Standard Operating Procedures. Workshop times and locations are noticed in advance through the Federal Register. For more information about the SEDAR visit http://www.sefsc.noaa.gov/sedar/. SEDAR Assessments for species in the U.S. Caribbean include:

- SEDAR 03-Southeastern United States Yellowtail Snapper
- SEDAR 04- Atlantic and Caribbean Deepwater Snapper-Grouper, Caribbean Species
- SEDAR 08A- Caribbean Spiny Lobster & Yellowtail Snapper
- SEDAR 14 - Caribbean Yellowfin Grouper, Mutton Snapper, Queen Conch
- SEDAR 26 - Caribbean Queen Snapper, Silk Snapper and Redtail Parrotfish
- SEDAR 30 -Caribbean Blue Tang and Queen Triggerfish

- SEDAR 35 - Caribbean Red Hind
- SEDAR 46 – Caribbean Data Limited Stocks
- SEDAR 57 – Caribbean Spiny Lobster (*to be held in 2018*)

### M3.2.3 Catch-Per-Unit-Effort Determination

In the U.S. Caribbean, effort data need to be improved so a more accurate catch per unit effort (CPUE) can be derived. The CPUE is used as a measure of economic efficiency and index of fish abundance, and in the U.S. Caribbean is fraught with issues. In addition, fishermen report the time actually fishing, which is a parameter to calculate CPUE, and the time away from the dock interchangeably (MRAG 2009). Multiple SEDAR assessments have attempted to develop standardized CPUE abundance trends from the U.S. Caribbean landings data, with minimal success (SEDAR 2009). For example, for queen conch, there is not a clear definition of the units of effort recorded for CPUE. This lack of definition results in indices that do not properly reflect queen conch abundance (MRAG 2009).

Improved calculations of CPUE can be achieved through enhanced reporting by fishermen. Better reporting would consist of denoting fishing start and end times. Another helpful improvement would be identifying specific location in which fishing was conducted to help identify transit time. To standardize this data, managers have developed and provided to licensed fishermen a gridded map to properly distinguish locations. Finally, quantifying the total number of helpers on board a fishing vessel would also benefit managers (MRAG 2009).

### M3.2.4 Biological Data Collection

The analysts and reviewers involved with SEDAR assessments have associated several problems with the inability to establish species abundance trends. First, the data lacks an adequate number of samples (temporally or spatially) for constructing an appropriate length time series (e.g., 1-2 life spans) which would allow evaluation of changes in population size over time. There is also inadequate secondary information on the fishing event to explain changes in rate of harvest over time, often resulting in indices with weak ability to predict trends.

Port samplers provide additional fishery-dependent data when collecting species harvest data from the docks. Length-frequency of the catch and species composition is the most important piece of information to collect (MRAG 2009). Port samplers could also collect additional biological samples of ageing parts (i.e., otoliths, fins, dorsal spines) for specific species. When collected alongside length measurements and species composition, such samples would provide essential information on age-length relationships. The third priority in sampling is maturity and reproductive data (e.g., age and size at maturity, fecundity, reproductive strategy). The last priority is gathering trophic data (acquired through analyzing stomach contents). All of this data

combined would help lower scientific uncertainty if collected according to valid scientific and statistical protocols (MRAG 2009).

The Council's Scientific and Statistic Committee has also provided data research recommendations for purposes of enhancing SEDAR Assessment. These are listed in Appendix D. Some examples of information needed include life history information, updating size/age studies and addressing sampling issues for under-sampled species, evaluating commercial landing expansion factors for Puerto Rico, and include spiny lobster and queen conch into MRIP (Source: SSC Meeting March 2016).

# Appendix N. Essential Fish Habitat Description for Species in the Puerto Rico FMP (Including for Species New to Federal Management in the Puerto Rico FMP)

**Background**

The information for the 18 finfish species proposed for management (Action 2, Preferred Alternative 2) include species considered coral-reef associated species, pelagic species in additional to a number of benthic invertebrates (sea urchins and cucumbers).

The species described in this section, described as coastal pelagics, are generally found over a broad longitudinal and latitudinal range in the Atlantic in addition to the Puerto Rico - Virgin Island platform or might be circumtropical in nature. Some species such as the dolphin, little tunny, blackfin tuna and possibly wahoo are oceanic species and are found in the high seas of the Atlantic and Pacific in addition to coastal areas. Species such as the mackerel, blue runner and rainbow runner are migratory and primarily are captured in the management area on the outer shelf edge. Other species such as the barracuda and many members of the jack family have characteristics similar to the reef fish, in that they are frequently found among the larger reefs and may even remain on one reef for extended periods. This situation is further complicated by the fact that these species do not universally follow the above generalities and occasionally may be found at sea, on reefs or near shore (CFMC 1983). A specific habitat description is further complicated by the fact that the specific location of larval development is unknown and little scientific information is available on specific migration patterns through the area. These species are also present only seasonally around Puerto Rico and the US Virgin Islands, with presence being highly variable in time and space.

In 1983, the Caribbean Fishery Management Council (Council) developed a Draft Environmental Impact Statement (DEIS) for the Caribbean Coastal Migratory Pelagic Fishery Management Plan (CCMP FMP) (CFMC 1983). The DEIS included objectives, description of the fisheries, description of the habitats and management measures, however, the FMP was not approved at the time. The species considered under the CCMPFMP were: cero mackerel (*Scomberomorus regalis*), king mackerel (*Scomberomorus cavalla*), great barracuda (*Sphyraena barracuda*), dolphinfish (*Coryphaena hippurus*), almaco jack (*Seriola rivoliana*), bar jack (*Caranx ruber*), greater amberjack (*Seriola dumerili*), horse-eye jack (*Caranx latus*), yellow jack (*Caranx bartholomaei*), blue runner (*Caranx crysos*), rainbow runner (*Elagatis bipinnulatus*), and wahoo (*Acanthocybium solanderi*). Closely associated with these species, but not considered part of the management unit were: blackfin tuna (*Thunnus atlanticus*) and little tunny (*Euthynnus alletteratus*). New pelagic species proposed for federal management in the Puerto Rico exclusive economic zone (EEZ) under **Action 2, Preferred Alternative 2** include: cero mackerel (*Scomberomorus regalis*), king mackerel (*Scomberomorus cavalla*), blackfin tuna

(*Thunnus atlanticus*) and little tunny (*Euthynnus alletteratus*), wahoo (*Acanthocybium solanderi)* great barracuda (*Sphyraena barracuda*), dolphinfish and pompano dolphin (*Coryphaena hippurus* and *C. equiselis*), crevalle jack (*Caranx hippos*), rainbow runner (*Elagatis bipinnulatus*), African pompano (*Alectis ciliaris)*. Additionally, tripletail *Lobotes surinamensis*, the manta (*Manta birostris*), the spotted eagle ray (*Aetobatus narinari*) and the southern sting ray (*Dasyatis Americana*) are also proposed for management.

At that time, the Council also proposed to ban the sale of certain species due to ciguatera through the following management measure: "The sale and marketing of barracuda, amberjack, horse-eye jack and black jack, taken in the FCZ, shall be prohibited for human consumption because of the serious possible harm to consumers, due to ciguatera poisoning." The CMPFMP was never formalized. The Draft FMP was submitted in April 1983 at the 46$^{th}$ Council meeting but was withdrawn in December 1983 (48$^{th}$ CFMC meeting). The Draft Coastal Pelagic FMP was proposed because of concern with these species and the variability in their temporal-spatial presence in the Islands.

The information included in this Appendix also includes the reef-associated species: *Lutjanus cyanopterus* (Cubera snapper, yellowmouth grouper, *Mycteroperca intersticialis*, *Balistes capriscus*, the grey triggerfish,

The geographical extent of these species is considered in the description of EFH below. However, there are still questions about there being one or more stocks (e.g., dolphin fish) in the area around Puerto Rico and the US Virgin Islands. Additionally, it is not until recently that the pelagic species have sparked some research interest in the region, most likely due to their seasonal presence.

**Essential Fish Habitat (EFH)**

This section describes the EFH for those species that are new to fisheries management in the Puerto Rico FMP. The species that would be retained for management resulting from Action 2 (Preferred Alternative 2) of the DEIS, have EFH described and identified through the 1998 EFH Generic Amendment, the 2004 Environmental Impact Statement (EIS) (CFMC 2004), and the 2005 Sustainable Fisheries Act (SFA) Amendment (CFMC 2005) as well as its EFH designation being reviewed under the 2011 five-year EFH Review (CFMC 2011) and the on-going Council five-year EFH review. The 2011 EFH five-year review includes revision of literature that include most of the species proposed for management, such as Cubera snapper, yellowmouth grouper, and others.

