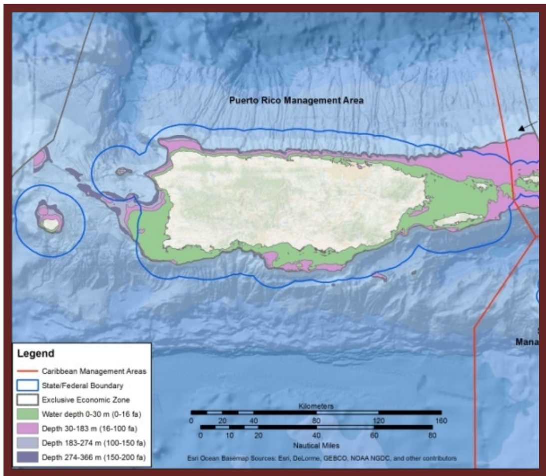

Comprehensive Fishery Management Plan for the Puerto Rico Exclusive Economic Zone

Including Environmental Assessment, Regulatory Impact Review, and Fishery Impact Statement

Final Version
December 2019

Comprehensive Fishery Management Plan for the Puerto Rico Exclusive Economic Zone and Environmental Assessment

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 U.S. Caribbean-wide FMPs with respect to measures applicable within the Puerto Rico Exclusive Economic Zone. The action would also modify the composition of the stocks to be managed under the Puerto Rico FMP, organize those stocks for effective management, establish status determination criteria and 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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Table of Contents for the Environmental Assessment

Note to readers: This document is an integrated Fishery Management Plan (FMP)/Environmental Assessment (EA). The EA evaluates seven actions within the Puerto Rico FMP.

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Abbreviations and Acronyms Used in this Document

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 report
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
GDP	gross domestic product
GNI	gross national income
GNP	gross national product
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
MRIP	Marine Recreational Information Program
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
ORCS	only reliable catch stocks
OY	optimum yield
PDF	probability density function
PSA	productivity-susceptibility analysis
RA	Regional Administrator of the National Marine Fisheries Service
RFA	Regulatory Flexibility Act
RIR	Regulatory Impact Review
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

Chapter 1. Introduction

1.1 What Action is Being Proposed?

The Caribbean Fishery Management Council (Council) is considering shifting from a U.S. Caribbean-wide management approach to an island-based management approach, applicable to the three separate 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 U.S. Caribbean-wide fishery management plans (FMPs): the FMP for the Reef Fish Fishery of Puerto Rico and the USVI (Reef Fish FMP), the FMP for the Spiny Lobster Fishery 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/environmental assessment (EA), and the parallel integrated FMP/EAs for St. Thomas/St. John and St. Croix, the Council is proposing to repeal the four extant U.S. Caribbean-wide FMPs and manage fishery resources 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). This document concerns the transition as it applies to management in the U.S. EEZ off Puerto Rico (Puerto Rico EEZ). The Council is preparing two additional documents, one concerning the transition for management in the U.S. EEZ off St. Thomas/St. John (St. Thomas/St. John EEZ) and one concerning management in the U.S. EEZ off St. Croix (St. Croix EEZ).

Implementing an island-based FMP for Puerto Rico would allow the Council to manage the stocks[1] 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 those waters, 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 U.S. Caribbean-wide management to an island-based approach for Puerto Rico, 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 establishes a Puerto Rico FMP based on existing management measures that apply to the Puerto Rico EEZ;

[1] Stock: The term "stock of fish" means “a species, subspecies, geographical grouping, or other category of fish capable of management as a unit.” 16 U.S.C. § 1802(42).

- Action 2 revises the list of species included for management, focusing on those applicable to the Puerto Rico EEZ;
- Action 3 establishes how the stocks (i.e., species included for management) 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 extant Reef Fish, Spiny Lobster, Queen Conch, and Coral 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). For example, 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 ACL values and AMs within each of those three EEZ subdivisions. Thus, some management measures already apply at specific island or island group levels. However, other components of management, including a proxy for MSY and an overfishing limit (OFL), were maintained at a U.S. Caribbean-wide level. The Puerto Rico FMP 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 measures 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.

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 U.S. Caribbean-wide management approach to an island-based approach: *Development of Island-Based FMPs in the U.S. Caribbean: Transition from Species-Based FMPs to Island-Based FMPs* (2014 EA) (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). 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 extant U.S. Caribbean-wide FMPs with island-based FMPs.