This section is arranged in the following order: summary of species distribution, habitat (including information on eggs, larvae, feeding and spawning), predator-prey interactions and reported incidence of ciguatera. The issue of ciguatera is significant in the region and should be considered when there are site-specific areas of ciguatoxic fish. Ciguatera is presumably

primarily caused by the bioaccumulation of the toxin by *Gambierdiscus toxicus*, dinoflagellates, eaten by herbivores feeding on macroalgae growing on coral and passed up through the food chain. In the US Virgin Islands, Commercial fishers of St. Thomas reported high incidence of ciguatoxic fish from the south side of St. Thomas. No such ciguatera specific areas have been reported in Puerto Rico. The Government of Puerto Rico has banned the sale of suspect ciguatoxic fish although seasonality in the presence of ciaguatoxin in barracuda (October-November) could indicate changes in the environment conducive to HABs (harmful algal blooms) ((Tosteson 1988). Ciguatera was described in fish from the Pacific prior to being reported in the Atlantic/Caribbean in the 1950s (de Sylva 1956).

**Lutjanidae- Snappers**

Distribution of Cubera Snapper

*Lutjanus cyanopterus* (Cubera snapper) is distributed in the western Atlantic from Nova Scotia, Canada 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. Its depth range is one meter to at least 85 m (Allen 1985, Lindeman et al. 2000). It appeared to be rare in the Gulf of Mexico (Allen 1985), however, spawning adults have been reported from the northwestern Gulf of Mexico in July and August (Heyman, unpublished in https://geo.gcoos.org/restore/species_profiles/Cubera%20Snapper/).

Habitat of Cubera Snapper

Lutjanid eggs in general are pelagic and contain an oil globule indicative of flotation in the water column. Ramírez-Mella and García-Sais (2003) reported that in Puerto Rico, snapper larvae are found in neritic and oceanic environments with a higher number found in the neritic corridor between 6 - 10 km offshore. Larval pelagic duration for Lutjanidae larvae lasts between 22-38 days. No specific information was found for *L. cynopterus* eggs and larvae from Puerto Rico.

Cubera snappers are reported form near shore habitats including areas near river mouths and upstream up to areas of low salinity (J. Torres, Fisher from Toa Alta, PR, personal communication). They are found in depth ranges from very shallow in rocky shorelines of the north coast of Puerto Rico to mesophotic reefs. Juveniles can be seen in mangrove areas and seagrass beds, estuaries and freshwater/saltwater exchange areas (Grana Raffucci 2005a, 2005b).

García Sais et al. (2005, 2007, 2010, 2011, 2012, 2013) reported Cubera snappers form the deep reef in Desecheo, specifically from reef tops at mesophotic reefs (30-50 m) within the seasonally closed areas off the west coast of Puerto Rico in Bajo de Sico (BDS), Abrir La Sierra (ALS), and Tourmaline, and in known but not protected spawning site of El Seco (Vieques). Higher abundance of Cubera snappers were reported from ALS than Desecheo and BDS in 2011-2012 (García-Sais et al. 2012). Highest densities however were recorded at El Seco in Vieques (García-Sais et al. 2011). All Cubera snappers reported from mesophotic reefs in Puerto Rico, at depths of 30-50 m, were well above size at first reproduction with no juveniles of Cubera

observed. Although aggregations of Cubera snappers were reported, no spawning behavior was observed at any of the sites surveyed.

Cubera snappers represent one of the top demersal predators of shelf-edge habitats, where they are transient between outer neritic and upper insular slope domains. They seem to have wide foraging areas with ample depth range (García-Sais et al. 2012). Lower number at Desecheo may be related to the lack of connectivity with recruitment and/or nursery habitats and/or to larval dispersal dynamics (García-Sais et al. 2012).

Large adult cubera snappers were the most abundant and commonly and frequently observed at the coral reef bank and patch reefs at El Seco, with a large school of over 80 adult individuals being reported García-Sais et al. (2011). Cuberas were however absent from colonized pavements at depths of 30-50 m. The suspect tiger grouper spawning site at El Seco included the presence of Cubera snappers (>60 individuals) but not spawning was observed in 2011, during the survey (February-April).

Abundance of large cubera snappers were estimated in the low to mid hundreds within mesophotic habitats at ALS and in the low hundreds at Bajo de Sico. The maximum depth of all surveys conducted at the mesophotic reefs of Puerto Rico by García Sais et al. was 50 m.

Spawning aggregations of Cubera have been reported at specific sites in Florida, Cuba, Mexico, US Virgin Islands and Belize (https://www.scrfa.org/cubera-snapper.html), but not from Puerto Rico. Local knowledge and information provided by fishers interviewed by Ojeda et al. (2007) identified potential SPAGs for Cubera snapper (*L. cyanopterus*), with spawning taking place between January and August, at Grappler Bank, three other sites in the south coast of PR, east of Vieques (other than El Seco), and two potential SPAGs in the north coast. None of these sites have been surveyed to confirm spawning aggregations of Cubera snappers.

Biggs and Nemeth (2016) suggest that *L. cyanopterus* utilize a spawning area of 1.4 to 1.5 $km^2$, centered at the shelf promontory and shelf edge in Grammanik Bank, a seasonally closed area (CFMC 2004-2005) used by a number of grouper (e.g., *Mycteroperca venenosa*, yellowfin grouper) and snappers as a spawning aggregation site. No actual spawning has been document but hydrated eggs found in fish form the area are indicative of imminent spawning. These multi-species aggregation sites are utilized by different species over different times, with one displacing another. *L. cyanopterus* aggregated monthly from May through November, with residence time peaking in August (peak when highest temperatures are recorded) while another snapper, *L. jocu* aggregated monthly through-out the year and residence time did not vary significantly by month. Acoustic data showed that fish detections increased in the week before and the first week after the full moon, but then decreased to zero by the third week after the full moon, indicating the end of the aggregation. Biggs and Nemeth (2016) comment on the

connectivity and the migration of spawning fish between the East coast of Puerto Rico and Grammanik Bank (South of St. Thomas) information that could suggest large home ranges for Cubera snappers. Benthic habitat at the mesophotic reefs of Grammanik Bank where Cubera snapper aggregate at depths of 30-60 m, are a combination of Montastrea/Orbicella coral and hard bottom interspersed with gorgonians and sponges (Smith et al. 2008).

Prey-Predator Relationship

Randall (1967) reported fish as the main diet of Cubera. Prey included grunts, *Diodon* sp., and scarids, all demersal species, as well as more pelagic species such as clupeoids; indicating feeding in the water column and on reef-associated habitats.

García Sais et al (2007) suggest that the reef promontories at BDS, including the reef top and reef wall appear to function as one large residential and foraging habitat for top reef demersal predators such as adults of the Cubera snapper. García Sais et al (2011) suggest that the bank coral reef at El Seco function as the residential and/or foraging habitat for Cubera snapper.

Cubera snapper and Ciguatera

Cubera snappers are said to be highly ciguatoxic. Citing the DNER Fishing Regulation 6768 (2004), the PR Department of Health printed a pamphlet including Cubera snapper as one of the most common fish causing ciguatera poisoning. In the USVI, *L. jocu* is considered ciguatoxic but not *L. cyanopterus*.

**Serranidae - Groupers**

Distribution of yellowmouth grouper, *Mycteroperca intersticialis*

Randall (1967, 1983) indicated that yellowmouth grouper were not very common in the West Indies. The yellowmouth grouper, *Mycteroperca interstitialis*, occurs off Bermuda and the Bahama Islands, from North Carolina southward to the Florida Keys, throughout the Gulf of Mexico and Caribbean Sea, and southward to Brazil (Smith, 1971). This species occurs at depths greater than about 30 m in the eastern Gulf of Mexico, but it may be found at shallower depths in Bermuda and the Florida Keys (Bardach et al. 1958; Bullock and Smith, 1991).

Habitat of yellowmouth grouper

Grouper eggs are in general pelagic and contain an oil globule indicative of flotation in the water column. Hatching occurs in 2-3 days after the absorption of the yolk sac.

Serranid larvae are found in low numbers in the surveys conducted in Puerto Rico (e.g., Ramírez-Mella and García-Sais 2003) and in general have a larval pelagic duration of 35-40 days. The larvae reported from southwestern Puerto Rico were found between 13 and 29 km offshore (Ramírez-Mella and García-Sais 2003).

The yellowmouth grouper is a reef-associated species inhabiting rocky and coral areas in depths from shallow water (mangrove lagoons, Craig et al., 2011) to about 150 m (Heemstra and Randall 1993). Juveniles are present at Bajo de Sico (Shärer et al. 2015) in Western Puerto Rico. Yellowmouth groupers were typically observed swimming at or near the base of the promontory and along the sand channels in the deeper sections of the reef at BDS (García Sais et al. 2007)

Juveniles of *M. interstitialis* were reported at BDS during the 2013-2014 surveys targeting Nassau grouper suggesting that BDS could be considered a nursery area for yellowmouth grouper (Shärer and Nemeth 2015). Spawning aggregation sites such as El Seco in Vieques (García-Sais et al 2011), Mona Island (Schärer et al. ), and Grammanik Bank south of St. Thomas (Nemeth et al. 2006) are used by multiple species such as tiger grouper, Cubera snapper and yellowfin grouper and include, although in small numbers, yellowmouth grouper. However, yellowmouth grouper encounters were rare at US Caribbean spawning sites (e.g., Schärer et al. 2012, Kadison et al. 2017).

Yellowmouth grouper are reported from the mesophotic reef at Bajo de Sico (Gracia Sais et al. 2007) co-occurring with black and yellowfin groupers in the survey areas between 30-50 m. The species was reported to occur to depths of 450 m (Grana Raffucci 2005). BDS is a residential site for yellowmouth groupers.

Fishers identified potential spawning aggregation sites for *M. interstitialis* when interviewed by Ojeda et al (2007). These sites were Grappler Bank, a few non-specific areas in SW Puerto Rico but in an area surrounded by water deeper than 500 fathoms (1,000 m), and three sites very close to shore on the north coast (Ojeda et al. 2007). Approximate coordinates for these SPAGs are presented in the report as well as the months when the aggregations take place (December-May). None of these sites have been confirmed as SPAGs.

Schärer et al. (2009) and Nemeth et al. (2007a) documented the presence of yellowmouth grouper at Mona and Monito Islands, west coast of PR at the spawning aggregation sites of tiger and yellowfin groupers. These species co-occur at the aggregation sites during the months of February through May. Although no actual spawning has been observed, and only a small number of fishes were present, the color phase indicative of reproductive behavior was documented for yellowmouth at the sites. BDS is a known spawning aggregation site for yellowmouth grouper.

The shallower part of Mona Island (30 m), the southern part of the island, supports coral reefs and seagrass habitats. The Islands of Mona and Monito are surrounded by waters deeper than 40 m to the north. Descriptions of the habitats in detail were prepared by Schärer (2009) and Schärer et al. (2010) but no specific areas or habitat were identified for *M. interstitialis*, except

for the few fish observed at the spawning site as part of a multi species aggregation occurring at the shelf edge of the Mona sites.

The following table is a summary of the information available form the protected SPAGs in western Puerto Rico and where to date species within the same stock unit as yellowmouth grouper have been identified. The maximum depths at which yellowmouth grouper occur have not been established in these areas. (García Sais et al. 2007, 2010, 2012, 2013).

| Closure | P=present | | A=aggregated | | | | S=spawning(?) | | R=Resident | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | March | April | May | June | July | Aug | Sept | Oct | Nov | Dec |
| **Bajo de Sico** | | | | | | | | | | | | |
| Red hind | P,A,S | P,A,S | P,A,S | P,A | P,A | P | P,A | R | R | R | P | P,A |
| Nassau | P,A,S | P,A,S | P,A,S | P,A | P | P | P | R | R | R | R | P,A |
| Tiger | P | P,A | P,A | P,A | P | P | P | | | | | P |
| Yellowfin | P,A | P,A | P,A | P,A | P,A | P | P | R | R | R | R | P |
| Black | P,A,S | P,A,S | P,A,S | P,A | P,A | P | P | R | R | R | R | P |
| Yellowmouth | P | P | P | P | P | P | P | R | R | R | R | P |
| | | | | | | | | | | | | |
| **Tourmaline** | | | | | | | | | | | | |
| Red hind | P,A,S | P,A,S | R | R | R | R | R | R | R | R | R | P,A,S |
| Nassau | P | P | P | P | P | P | P | P | P | P | P | P |
| | | | | | | | | | | | | |
| **Abril La Sierra** | | | | | | | | | | | | |
| Red hind | P,A,S | P,A,S | P,A,S | P | P | P | R | R | R | R | P | P,A,S |
| Nassau | | P | | | | | | | | | | |
| Yellowfin | | P | | | | | | | | | | |
| Black | | P | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Groupers** | **S** | **S** | **S** | **S** | **S** | | | | | | | **S** |

<u>Yellowmouth grouper and Ciguatera</u>

Large groupers are said to be ciguatoxic but this species is not listed separately in the literature as being ciguatoxic.

**Balistidae - Triggerfish**

<u>Distribution of *Balistes capriscus* , the grey triggerfish</u>

*Balistes capriscus* is widespread in the Atlantic Ocean. In the western Atlantic, it is known from Nova Scotia (Canada) south along the U.S. coast, Bermuda, the Bahamas, throughout the Gulf of Mexico and Caribbean Sea, and along South America to Argentina, including Trinidad Island (Simon et al. 2013). In the eastern Atlantic, it is known from Ireland south into the Mediterranean Sea, the Azores, the Canary Islands, the Islands of Madeira, and along West Africa to Angola, including offshore oceanic islands in this region. Its depth range is 0-110 m. (https://www.iucnredlist.org/species/193736/97662794).

Habitat of Grey Triggerfish

Information on eggs and larvae of the grey triggerfish specific to Puerto Rico is only known at the family level. Larvae abundance of Balistidae peak offshore (29 km) with decreasing numbers even furthers offshore (46 km) (Ramirez-Mella and Garcia-Sais 2003).

Larvae and juveniles of grey triggerfish were among the most abundant groups sampled in the Gulf of Mexico associated with Sargassum matts (Wells and Rooker, 2004); juveniles settle back to the benthos after one year in the pelagic environment (Simmons and Szedlmayer, 2011).

Reproductive behavior in this species is associated with the benthos and demersal in nature, including the building of nests (MacKichan and Szedlmayer, 2007), and showing parental care (Simmons and Szedlmayer 2012).

Prey-predator Relationship

Ciguatera
Grey triggerfish are listed as being implicated in Ciguatera

**Sphyraenidae- Barracudas**
Distribution of Great Barracuda
The greater barracuda, *Sphyraena barracuda*, is distributed worldwide throughout tropical and subtropical regions except eastern Pacific Ocean and Mediterranean Sea, probably due to cold current barriers. The barracuda's poleward distribution is limited by the approximate location of the 20°C isotherm (DeSylva 1970). It is distributed from Massachusetts to Brazil, including the Gulf of Mexico and the Caribbean, the eastern Atlantic, the Indo-Pacific, and the Red Sea.

Barracudas, in general, are diurnal, although there are some reports of certain species feeding at night, particularly during periods of full moon (Randall 1967). They are voracious open water predators, mainly piscivorous (jacks, grunts, groupers, snappers, herrings, parrotfish and anchovies) but also feeding on cephalopods and shrimps. Stomach contents indicate that these fish co-occur with mackerels. Adult barracudas are usually solitary being found in deeper water

in and over the shelf edge both near the surface and benthos (personal observation). Stomach content of smaller size barracudas and juveniles indicate proximity to shore feeding on schooling clupeoids and atherinid fishes. Barracudas are also associated with reef fish habitats evidenced by the presence of moray eels and other coral reef associated reef fish (Randall 1967).

Habitat of Great Barracuda

Eggs of barracuda are pelagic and contain an oil globule indicative of flotation in the water column. Ramirez-Mella and García-Sais (2003) reported larvae of Sphyraenidae as being neritic from samples taken from southwestern Puerto Rico. Hatching occurs after the absorption of the yolk sac. Larval pelagic duration is about 16 days.

However, postlarval barracuda are collected near the surface far from shore. In south Florida, temperature evidently dictates the movement of both young and adults. During their first spring young barracuda move inshore and spend the summer in shallow grass beds or sandy areas where they find protection in floating weeds and detritus or among the blades of seagrass. At this stage they may form loose aggregations of 10 to 30 individuals. When they are about 7 inches long, they move into grass flats one or two fathoms deep. When they are 8-10 inches long, they are found in the mangrove habitat. Juveniles are also reported from among the roots of the red mangrove *Rhizophora mangle* (FAO 1986). Apparently, young barracuda have a greater tolerance to hyposaline conditions than adults and find some protection from their predators. In their second winter, at about 20 inches length, they enter the coral reef habitat and deeper grass beds. During the following spring they migrate into deeper water and return to the reefs the following fall. Adults often occupy the sandy interface between the turtle grass beds and the fringing reefs. Large solitary individuals are occasionally found out in open sea. Records from the commercial catches in Florida suggests that barracuda may migrate northward in spring and southward in fall. Probably this seasonal pattern is temperature dependent and does not relate to the Caribbean populations (DeSylva 1970). Barracudas are said to aggregate to spawn (FAO 1986). Breeding behavior has not been reported but probably occurs in the open ocean where schools have been observed.

In general, greater barracuda are found from nearshore coral reefs, seagrasses, and mangroves to open waters, at or near the surface to depths of more than 100 meters. The reported preferred habitat is high profile-bottom such as reefs and wrecks in waters that are 68 °F or warmer (FLMNH, 2007; Manooch, 1988). Small individuals often form schools and are found over sandy bottoms and seagrass beds in shallow water. Larger individuals (over 65 cm) are generally solitary. However, schools of adult barracuda have been observed occasionally and are probably connected to spawning behavior (Fischer, 1978).

Barracudas are also present in murky waters nearshore based on the number of attacks on humans as reported by Randall (1996).

Pelagic species associated with mid-slope habitats reported by the Seward Johnson Sea-Link II submersible survey (Nelson and Appeldoorn, 1985) include Jacks (*Seriola spp., Caranx spp.*), mackerels (*Scomberomorus spp*.) and great barracuda (*Sphyraena barracuda).* Most pelagic game fishes, including tunas (*Thunnus spp*), and wahoo *Acanthocibium solanderi*) are commonly fished in the vicinity of insular slope habitats (Randall, 1983).