1.3. Who is Proposing the Action?

The Council proposes the action considered to establish a new Puerto Rico FMP and repeal the U.S. Caribbean-wide FMPs as they apply to management in federal waters off of Puerto Rico [2], modify the composition of the stocks to be managed under the Puerto Rico FMP, organize those stocks for effective management, establish SDC, management reference points, and AMs for managed stocks, 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.

[2] Repealing the U.S. Caribbean-wide FMPs in their entirety, as opposed to repealing them as they apply to fisheries to be managed in federal waters of Puerto Rico alone, requires the Council to take similar action to repeal and replace the U.S. Caribbean-wide management with island based management in the St. Thomas/St. John FMP and the St. Croix FMP. If the Council takes action here to repeal the plans as they apply to federal waters off Puerto Rico, but does not take action to repeal the plans with respect to the other managed areas, the Caribbean wide FMPs would have to be amended to reflect the Council's decision to manage only certain island areas separately (e.g., to reflect that only Puerto Rico would be managed separately, or to reflect that only Puerto Rico and St. Croix would be managed separately).

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 FMP/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 approach, applying the best available scientific information regarding the management of fishery resources in Puerto Rico EEZ waters. Alternatives considered in the EA include a "no action" alternative, which would not transition from U.S. Caribbean-wide management to an island-based approach for Puerto Rico (Action 1). After selecting the "action alternative" in Action 1 and establishing an island-based FMP for Puerto Rico based on existing management measures, Actions 2-7 provide a range of viable alternative approaches for revising the management of fisheries in the Puerto Rico EEZ. The outcomes of the Council's preferred alternatives are listed in Chapter 5: Conservation and Management Measures – Action Plan.

The Council and NMFS considered public comments received on the draft Puerto Rico FMP and associated draft EA before voting to approve the Puerto Rico FMP for submission 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.

1.4 Statement of Purpose and Need

The Puerto Rico FMP is one of three island-based FMPs developed by the Council to update management of federal fishery resources in the U.S. Caribbean. The Puerto Rico FMP incorporates those components of the U.S. 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 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.

Shifting management from a U.S. Caribbean-wide approach to an island-based approach for Puerto Rico 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. The commenters agreed that an island-based approach is needed to better focus federal fishery management efforts on issues unique to Puerto Rico (See Section 1.8 for specific Goals and Objectives of the Puerto Rico FMP).

Commenters also recognized a need to update federal management. 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. Thus, the second action considered in this FMP/EA is to develop and apply a rigorous process for identifying those species in need of conservation and management in federal waters surrounding Puerto Rico. A logical next step in that process is to determine if 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, the Council also should consider whether it needs to update reference points for previously managed stocks to reflect the best scientific information available.

The next action 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 U.S. Caribbean-wide 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, and the Council considered alternative approaches to identifying EFH. 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 designed to allow for more efficient responses to changing environmental or biological conditions are included in the final action described below.

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.