Figuerola-Fernandez et al. (2008) report that a 6-month main spawning season (March-August) for great barracuda around Puerto Rico with a potential for reproductive activity year-round (Erdman 1978). It is believed that spawning takes place in deeper, offshore waters (FLMNH, 2007).

Prey-predator Relationship of Great Barracuda

A change in type of food eaten by barracuda occurs with the change in habitat. Young barracuda eat primarily gobies, mojarras, atherinids, young parrotfish, and needlefish. Adults feed on grunts, puffers, jacks, seabasses, half-beaks, and mackerel. The adults eat the reef dwelling fish and fast swimming fish of the surface and mid-depths (DeSylva 1970). The barracudas are top predators feeding on cephalopods and crustaceans (Randall 1967). Also feed on larger fish that can easily be torn apart (FAO 1986). With the change in habitat and food comes the increased probability of ciguatera poisoning. Shark, tuna, and goliath grouper have been known to feed on barracudas.

Randall (1960) discussed the problem of barracuda which fed upon tagged reef fishes before they could reach the shelter of the reef after release from a boat. “The following tagged fish were taken from the stomachs of two such marauding barracudas: Acanthurus bahianus, A. coeruleus, Mulloidichthys martinicus, Pseudopeneus maculatus, and Sparisoma sp.” (Randall 1967)

Great Barracuda and Ciguatera

Mortalities have been reported from the ingestion of barracuda and this species is a frequent carrier of ciguatera. Barracuda are almost universally feared throughout both Puerto Rico and the Virgin Islands with very few regions eating fish larger than 2 to 3 pounds. The high incidence of ciguatera in large barracuda is perhaps explained by the barracuda's location on the food chain and their sedentary characteristic of feeding on one reef (deSylva, 1963; Tosteson, 2004.

**Lobotidae**

The tripletail, *Lobotes surinamensis*, is mostly know in Puerto Rico associated with fish aggregating devices (FADs, Wessley Martin, personal communication).

Distribution of tripletail

The distribution of tripletail includes tropical and subtropical waters of all oceans: Western Atlantic (New England and Bermuda southward to Argentina (Ref. 114270); and Falkland Islands (Ref. 114522). Eastern Atlantic: presumably along the coast from the Straits of Gibraltar to the Gulf of Guinea, including Madeira, although reliable records still lacking from Angola, the Canary Islands, and Cape Verde Islands; and Mediterranean (Ref. 114272). Indo-Pacific: East Africa through all countries of Southeast Asia north to Taiwan Province of China and southern Japan, northern Australia to southern Queensland, New Guinea to New Britain, and south to Fiji. Reported as rare visitors in Ponape, Hawaii, and Tahiti (Ref. 47694). Records from eastern central to southeastern Pacific need further confirmation and may refer to *Lobotes pacificus*.

Habitat of the tripletail

Ditty and Shaw (1983) described the larval development of the species in the Gulf of Mexico. The recent efforts in collecting larvae from the U.S. Caribbean does not include information on this species in the Cruise Reports (SEFSC). Larvae are usually found offshore and in surface waters (Ditty and Shaw 1983). Finding larvae offshore would suggest spawning takes place offshore but this information has not been documented (Ditty and Shaw 1983).

Early juveniles are associated with Sargassum (Franks et al 2001) but have not been documented in the U.S. Caribbean

Adult tripletail occur primarily in gulf waters, but enter passes, inlets, and bays near river mouths (Gudger, 1931; Baughman, 1941). The degree to which tripletail utilize estuaries during their life history is unknown.

Prey-predator Relationship

Tripletail and Ciguatera
There is no information on tripletail and ciguatera.

**Myliobatidae** - Mantas and Rays
The two species proposed for federal management in the Puerto Rico FMP are the manta (*Manta birostris*) and the spotted eagle ray (*Aetobatus narinari*).

Distribution of *M. birostris*
The geographic distribution of *Manta birostris* (Walbaum, 1792) is worldwide and have an extensive migratory pattern. Mantas are reported visiting the USVI waters during the spring

(https://www.nps.gov/viis/learn/nature/virgin-islands-sharks-and-rays.htm). The giant manta ray is found worldwide in tropical, subtropical, and temperate bodies of water and is commonly found offshore, in oceanic waters, and near productive coastlines. As such, giant manta rays can be found in cool water, as low as 19°C, although temperature preference appears to vary by region. For example, off the U.S. East Coast, giant manta rays are commonly found in waters from 19 to 22°C, whereas those off the Yucatan peninsula and Indonesia are commonly found in waters between 25 to 30°C. The species has also been observed in estuarine waters near oceanic inlets, with use of these waters as potential nursery grounds (https://www.fisheries.noaa.gov/species/giant-manta-ray).

The giant manta ray is a circumglobal species found in temperate to tropical waters (Marshall et al. 2009). In the Atlantic, it ranges from Rhode Island to Uruguay in the west and from the Azores Islands to Angola in the east. The species is also found throughout the Indian Ocean, including off South Africa, within the Red Sea, around India and Indonesia, and off Western Australia. In the Pacific, the species is found as far north as Mutsu Bay, Aomori, Japan, south to the eastern coast of Australia and the North Island of New Zealand (Marshall et al. 2011a; Couturier et al. 2015). It has also been documented off French Polynesia and Hawaii, and in the eastern Pacific, its range extends from southern California south to Peru (Marshall et al. 2009; Mourier 2012; CITES 2013). Marshall et al. (2009) note that the available information indicates that *M. birostris* is more oceanic and undergoes significant seasonal migrations. In a tracking study of six *M. birostris* individuals from off Mexico's Yucatan peninsula, Graham et al. (2012) calculated a maximum distance travelled of 1,151 km (based on cumulative straight-line distance between locations), further confirming that the species is capable of fairly long-distance migrations.

Habitat of M. birostris

The species is thought to spend the majority of its time in deep water, but migrates seasonally to productive coastal areas, oceanic island groups, pinnacles and seamounts (Marshall et al. 2009; CITES 2013). Giant manta rays have been observed visiting cleaning stations on shallow reefs (*i.e.*, locations where manta rays will solicit cleaner fish, such as wrasses, shrimp, and gobies, to remove parasitic copepods and other unwanted materials from their body) and are occasionally observed in sandy bottom areas and seagrass beds (Marshall et al. 2011a). While generally known as a solitary species, the giant manta ray has been sighted in large aggregations for feeding, mating, or cleaning purposes (Marshall et al. 2011a). In parts of the Atlantic and Caribbean, there is evidence that some *M. birostris* populations may exhibit differences in fine-scale and seasonal habitat use (Marshall et al. 2009).

NMFS did not designate critical habitat for the giant manta at the time it listed the species as threatened, finding that "sufficient information is not currently available to: (1) Identify the physical and biological features essential to conservation of the species at an appropriate level of

specificity, particularly given the uncertainty surrounding the species' life history characteristics (*e.g.*, pupping and nursery grounds remain unknown) and migratory movements, (2) determine the specific geographical areas that contain the physical and biological features essential to conservation of the species, particularly given the global range of the species, and (3) assess the impacts of the designation. (See also the *Critical Habitat* section for additional information.)" https://www.federalregister.gov/documents/2018/01/22/2018-01031/endangered-and-threatened-wildlife-and-plants-final-rule-to-list-the-giant-manta-ray-as-threatened.

Prey-predator Relationship of *M. birostris*

*M. birostris* and Ciguatera

There is no information on mantas and ciguatera.

Distribution of spotted eagle ray (*Aetobatus narinari*)
The spotted eagle ray (*Aetobatus narinari*, Euphrasen, 1790*)* is "A large eagle ray with a widespread distribution across the Indo-Pacific and eastern and western Atlantic in tropical and warm-temperate waters. Recorded over the continental shelf from the surface to 60 m depth in coastal and open ocean environments. Sometimes enters lagoons and estuaries and is often associated with coral-reef ecosystems. The presently known *Aetobatus narinari* is most probably a species-complex of at least four different species. However, it is here considered as a single species as presently recognized." http://www.iucnredlist.org/details/39415/0
Spotted eagle rays live along the open coast in warm waters throughout the world, though they are often associated with coral reefs and sometimes enter protected bays to feed or mate. They are generally considered a coastal species, but the worldwide geographic distribution implies that some individuals must migrate far distances over deep water. It is possible, however, that further genetic study will reveal that spotted eagle rays in different ocean basins (e.g., Atlantic vs. Pacific oceans) are actually different species. (https://oceana.org/marine-life/sharks-rays/spotted-eagle-ray)

Habitat of *A. narinari*
'The spotted eagle ray is usually in motion, swimming gracefully over sand, grass, and mud flats and reefs' (Randall 1967).

Prey-predator Relationship of *A. narinari*
The eagle ray feed mainly on gastropods: *Strombus gigas*, *S. gallus* and *Astrea tuber* and bivalves. Randall (1964a) discussed the depredations by this ray on the most valuable West Indian mollusk resource, the queen conch (*Strombus gigas*).

*A. narinari* and Ciguatera

The spotted eagle ray doesn't appear among the species listed to be implicated in ciguatera (e.g., Olsen et al. 1986).

**Dasyatidae**
The species proposed for federal management in the Puerto Rico FMP is the sting Ray *Dasyatis americana* (Bancroft, 1831).

Distribution of *D. americana*

The southern stingray is a coastal resident of the western North Atlantic Ocean. It ranges from Chesapeake Bay south to Florida, and in the Gulf of Mexico south to Campeche, Mexico, across the Larger and Lesser Antilles in the Caribbean.

Habitat of *D. americana*
The stingray has diurnal habits, it is pelagic in its movements and it is found at rest on the sandy bottoms where it can cover itself with sand to protect itself from predators. It excavates the sandy/silt bottom to feed on invertebrates (bivalves, amphipods, etc.).

This stingray prefers warm coastal and estuarine waters above 59° F (15° C) in the norther part of its range and can endure temperatures above 86° F (30° C). Temperature induced seasonal migrations have been observed throughout its range. This fish prefers habitats with a sand or silt/sand seabed, which allows the stingray to bury itself to hide from prey or predators.

Prey-predator Relationship of *D. americana*
Although not a resident of reefs, this ray is often seen cruising over reefs or lying at rest in small sand patches along reefs. It may make broad excavations in the sand when feeding (Randall 1967). Randall (1967) reported that the main food items found in the stomach of sting rays in the US Virgin Islands were fish (Acanthuridae sp. juveniles), worms, and crabs.

A number of shark species, such as the white, tiger and bull sharks are the major predators on the stingray.

*D. americana* and Ciguatera
Stingrays,commonly known as chcuchos in Puerto Rico, along with any other rays, are used in the preparation of popovers (empanadillas). They have a very ow risk of being implicated in ciguatera (Olsen et al. 1986. Marine Fisheries Review).

**Carangidae** – Jacks
There are three species of jacks proposed for federal management, *Caranx hippos* (Linnaeus, 1766), commonly known as crevalle, *Alectis ciliaris* (Bloch, 1787), African pompano, and *Elagatis bipinnulata* (Quoy & Gaimard, 1825), known as rainbow runner.

Distribution of Crevalle

Crevalle jacks are found in both sides of the Atlantic Ocean, in the eastern from Portugal to Angola including the Mediterranean Sea and in the western from Nova Scotia throughout the Gulf of Mexico, Caribbean and Uruguay. It is rare in the West Indies and Bahamas, absent in Bermuda (Smith-Vaniz, 2002).

Habitat of Crevalle

Crevalle jacks, like other species in the Carangidae family, is a pelagic fish found in oceanic, estuarine and riverine environments, depending on its life stage. Juveniles and larval stages are common in shallow brackish waters. Adults are found in upstream currents, reefs, offshore areas or shallow inshore areas (FLMH, 2007). Both adults and juveniles are usually found in schools, but larger individuals may be solitary. Crevalle jack is a diurnal predator, feeding of fish, shrimp and invertebrates (Sierra et al., 1994).

The crevalle jack spawns at subtropical and tropical latitudes (Mc Bride and McKown, 2000). The spawning season is early March to early September; the spawning takes place offshore (FLMH, 2007). Figuerola-Fernandez et al. (2008) suggest that the crevalle jack reproduces mainly from April-November, with a period of increased activity between May to July in Puerto Rico. Randall (1967) observed C. hippos in clear waters only as solitary large adults stating that the species was more characteristic of turbid inshore waters and regions of low salinity. The stomachs of this species in the Virgin Islands were empty (Randall 1967).

Crevalle jack and Ciguatera

There have been some reports of ciguatera poisoning for this species (Halstead, et. al, 1990). Olsen el al. (1986) did not include crevalle jack in their review of ciguatera in the Eastern Caribbean.

Distribution of African pompano - *Alectis ciliaris*

Sommer et al. (1996) describe the African pompano as being found globally in tropical waters. In the Western Atlantic, they can be found in waters from Massachusetts and Bermuda to Santos, Brazil; the species is also distributed throughout the Caribbean Sea and Gulf of Mexico.

Habitat of African pompano

These species is found near shore in shallow areas and are described as neritic and oceanic; from near surface to beyond 100 m. They are associated with both the pelagic and the reef habitats.

Randall (1967) reported empty stomachs of this species from the samples taken in the USVI.

Predator-Prey

Ciguatera
Olsen et al (1986) do not list African pompano as a ciguatera risk fish.

Distribution of Rainbow Runner - *Elagatis bipinnulata*
The rainbow runner is circumtropical in distribution, occurring throughout the warm temperate and tropical oceans. In the western Atlantic it is known from New England to the northern coast of South America including, the Gulf of Mexico and the Caribbean (FAO, 1978).

Habitat of Rainbow Runner
Adult and young rainbow runners occur on the outer shelf, around offshore islands and banks and offshore. Most sightings are around floating, artificial structures or drifting vessels. They are frequently seen over deeper reefs. Usually they are absent over depths of 37 meters or less, and occur occasionally over depths of 59 meters and commonly over reefs of 100-130 meters. Usually the rainbow runner is found in small schools but in certain locations at specific times of the year large schools are found. Such schools have been reported from the Navidad and Silver Banks in the Caribbean as well as elsewhere in the world. The rainbow runner is often seen in association with several species of sharks. Larval and juvenile rainbow runners were captured at surface water temperatures ranging between 26.5° C and 29.9° C with the highest occurrence at 28°C. In a few regions, such as La Blanquilla, Venezuela, the rainbow runner is plentiful. However, in most areas including the U.S. Caribbean, rainbow runner is seen infrequently (Randall, 1968).

Rainbow runner was described by Hiatt & Strasburg (1960) as an inshore pelagic species, and its food as "probably pelagic fish although it certainly will take swiming crustaceans or squid." (in Randall 1967).

**Pelagic species**
The pelagic species are the most affected by the oceanographic phenomena, these species follow for example currents or temperature gradients and have a general established seasonal movement throughout not only the US Caribbean but throughout the larger area of distribution.
Coryphaenidae: The following sections are modified from the proceedings of the dolphin/wahoo workshop (SAFMC 1998a). Unless otherwise cited, the workshop report is the source for the material in these sections.

**Dolphinfish** – *Coryphaena hippurus* and *C. equelis*
The common dolphin (*Coryphaena hippurus)* is an oceanic pelagic fish found worldwide in tropical and subtropical waters. The range for dolphin in the western Atlantic is from George's Bank, Nova Scotia to Rio de Janeiro, Brazil. They are also found throughout the Caribbean Sea and the Gulf of Mexico, and they are generally restricted to waters warmer than 20˚C (Oxenford,

1997). According to Shcherbachev (1973), dolphin penetrates temperate latitudes to range above 40°N in the summer. Rose and Hassler (1968) give Prince Edward Island, Nova Scotia and the southern tip of Africa as the range limits of the dolphin in the Atlantic. Sightings in the extreme limits of the range reportedly are rare, and the general range of this species probably is best described by the 20°C (68°F) isotherm (Gibbs and Collette, 1959).

Dolphin is oceanic but also approaches the coast. Gibbs and Collette (1959) report that this species comes close to shore; where blue waters sometimes are found near the shore. The increase in river outflow, rain events, near shore water contamination and sedimentation could have changed the behavior of the dolphin fish thus not allowing it to come nearshore. García-Moliner (2013) showed that during significant events of rain in the Amazon and the entrainment of these "green waters" in water masses moving from Brazil through the Caribbean, the landings of dolphin fish decreased significantly. Other changes in the habitat of dolphin fish include the massive presence of Sargasso in the Caribbean (Franks et al. 2010). Dammann (1969) reported that dolphin were caught in the Virgin Islands at the edge of the 100 fathom shelf and sometimes inshore. Dammann (pers. com. CFMC 1983) also reported that dolphin have been caught in green water on top of the shelf very close (i.e. 100 yards) to shore.
The commercial and recreational landings clearly indicate the seasonality of the dolphin fish in the U.S. Caribbean. There are two defined peaks in landings that depict season and area; a northern and a southern coast season.

Habitat of the dolphin fish include floating objects such as trees and other material brought by currents and river outflows, flotsam and jetsam, Sargasso and other floating seaweeds (lines of *Thalassia* and *Syringodium* for example concentrated by Langmuir circulation). The floating objects and vegetation create an environment where dolphin fish can feed and shelter during various life stages. The dolphin is well known for its propensity to station itself near nonmotile objects on the ocean surface (Kojima, 1965). This is because there is a greater availability of food near floating objects.