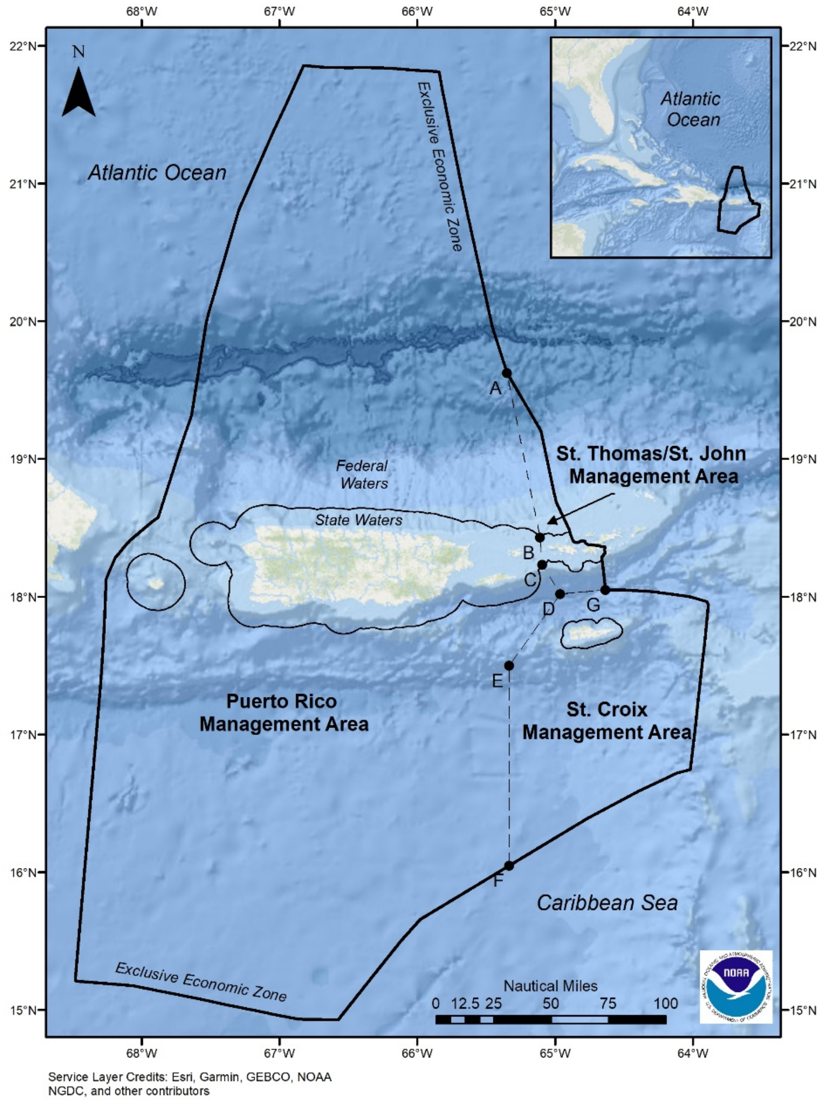

Figure 1.5.1. Jurisdictional boundaries of the Caribbean Fishery Management Council. Latitude and longitude coordinates for the boundary connecting points A-G are listed in the Code of Federal Regulations, part 622 (Fisheries of the Caribbean, Gulf of Mexico, and South Atlantic).

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 [17 - 370 km] from the coast). 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 that will be contained within the Puerto Rico FMP will be enforced through actions of NOAA's Office of Law Enforcement, the U.S. Coast Guard, and various Puerto Rico authorities, as were the regulations implementing the management measures contained within the U.S. Caribbean-wide FMPs that will be incorporated into the Puerto Rico FMP. To better coordinate enforcement activities, federal, and commonwealth enforcement agencies have developed cooperative agreements to enforce the Magnuson-Stevens Act.

[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 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.

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. For more information, please visit the Council website.

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 voting members appointed by the Secretary of Commerce, at least one of whom is appointed from each of the Commonwealth of Puerto Rico and the Territory of the USVI.

- 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 Procedure 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. 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 (MSA 302(g)(1)).

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 (MSA 302(g)(2)). An AP may include individuals who are not members of the Council. The Council has created a District Advisory Panel (DAP) for each of Puerto Rico, St. Thomas/St. John, and St. Croix. The Puerto Rico DAP was composed of fifteen members either actually engaged in the harvest, processing, or consumption of fishery resources, or who are knowledgeable of the conservation and management of fishery resources and the ecosystem upon which they depend. The Puerto Rico DAP obtained and transmitted to the Council advice and information from the people most affected by and knowledgeable of fishery management actions and needs. The

Puerto Rico DAP has aided the Council in establishing the goals and objectives of the island-based plan, while also providing a communication link with those who operate under the management regime.

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 visit the Atlantic Highly Migratory Species webpage.

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)[4] for 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

[4] 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."

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-Umpierre et al. 2014).

Puerto Rico's DNER has a designated seat on the Council to facilitate state participation in federal fishery management decision-making. Puerto Rico exercises legislative and regulatory authority over its natural resources through discrete administrative units. Puerto Rico cooperates with numerous state and federal regulatory agencies when managing marine resources within its jurisdiction. 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 Commonwealth 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 Commonwealth waters. The lack of compatible regulations complicates enforcement, confuses the public with regard to applicable regulations, and may hinder both the Commonwealth'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. The federal consistency provision of the Act, Section 307,[5] provides states with an important tool to manage coastal uses and

[5] The federal consistency provision of the CZMA provides 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 to the maximum extent practicable (DOC 2009).

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.

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 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 50 CFR 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[6] (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 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.

[6] 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.

1.6.4 Ecosystem-based Fisheries Management

On May 23, 2016, NOAA's NMFS released their ecosystem-based fisheries management policy[7]. 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.

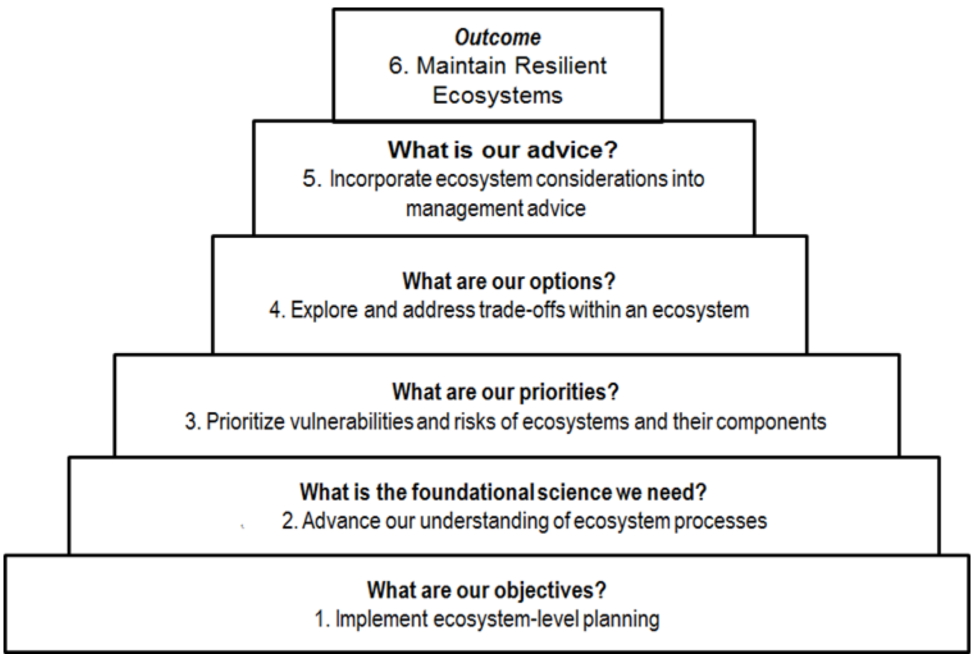

Figure 1.6.1. Hierarchical arrangement of NMFS' six guiding principles for implementation of ecosystem-based fisheries management.
(Source: http://www.nmfs.noaa.gov/op/pds/index.html)

[7] National Marine Fisheries Service Policy 01-120, May 23, 2016, available at: https://www.fisheries.noaa.gov/resource/document/ecosystem-based-fisheries-management-policy)

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[8] and sustainability of the ecosystem[9]; 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.

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 DAPs 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 to an EBFM approach is the shift from U.S. Caribbean-wide 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 U.S. Caribbean-wide FMPs, are of particular relevance to the development of the Puerto Rico FMP: (1) the Caribbean SFA Amendment (CFMC 2005), where the Council took several actions to

[8]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.

[9]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.

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[10], 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 from a U.S. Caribbean-wide approach to an island-based approach and set the basis for the reorganization of management 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 U.S. Caribbean-wide 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.

[10] 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).

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 4: 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 5: Promote international and domestic cooperation in the management of pan-Caribbean stocks.

Objective 6: Minimize conflicts between stakeholders by promoting effective marine spatial planning.

Objective 7: 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 8: Establish resource access permits as necessary and appropriate to facilitate data collection, sustainability, and long-term yield.

Objective 9: 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 socio-economic information.

Objective 10: 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.

Objective 11: 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 12: Ensure the socio-economic health of the fishing communities dependent on federal fishery resources.

Objective 13: Protect spawning aggregations and, when needed, the habitats supporting those aggregations to ensure the future health of the resource.

Objective 14: 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 15: Map, define, and manage habitat upon which the resource depends, with particular emphasis on coral reef resources throughout the region.

Objective 16: 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 17: 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 18: 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 19: 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.

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 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 U.S. Caribbean-wide FMPs (by selecting the no action alternative), or switch to an island-based approach in Puerto Rico through the establishment of a Puerto Rico FMP (by selecting the action alternative). To transition to island-based management throughout the U.S. Caribbean, 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, it developed and evaluated Actions 2-7, which provide the opportunity to modify the measures in that newly created FMP. 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. 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.