In the Florida Current and Gulf Stream dolphin associate with Sargassum windrows and, according to Beardsley (1967) and Gibbs and Collette (1959), take much of their food from that community. This tendency of dolphin to accumulate around floating objects also appears to take place in the Caribbean. Commercial and recreational fishermen in the Virgin Islands and Puerto Rico indicate increased catches of dolphin when fishing near floating debris. It is common practice for fishermen to troll around floating buoys, discharged garbage, and Sargassum rafts. Pompano dolphin *(Coryphaena equiselis)*, a more pelagic species, has been recorded off North Carolina, Florida, Bermuda, and in the central Atlantic, Gulf of Mexico, and Caribbean including off Puerto Rico. Pompano dolphin were found in waters which exceed 24˚C (Mather and Day, 1954).

The common dolphin (*Coryphaena hippurus*) and pompano dolphin *(Coryphaena equiselis)* will subsequently be referred to as dolphin. There is no species-specific information for the pompano dolphin from the U.S. Caribbean.

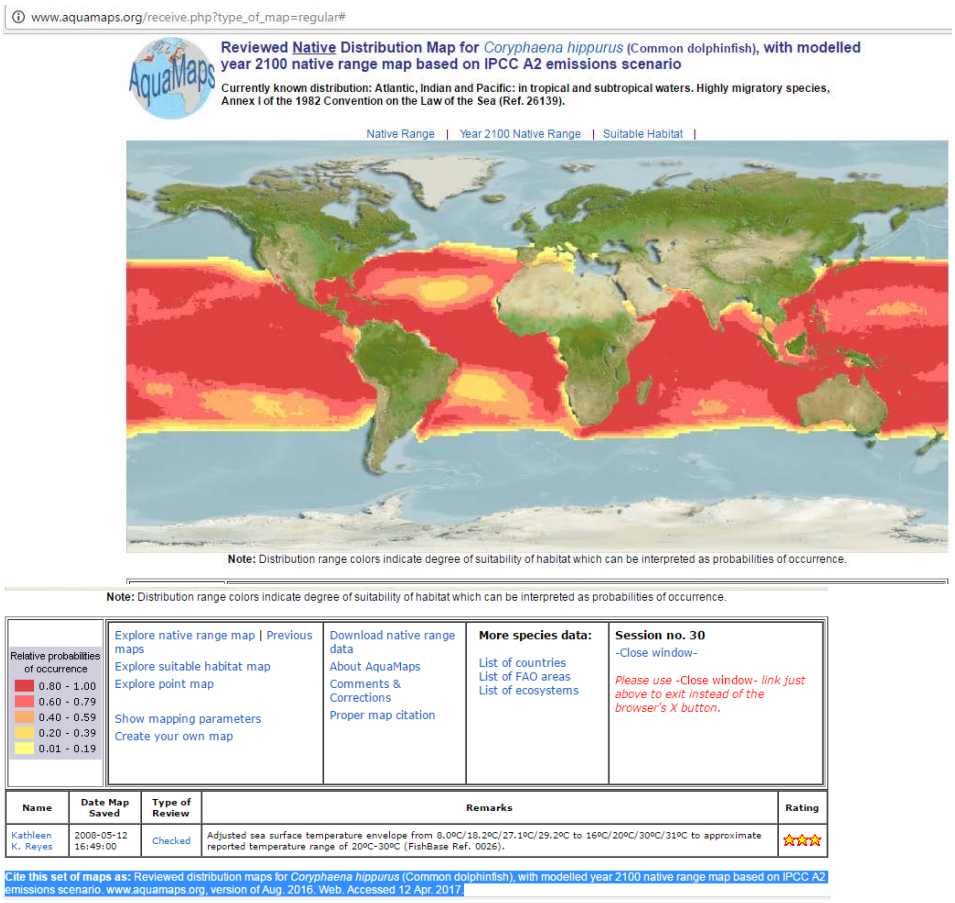
There is pronounced seasonal variation in abundance. Dolphin are caught off North and South Carolina from May through July. Dolphin caught off Florida's East Coast are caught mainly between April and June. February and March are the peak months off Puerto Rico's coast. Dolphin are caught in the Gulf of Mexico from April to September with peak catches in May through August (SAFMC 1998a).

Juvenile and adult dolphin fish occur in the same areas. Ripe pompano dolphin have been collected in the Atlantic at 205 mm standard length (SL) (Gibbs and Collette, 1959). Larvae have been collected.

Essential fish habitat for dolphin fish (*C. hippurus* and *C. equiselis*) occurs throughout the state and federal waters of the US Caribbean, throughout the wider Caribbean and extends from George's Bank, Nova Scotia and Northeast US to Brazil.

Do all sizes occur in the US Caribbean?
Rodriguez-Ferrer and Rodriguez-Ferrer (2011) report that in Puerto Rico, dolphinfish is the most landed species during fishing tournaments. Although there has not been an attempt to delineate EFH form dolphinfish based on the occurance of the tournaments, this might be a worthwhile exercise. Recently, the fishing trips around FADs in Puerto Rico showed preference for the locations of some FADs; not all where fished equally (https://beyondourshores.org/wp-content/uploads/2018/12/Q4-Dec-FAD-eNewsletter.pdf?utm_source=newsletter&utm_medium=email&utm_content=click%20here&utm_campaign=U.S.%20Caribbean%20FAD%20Research%20Q4%20eNewsletter)

The migratory circuits of the dolphin fish include a northern cycle – extending from the east coast of the US to north of Puerto Rico and the US Virgin Islands and a southern circuit extending from south –southeast Puerto Rico to the south. The peak season in Puerto Rico is reported to occur in February-March (SAFMC SAFE Report Dol-Wa FMP 1999) but having two seasons that are different for the North and South coasts.




## Spawning

In the Caribbean area most adult female dolphin had sub ripe ovaries throughout the year with a probable peak in February (Erdman, 1976). More than one set of eggs in the ovary of a single dolphin may ripen at different stages indicating that dolphin may have more than one spawning per season (Beardsley, 1967).

An extended spawning season throughout the year, with peaks when they are more abundant (March and June) was reported by Pérez et al. (1992).

## Feeding

Stomach content analyses of dolphin indicate that fish are the most abundant, but not the sole food item, indicating that dolphin are non-selective feeders. In Puerto Rico, Erdman (1976) showed that the diet of dolphinfish includes reef-associated species in the families Balistidae and Monacanthidae (triggerfish and filefishes), Acanthuridae (surgeonfish), *Pseudupeneus maculatus* (goatfish) Carangidae (jacks) as well as surface -associated species of flying fish, ballyhoo, with additional differences in species specific prey items during each season. The orange spotted filefish, *Cantherines pullus* being the most common fish found in the dolphin fish stomachs indicates that dolphin fish move throughout the water column since its prey item tend to stay

near the bottom and near reef structures.  Other prey species include *Priacanthus* spp found near deep water reefs.

The importance of the Sargassum community in providing food for common dolphin, particularly for juvenile and younger mature individuals, has been noted by several authors. Rose and Hassler (1974) found significantly more empty stomachs in small female dolphin in a summer when tidelines off the North Carolina coast were relatively rare, which suggests that this community makes an important contribution to the food supply of this group. Kojima (1965), Rose and Hassler (1974), and Beardsley (1967) considered the Sargassum community to have great ecological importance to the dolphin because of the food supply it provides. Furthermore, the Sargassum community provides protection for younger individuals from predation by other species. Segregation of younger from older individuals through behavioral differences reduces cannibalism. An adaptive significance to the attraction of smaller individuals to the Sargassum community is suggested (Rose and Hassler, 1974).

The common dolphin is thought to be a day feeder (Erdman, 1958) and perhaps does not feed effectively in darkness (Gibbs and Collette, 1959), although they will feed at night on small fishes and squid attracted to light from ships.

Two known predators of the common dolphin in western Atlantic waters are the blue marlin (*Makaira nigricans*) (Gibbs and Collette 1959), and the swordfish (*Xiphias gladius*) (D. DeSylva, pers. comm. CFMC 1983).

The determination of EFH for dolphinfish could be influence by the presence of floating objects and FADs. Association of dolphinfish with floating objects could be determined by the presence of prey, an association that could change over time as fish grow. Palko et al (1982) suggested that the distribution and migration of dolphin fish can be highly influenced by the drifting floating objects. Taquet et al. (unknown) suggest the presence of FADs can also influence the migration of dolphinfish and wahoo specifically arguing that juvenile fish aggregate and remain near these FADs because food is available. Further, because it has been shown in other pelagic species (Cayré, 1991; Marsac et al., 1995), dolphin and wahoo could learn to navigate among FADs

Taquet et al. argue, based on stomach contents studied by Oxenford & Hunte (1999), that food is an important factor in determining the aggregation of dolphinfish and can be concluded that in the determination of EFH. Stomach contents of wahoo and dolphinfish show them to be piscivorous, most significantly feeding on fish know to be associated to drifting objects.

Hemphill (2005) argues that the Sargassum, as it extends into international waters, is an ecosystem that should be considered critical marine habitat. A pelagic top predator such as

dolphinfish have been shown to be food-dependent on floating algae such as Sargassum (Manooch et al. 1984) in at least part of their range. The changes in the presence of Sargassum throughout the Caribbean might influence the presence, abundance, and seasonality of the dolphinfish.