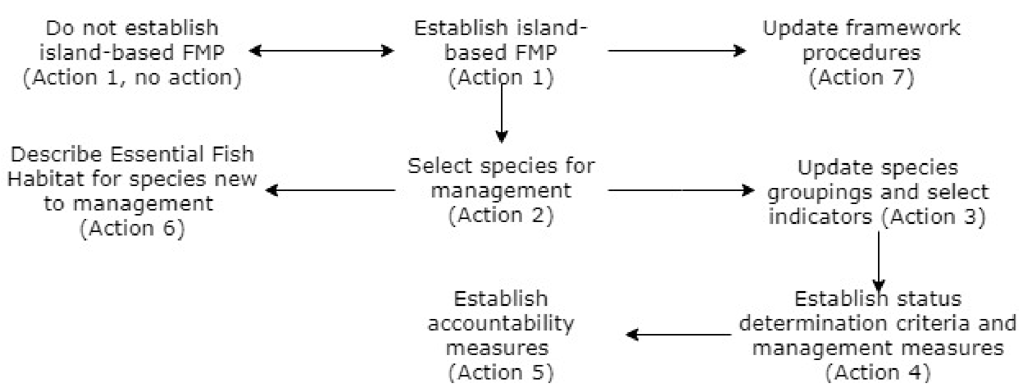

Figure 2.1. Structure of the management actions considered in Chapter 2.

2.1 Action 1: Transition Fisheries Management in the Puerto Rico Exclusive Economic Zone (EEZ) from a U.S. Caribbean-wide Approach to an Island-based Approach

Action 1 provides the actual mechanism for transitioning from U.S. Caribbean-wide to island-based management in Puerto Rico EEZ waters. This action has two alternatives.

2.1.1 Proposed Alternatives for Action 1

Alternative 1. No action. The transition from a U.S. Caribbean-wide approach to a fully island-based approach to management within the Puerto Rico management area would not be implemented. Instead, the four extant, U.S. Caribbean-wide FMPs (Reef Fish FMP, Spiny Lobster FMP, Queen Conch FMP, and 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 Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs as they apply to the Puerto Rico EEZ 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.

2.1.2 Discussion of Action 1 Alternatives

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

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 U.S. Caribbean-wide fishery management 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 Council's four U.S. Caribbean-wide 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 FMP/EA (Actions 2-7), shifting from the U.S. Caribbean-wide 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 subdivision for Puerto Rico established in the 2010 and 2011 Caribbean ACL Amendments (CFMC 2011a, b). This island-based allocation provided the initial foundation for partitioning the current U.S. Caribbean-wide FMPs into three island-based FMPs. **Preferred Alternative 2** would establish the same management regime chosen by the Council in the 2014 EA (i.e., transition to island-based management) 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 U.S. Caribbean-wide plans.

An implicit requirement of transitioning to island-based management throughout the entire U.S. Caribbean is that **Preferred Alternative 2** be implemented for all three island-based management areas: Puerto Rico, St. Thomas/St. John, and St. Croix. The four U.S. Caribbean-wide FMPs were based on certain measures that were established across the entire U.S. Caribbean region. For example, in the 2010 Caribbean ACL Amendment, the maximum sustainable yield (MSY) and overfishing limit (OFL) were set on a U.S. Caribbean-wide basis for managed stocks and stock complexes. In the 2011 Caribbean ACL amendment, two stock complexes (tilefish, aquarium trade) were managed Caribbean-wide. Removing some, but not all, of those management measures from the four U.S. Caribbean-wide FMPs would undermine the rationale behind those FMPs. Thus, if the Council chose to partially transition to island-based management, implementing island-based management for the Puerto Rico EEZ alone, the U.S. Caribbean-wide FMPs would have to be amended to remove Puerto Rico so that the Council would not have two sets of management measures applicable to the Puerto Rico EEZ. Without amendment, 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 U.S. Caribbean-wide management measures established in the extant FMPs are not amenable to being transferred to the island-based FMPs. Thus, after choosing to transition to island-based management, the U.S. 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; and therefore, **Alternative 1** 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 of continuing management under the U.S. Caribbean-wide plans could be negative because this approach would not provide the Council with their preferred mechanism to tailor fisheries management to the different cultural, social, and economic factors that affect the fisheries at the sub-regional (island) level.

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 future impacts to the human environment depend on the nature of the specific future management actions. 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. Even under **Alternative 1**, however, the Council could choose to amend management, with some of the benefits expected under **Preferred Alternative 2**, though the Council expects more beneficial results from managing at an island-level as discussed in the 2014 EA (NMFS 2014).

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 Federal Fisheries Management).

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

Through Action 2, the Council would determine the species[11] that would be included for management under the new Puerto Rico FMP. This action follows from selecting Preferred 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.

[11] For purposes of this FMP, the term species refers to an animal as it occurs throughout its range. Since species can occur over large geographic areas, they are often managed as separate, but interrelated stocks. The Council and its Scientific and Statistical Committee considered the list of species occurring in the Puerto Rico management area, and selected stocks for management within the Puerto Rico FMP.

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.

Preferred Alternative 2. 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 NMFS determination, or for which historically identified harvest is now prohibited due to their ecological importance as habitat (all corals) 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, <u>include</u> 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 species, include any other species that the Council determines are in need of conservation and management (Table 2.2.5).

Table 2.2.1. Species included in the Puerto Rico FMP 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
	Epinephelus morio	Red grouper
	Mycteroperca tigris	Tiger grouper
	Mycteroperca venenosa	Yellowfin grouper
	Hyporthodus 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 (See Appendix E for examples)	

Table 2.2.2. Species that would be excluded from the Puerto Rico FMP based on Preferred Alternative 2, *Criterion B*. Species that were not managed under the Coral and Reef Fish FMPs are noted with a ^.

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

Family	Scientific Name	Common Name
	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
	Melichthys niger	Black durgon[1]
Monocanthidae -- Filefishes	*Aluterus scriptus*	Scrawled filefish
	Cantherhines macrocerus	Whitespotted filefish
Ostraciidae -- Boxfishes	*Lactophrys polygonia*	Honeycomb cowfish
	Lactophrys quadricornis	Scrawled cowfish
	Lactophrys trigonus	Trunkfish
	Lactophrys bicaudalis	Spotted trunkfish
	Lactophrys triqueter	Smooth trunkfish
Sphyraenidae -- Barracudas	*Sphyraena guachancho*	Guachanche^
Aquarium Trade 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

Family	Scientific Name	Common Name
	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
	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 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	Branching base sponge
	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

Family	Scientific Name	Common Name
	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
	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
	Subphylum Urochordata	Tunicates

[1] Black durgon was listed incorrectly as a filefish in the species table in Appendix A to Part 622 (Caribbean Reef Fish). Here, it is properly identified as a triggerfish.

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	*Cephalopholis fulvus*	Coney
	Cephalopholis cruentatus	Graysby
	Epinephelus adscensionis	Rock hind
	Hyporthodus mystacinus	Misty grouper
	Mycteroperca interstitialis	Yellowmouth grouper*
Scaridae -- Parrotfishes	*Scarus vetula*	Queen parrotfish
	Scarus taeniopterus	Princess parrotfish
	Sparisoma chrysopterum	Redtail parrotfish
	Sparisoma viride	Stoplight parrotfish
	Sparisoma aurofrenatum	Redband parrotfish
	Scarus iseri	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
	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
Sphyraenidae -- Barracudas	*Sphyraena barracuda*	Great barracuda*
Lobotidae -- Tripletail	*Lobotes surinamensis*	Tripletail*
Myliobatidae – Eagle and Manta rays	*Manta birostris*	Giant manta ray*
	Aetobatus narinari	Spotted eagle ray (chucho)*
Dasyatidae - Stingrays	*Hypanus americanus*	Southern stingray*

Table 2.2.4. Species 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*

Family	Scientific Name	Common Name
	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 mackerel*
	Acanthocybium solandri	Wahoo*

Table 2.2.5. Species included in the Puerto Rico FMP based on Preferred Alternative 2, *Criterion E.*

Class	Scientific Name	Common Name
Holothuroidea – Sea cucumbers	All (See Appendix E)	Sea cucumbers
Echinoidea* – Sea urchins	All (See Appendix E)	Sea urchins

*Orders Arbacioida, Camarodonta, Cassiduloida, Cidaroida, Diadematoida, Echinolampadoida, Echinoneoida, Echinothurioida, Pedinoida, Salenioida, and Spatangoida.