**Scombridae**

The two species of tunas proposed for management in the Puerto Rico FMP are not defined as HMS under the Magnuson-Stevens Act. The definition of HMS includes tuna species, but tuna species is further defined and that definition does not include little tunny or blackfin tuna..

These two species, little tunny – *Euthynnus alletteratus* (Rafinesque, 1810) and blackfin tuna – *Thunus atlanticus* (Lesson 1830) are found in the western Atlantic Ocean extending their range from New England through the Caribbean to Brazil.

Distribution of Little Tunny– *Euthynnus alletteratus* (Rafinesque, 1810)

The little tunny ranges from Brazil, north to Bermuda and the Gulf of Maine and throughout the Caribbean and to the northern and eastern Gulf of Mexico. The species also is found in the eastern Atlantic and Mediterranean, as well as the Gulf of Aqaba, the Red Sea, and South Pacific near Australia. Little tunny reaches its maximum concentration in the tropical/intertropical zone. Both north/south and, inshore-offshore displacements of populations occur and are thought to be governed by seasonal temperature and salinity variations in inshore - waters (DeSylva and Rathjen 1961 and Marchal 1963).

Habitat of Little Tunny

Cruise collection data compiled by DeSylva and Rathjen (1961) suggest that this is a fish of the continental shelf rather than the deep ocean; and a "green water" rather than a "blue water' species (in Jacobsen and Browder 1987; 2006). Marchal's (1963) observations indicate this habitat preference along the African coast. Various coastal range limits that have been noted are the 20-fathom line (37m) and the 100-meter (54 fathom) isobath. They are sometimes found in turbid waters and have been taken by seine in large numbers in some West African rivers.

Little tunny is a schooling species, although they tend to disperse at certain times of the year. On the coast of South America, the schools are well defined, elliptical in shape, and may be as large as 3 kilometers on their long axis. Young little tunny at times school with the young of other species of fish of the same size such as the Atlantic bonito (*Sarda sarda*) (Marchal, 1963). In the Puerto Rico/Virgin Islands area little tunny are caught throughout the year in the surface waters of the continental shelf. This species also appears to follow the east west migration pattern of the other pelagic species.

Fish with ripe ovaries and testes were found March through June in Puerto Rico. In the Gulf of Mexico more eggs and larvae are present in the plankton in spring and summer. Spawning appears to occur near the surface usually in water deeper than 45 meters (Marchal 1963; DeSylva and Rathjen 1961).

Prey-Predator Relationship of Little Tunny

The round herring (*Etrumeus sardina*) was the most important food species of *Euthynnus alletteratus* in specimens collected from the southern Atlantic coast of the U.S., making up 39% of stomach contents items. Squid also was important, accounting for 28% of food items, and the Spanish sardine (*Sardinella anchovia*) made up 12% of food items. Other components of the stomach contents were the round scad (*Decapterus punctatus*) (7.7%), Spanish mackerel (*Scomberomorus maculatus*) (2%), and mud parrotfish (*Sparisoma flavescens*) (2%). Unidentified fish made up 11% of total food items. In another study, both little tunnys collected contained Spanish mackerel. One little tunny contained larval little tunny, indicating cannibalism (Klawe 1961). Carangidae (jacks) and Exocoetidae (flyingfishes) are some other groups fed upon by little tunny. Little tunny is also known to feed on juvenile fish of their own species.

Randall (1967) reported that 'E. alletteratus is characteristic of the green inshore water over continental or insular shelves. It swims rapidly in compact schools and when feeding, the schools become more diffuse as individuals dart this way and that in pursuit of their prey. In the Virgin Islands little tunny stomach contained mostly fish (Jenkinsia, goatfish, etc.) and squids.

Blackfin tuna – *Thunus atlanticus* (Lesson 1830)

This species is found in the western Atlantic Ocean extending its range from New England through the Caribbean to Brazil. The blackfin tuna is a coastal pelagic species confined to the warm temperate and tropical western Atlantic. It ranges from southern New England to Rio de Janeiro and is found throughout the Gulf of Mexico and Caribbean. Seasonal concentrations occur off the Mississippi Delta, the Nicaraguan Shelf, the Coasts of Cuba, the northeast coast of Brazil and the Northern Lesser Antilles to the east coast of Puerto Rico.

Habitat of Blackfin Tuna

The blackfin tuna is the only tuna species restricted to the western Atlantic. The blackfin does migrate to higher latitudes when waters warm in summer, but to a lesser extent than the other tuna species. The blackfin tuna is usually restricted to the shelf areas and is not often found in waters less than 90 fathoms. It generally feeds near the surface in schools which sometimes number thousands of individuals. It is known to mix schools with the skipjack tuna (*Katsuwonus pelamis*).

Like other migratory species in the Caribbean the blackfin tuna typically follows an east to west route along the edge of the drop off during migrations along Puerto Rico and the Virgin Islands.

Prey-predator Relationship of Blackfin Tuna

The diet of the mature blackfin tuna consists of small fish, squid, and crustaceans. The species is a non-selective feeder and the majority of its diet is made up of clupeid fishes such as herring and sardine. Juvenile blackfin tuna have a diet made up primarily of plankton. Several shark species are believed to be major predators of black fin tuna. Blackfin tuna juveniles of 250 mm were found to be the bulk of blue marlin stomach contents in September (Erdman, 1976). Surgeonfish larvae have been observed in the stomachs of blackfin tuna (Reeson 1975a).

**King mackerel** – *Scoberomorus cavalla* (Cuvier, 1829)
The king mackerels inhabit the tropical western Atlantic with a north-south extension between Brazil and the Northeast USA.

Distribution of King Mackerel
Seasonal movement of king mackerel along the Gulf of Mexico and Atlantic coastlines of the United States is apparent. The species is more abundant in the northern part of its range during the summer and in south Florida during the winter. Tagging data (Williams unpub. man.1976, 1977) shows at least two migration patterns which may indicate two separate stocks in this area. Members of one group are found along the southeast coast of Florida from December to March. In the late winter and early spring, these fish move south through the Keys and into the Gulf of Mexico, appearing in the northern Gulf in June. They apparently remain in the norther Gulf until October, migrating at least as far west as Port Aransas, Texas. These fish reappear off Ft. Pierce at about the same time each year (Williams unpub. man.1977). Two tag returns from Mexico indicate some interaction with Mexican stocks.

A second group was defined by tagging in the spring off Boynton Beach, Florida. These fish (with two exceptions) travel north during the spring and summer as far as Virginia. Fish recaptured in summer in South Carolina, North Carolina and Virginia were larger than those recaptured in summer in south Florida (Williams unpub. man.1977).

Some fish remain in south Florida during the summer. There appears to be a size differential in the migration pattern. Fish tagged in Ft. Pierce and recaptured in the northern Gulf are larger (approximately 8.75 lbs.), and probably sexually mature, while those recaptured in south Florida during the summer averaged 5.5 lbs. and were probably not sexually mature (Williams unpub. man.1977). None of these tags have been recovered in the Caribbean.

To date no tagged king mackerel have been reported in the Caribbean and published information on the distribution and migration of king mackerel in the Caribbean is non-existent. However, contact with commercial and sport fishermen and review of landings statistics indicates that a definite migration of king mackerel takes place in an east-west direction and follows the edge of the shelf drop-off. King mackerel begin showing up early in November and continue through April. The migration is slow with fish appearing off the Virgin Islands a month before they

appear in Puerto Rico and they appear off eastern Puerto Rico several weeks earlier than off western Puerto Rico. It is even reported that on occasion fishermen follow the fish as they migrate east to west. During this migration period, king mackerel are found both in schools and as individuals.

There is also a year-round king mackerel population which is found on the reefs of the shelf. Those resident fish are primarily found alone with no large schools being reported year-round. The resident king mackerel population is made up of larger fish than the average size of those migrating (Olsen, pers. com.). The migration pattern for king mackerel and several of the other pelagic species needs to be defined.

Often found in outer reef areas. Larvae are encountered in surface waters of 26.3° to 31°C and 26.9 to 35 ppt. Feeds primarily on fishes with smaller quantities of penaeid shrimps and squids. Large schools have been found to migrate over considerable distances along the Atlantic US coast, water temperature permitting.
(https://www.fishbase.de/Summary/SpeciesSummary.php?ID=120&AT=king+mackerel)

Habitat of king mackerel

Temperature and salinity are believed to greatly affect the distribution of king mackerel. The northern range of the king mackerel is probably determined by the 20°C summer isotherm. Annual or long-term changes in temperature do appear to influence the occurrence king mackerel. It is a coastal species seldom found in water deeper than 73 meters or in estuaries of greatly reduced salinity (Berrien and Finan 1977). Dammann (1969) reports that in the Virgin Islands it is found at the edge of the 100 fathom (180 meter) shelf as well as inshore. It appears to cross the deep channels between island banks.

In the Gulf of Mexico and the south Atlantic small similarly-sized fish tend to aggregate in areas of bottom relief such as reefs or holes. Older solitary individuals are often found around underwater structures such as wrecks, probably attracted to these structures by schools of prey fish.