2.2.2 Discussion of Action 2 Alternatives

Under **Alternative 1** (no action), the species included in the Puerto Rico FMP as established under Action 1 (i.e., the species previously managed under the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs) would not be modified. 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 tailored to the specific characteristics of the Puerto Rico EEZ, as many species included in the Council's extant 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 U.S. Caribbean-wide 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*[12]. However, at the 163rd Council meeting in August 2018, the Council decided to reject *Criterion E* (see Appendix F for the rationale) and replace it with a new *Criterion E* that would to reflect earlier work that the Council had completed to include species that require conservation and management but were not captured by *Criteria A-D,* such as sea cucumbers and sea urchins (See Appendix E for a partial list of these species).

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[13] occurring in Puerto Rico EEZ waters were in need of conservation and management and therefore should be included in the FMP under this criterion (See Appendix E for a partial list of corals).

Under *Criterion B* of **Preferred Alternative 2**, species that occur infrequently in federal waters would 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

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[12] 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 socio-economics rather than the biological condition of the stock.

[13] At their 153rd Regular meeting, the Council moved to include all soft, hard, mesophotic, and deep water corals under the new island-based FMPs. Corals included in the Puerto Rico FMP include the phylum Cnidaria (formerly Coelenterata) 1) Class Hydrozoa, Subclass Hydroidolina, Order Anthoathecata, Family Milleporidae and Family Stylasteridae; 2) Class Anthozoa, Subclass Octocorallia (soft corals, gorgonians, sea pansies, sea pens), Order Alcyonacea (soft corals), Order Pennatulacea (sea pens), Subclass Hexacorallia, Order Scleractinia (stony corals), and Order Anthipatharia (black corals).

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 predominantly occurred in Puerto Rico territorial waters (generally $\leq$ 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, all aquarium trade finfish species, 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).

From the remaining list of species (i.e., those not included under *Criterion A* or excluded under *Criterion B*), *Criterion C* of **Preferred Alternative 2**, would include a species 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*, 31 species would fall under this criterion, including the new species cubera snapper, yellowmouth grouper, gray triggerfish, great barracuda, tripletail, giant manta ray, spotted eagle ray, and the southern stingray (Table 2.2.3).

From the remaining list of species (i.e., those not included under *Criterion A,* excluded under *Criterion B,* or included under *Criterion C*), *Criterion D* of **Preferred Alternative 2** would include in the Puerto Rico FMP species that 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 mackerel, 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, the pelagic species including dolphin, pompano dolphin, wahoo, little tunny, and blackfin tuna, king mackerel, and cero mackerel, 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.

Criterion E of **Preferred Alternative 2** allows the Council discretion to add those species they considered were in need of conservation or management. All sea cucumbers and sea urchins that occur in the Puerto Rico EEZ would fall under this category (Table 2.2.5). 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.

When applying the criteria included in **Preferred Alternative 2**, 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 noted that barracuda occurs in the EEZ (not excluded under *Criterion B*) and opined that although 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 provided different recommendations to the Council. The Puerto Rico DAP recommended redfin parrotfish be included for management, but the SSC did not, noting that the redfin parrotfish stock rarely occurs in waters subject to federal management (i.e., those waters at least 9 nautical miles from shore, generally equivalent to those waters > 30 meters (m) depth). For this reason, the SSC recommended that redfin 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 2.2.6).

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 coral occurring in Puerto Rico EEZ waters, and 63 species of finfish (Table 2.2.6).

Table 2.2.6. 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). Species marked with an asterisk would be new to federal management.

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
	7	*Lutjanus synagris*	Lane snapper	A
	8	*Lutjanus analis*	Mutton snapper	A
	9	*Ocyurus chrysurus*	Yellowtail snapper	A
	10	*Pristipomoides aquilonaris*	Wenchman	D

Family or Class	#	Species Name	Common Name	Criterion
	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 bahianus*	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	50	*Sphyraena barracuda**	Great barracuda*	C
Lobotidae -- Tripletail	51	*Lobotes surinamensis**	Tripletail*	C
Myliobatidae -- Eagle and Manta Rays	52	*Manta birostris**	Giant manta ray*	C
	53	*Aetobatus narinari**	Spotted eagle ray*	C
Dasyatidae - Stingrays	54	*Hypanus americanus**	Southern stingray*	C
Haemulidae -- Grunts	55	*Haemulon plumierii*	White grunt	D

Family or Class	#	Species Name	Common Name	Criterion
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 mackerel*	D
	65	*Acanthocybium solandri**	Wahoo*	D
Class Holothuroidea -- Sea Cucumbers	66	All (See Appendix E)	Sea cucumbers	E
Class Echinoidea* -- Sea Urchins	67	All (See Appendix E)	Sea urchins	E
All Corals (soft, hard, mesophotic, deep-water)	68	All (See Appendix E)	Corals	A

* Orders Arbacioida, Camarodonta, Cassiduloida, Cidaroida, Diadematoida, Echinolampadoida, Echinoneoida, Echinothurioida, Pedinoida, Salenioida, and Spatangoida.