The pelagic zone is 'typical habitat' for the adults of king mackerel (*Scomberomorus cavalla*) (in Jacobsen and Browder 1987; 2006)

Prey-Predator Relationship of king mackerel

King mackerel are not highly selective feeders and their diet may differ markedly from one region to another. The primary food of the king mackerel in Florida is believed to be clupeid fishes such as herring and sardine, and invertebrates such as shrimp and squid. Beaumariage (1973) examined 366 king mackerel stomachs, of which 70 held identifiable food. Fish of the

families Carangidae (jacks), Lutjanidae (snapper), and Pomadasyidae (grunts) were the primary contents.

In a Texas study, Knapp (1949) found that in that region shrimp were the number one food item of king mackerel, accounting for 43.5% of food items in stomachs. Squid was also an important food item, making up 25.1% of food items. Stomachs of 831 king mackerel were examined from fish caught offshore of Louisiana. (C. Saloman and S. Naughton pers. comm; CFMC 1983). Fish were the dominant food, comprising over 99% by weight, and volume, and frequency of occurrence of the stomach contents. Primary species were in the families Clupeidae (sardines and herrings), Carangidae (jacks), Sciaenidae (croakers), and Trichiuridae (cutlassfish). Bottle-nose dolphin and several shark species are thought to be the major predators of king mackerel, due to their common occurrence around mackerel schools.

Randall (1967) reported that kingfish may be observed as a solitary fish or in small groups, swimnling in mid-water, but often nearer the bottom than the surface. The stomachs of 22 fish from the US Virgin Islands contained mostly fish (92%) including yellowtail snapper, jacks, and squid.

**Cero mackerel** – *Scoberomorus regalis* (Bloch, 1793)

Distribution of Cero Mackerel

Cero mackerel inhabits the tropical and subtropical western Atlantic with a north-south range between Rio de Janeiro, Brazil and Cape Cod, MA, USA (FAO, 1978) but are usually thought to be more restricted to the tropics than the king mackerel. This species is probably the most common of the scombrids in the local U.S. Caribbean waters.

The cero is uncommon on the Atlantic Coast of the United States and is usually not found north of Dade County in south Florida. It is common around Cuba, Jamaica, and Puerto Rico. In Cuba and the Bahamas, it is more common than the king mackerel. In Cuba, the landings of this species are slightly greater than the landings of king mackerel (Howell-Rivero 1953). Cero is the species of *Scomberomorus* most frequently encountered near shore in the Bahamas (Böhlke and Chaplin 1968). Cero mackerel appear to be caught more often around Puerto Rico in winter (Erdman 1978).

Habitat of Cero Mackerel

The species is considered a coastal pelagic species (FAO 1986). Cero mackerel is primarily a fish associated with reefs. It is usually solitary or forms small schools (FAO, 1978). At times it may come close to shore in pursuit of small schooling fish. They occur primarily in clear water inshore from a few feet above the bottom to just below the surface. They feed primarily on small schooling clupeoid and atherinid fishes (Randall 1967). The stomach content is indicative of the extension of the EFH of the species for feeding.

Cero mackerel are thought to spawn throughout the year in Puerto Rico with an increase in spring and summer (Erdman 1978). ·However, no specific information is available to describe spawning areas.

Prey-Predator Relationship of Cero Mackerel

Although the prey-predator relationships of cero mackerel are not specifically known they are thought to be similar to those of the king mackerel. They feed primarily on schooling fish, near the coast at dawn (FAO 1986).

Randall (1967) reported the cero as usually a solitary fish, with few fish travelling together on occasion. Always moving and are found primarily in inshore clear water in the water column from just above the bottom to just below the surface. They feed primarily on small schooling clupeoid and atherinid fishes; 96% of the stomachs sampled contained fish. Their feeding rushes toward such small fishes are extremely rapid.

Cero Mackerel and Ciguatera

The cero mackerel is considered highly ciguatoxic in the Virgin Islands, not as much in Puerto Rico. However, it is not considered as dangerous as barracuda, amberjack, bar jack, or horse eye jack (Sylvester, Dammann and Dewey 1977).

Fourteen world records for king mackerel, blue marlin, skipjack tuna (*Euthynnus pelamus*) and wahoo have been declared from the PRVI shelf (Walter, 1983a; FAO, undated).

**Wahoo** – *Acanthocybium solandri* (Cuvier, 1832)

The wahoo (*Acanthocybium solandri*) is an oceanic pelagic fish found worldwide in tropical and subtropical waters of the Atlantic, Indian and Pacific oceans and the Caribbean and Mediterranean Seas. The north to south extension of their distribution ranges from Brazil to the Northeast USA. In the western Atlantic wahoo are found from New York through Columbia including Bermuda, the Bahamas, the Gulf of Mexico, and the Caribbean, and seasonally extending its range into temperate waters (Collette, 2002; Hogarth, 1976).

There is pronounced seasonal variation in abundance. They are caught off North and South Carolina primarily during the spring and summer (April-June and July-September), off Florida's east coast year-round, off Puerto Rico and the U.S. Virgin Islands year-round with peak catches between September and March, in the Gulf of Mexico year-round, in the eastern Caribbean between December and June, and in Bermuda between April and September (SAFMC, 1998a). The species is landed in the Virgin Islands year-round although it is less abundant in June through August (Dammann, 1969).

Distribution of Wahoo

The wahoo is found in tropical and subtropical seas and seasonally extends into temperate waters (Collette, 2002; Hogarth, 1976). It has been caught along the coast of northwest Africa and inhabits the eastern part of the equatorial Atlantic. It is also common off northern Brazil in the Guiana Current, the Gulf of Mexico, in the Gulf Stream from Florida to Cape Hatteras and in the Caribbean (Böhlke and Chaplin, 1968). In the Pacific it is found off Central America, southern California, around Hawaii, and from Japan down to Australia (Iversen, 1957). It is reported from the Indian Ocean, and one specimen has been reported from the Mediterranean (CFMC 1983). However, nowhere is the fish very abundant and large accumulations of the fish are not known to exist in any of the regions (FAO, 1978). Routine seasonal migrations of wahoo are unknown in either Puerto Rico or the Virgin Islands. Wahoo apparently move frequently however and might be considered highly migratory species as exemplified by a recapture of one fish recaptured 6.5 months and 1,707 miles away after being tagged and released (WRP, 2007).

Theisen et al (2008) determined that wahoo constitute a “single globally distributed population” a finding attributed to extensive dispersal at all life stages. The determination of EFH for wahoo, as for other pelagic species in the US Caribbean would have to consider the international areas beyond.

Habitat of Wahoo

The pelagic zone is 'typical habitat' for the adults of the wahoo (in Jacobsen and Browder 1987; 2006). It appears to be migratory in the Florida Straits and Gulf Stream but is caught with regularity in the Virgin Islands. Wahoo have been reported to travel in small schools, but this trait is probably restricted to young fish. In the Pacific, wahoo are usually caught by trolling approximately 200 yards to 3 miles from fringing reefs or by long line not far from land. Experimental fishing in the Pacific suggests that wahoo prefer shallow depths and are more abundant close to land. Analysis of fish caught in the Gulf Stream suggests that they are pelagic fish of the open ocean and prey on organisms associated with Sargassum. Larval and post larval wahoo are usually collected in water at depths greater than 100 meters. The species is a very powerful fast swimmer and, like the dolphin fish, is also frequently found in the open ocean (Hogarth 1976 and Iversen 1957). Large fish appear to be solitary but have been reported to form aggregations of different size fish. It is not known if these aggregations serve a specific function. Wahoo tend to be found near flotsam and jetsam, Sargassum, and in distinct breaks in the water (e.g., weed lines, sediment fronts).

Although wahoo is a targeted species in both the commercial and recreational fisheries, little is known about its habitat (e.g., https://www.fisheries.noaa.gov/species/atlantic-wahoo), about its spawning sites or better information on the specific oceanographic conditions for growth to maturity, feeding and spawning.

EFH for dolphin and wahoo is the Gulf Stream, Charleston Gyre, Florida Current, and pelagic Sargassum (http://safmc.net/download/SAFMCEFHUsersGuideFinalRevAug17_2.pdf ). Lacking specific information on harvest sites, EFH for wahoo in Puerto Rico would be all the waters around the Island

In Puerto Rico, wahoo is also harvested with dolphin (target species) but Figuerola-Fernandez et al. (2008) found that when these two species are harvested together, wahoo tend to be sub-adults.

Wahoo abundance drops significantly during the summer months around Puerto Rico (Figuerola-Fernandez et al. 2008). This temporal variability could be due to the increase in temperature of the surface waters around during the summer and subsequent migration to more oceanic and deeper waters or to cooler waters to the north and other jurisdictions.

Eggs and Larvae

Wahoo produce buoyant eggs and are known to spawn in the vicinity of open-ocean currents, characteristics which can enhance dispersal (e.g., Brown-Peterson et al. 2000).

Prey-predator Relationship

Hogarth (1976) found that fishes accounted for 97.4% of all food items collected from stomach content with mackerels, butterfish, porcupinefish, and round herrings being the most identified fish.