Comparison of Action 2 Alternatives and Summary of Effects

Alternative 1 would continue management of those stocks that are included under the existing U.S. Caribbean-wide 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 fish (from 81 to 63). Both alternatives would continue to include spiny lobster and queen conch. Under **Preferred Alternative 2**, all species of corals, sea cucumbers, and sea urchins that occur in Puerto Rico EEZ waters would be added to the federal management regime (See Appendix E). In contrast, under **Alternative 1**, only the species or genera of corals, sea cucumbers, and sea urchins that were included in the Coral FMP would be managed in Puerto Rico EEZ waters.

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 and socio-economic 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 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 socio-economic 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 accountability measures (AM) in response to harvest exceeding the allowable catch limit.

When compared to the no action **Alternative 1**, the indirect benefits of **Preferred Alternative 2** on the physical, biological and ecological environments would depend on the management measures the Council puts in place for those stocks added to the FMP as in need of conservation and management. These stocks, and the physical and biological/ecological environment, could benefit from measures the Council establishes to prevent overfishing or from measures that result in new fishing area management, changes in the number of fish harvested, or fishing effort not previously analyzed. Likewise, for stocks removed from management, the indirect physical and/or biological/ecological effects on the environment depend on the extent to which fishing behavior would change once the stock is removed from federal management. For example, if fishing for a stock that would be removed from federal management under **Preferred Alternative 2** continues as is regardless of federal management, because the stock is largely harvested from territorial waters, effects would be minimal.

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 [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 Endangered Species Act (ESA)-listed giant manta ray). **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. **Preferred Alternative 2** would include for federal management all species of corals that occur within the Puerto Rico management area (See Appendix E), thereby providing protection not just for ESA-listed coral species but for the host of corals that provide the most essential of habitats supporting coral reef fisheries. Including all sea urchins occurring in the Puerto Rico EEZ for management provides an essential ecological service via grazing activities, which provides settlement substrate for coral propagules. Similarly, managing all sea cucumbers in federal waters provides an essential ecological service because they regenerate nutrients sequestered in the sediments surrounding coral reefs, making those nutrients available to primary producers (including coral symbionts).

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 **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.

In summary, when compared to **Alternative 1**, **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 are 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 species and associated 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.

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 Preferred Alternative 2 in Action 1 and proceeding with establishing a Puerto Rico FMP composed of measures pertinent to Puerto Rico.

Stocks may be grouped into stock 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 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.

2.3.1 Proposed Alternatives for Action 3

Alternative 1. No action. In the Puerto Rico FMP, 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 would 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 AMs as a group based on the ACL established for the indicator stock(s).

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, as applicable. Action 2 removed certain species from management and added others, so the stock complex composition under **Alternative 1** would differ from the stock complex composition under the Reef Fish FMP, as shown below (Table 2.3.1). Species added to management would not be grouped into stock complexes, but would be managed individually. Both spiny lobster and queen conch were previously managed as individual stocks, and individual stock management for these species would continue under the Puerto Rico FMP. Select coral, sea urchin, and sea cucumber species were managed under the Coral FMP (see Appendix D), but Action 2 modified that list to include all species within each of those groups (see Appendix E) occurring within the Puerto Rico EEZ. As a result, **Alternative 1** would contain three stock complexes, one for each of the corals, sea urchins, and sea cucumbers that were previously managed, as well as an unknown number of coral, sea urchin, and sea cucumber species that would be managed as individual stocks.

Table 2.3.1. Comparison of stock/stock complex organization under the Reef Fish FMP and Action 3, Alternative 1 (no action).

Scientific name	Common name	Reef Fish FMP	Alternative 1 (no action)
Apsilus dentatus	Black snapper	Snapper Unit 1	Snapper 1
Lutjanus buccanella	Blackfin snapper	Snapper Unit 1	Snapper 1
Lutjanus vivanus	Silk snapper	Snapper Unit 1	Snapper 1
Rhomboplites aurorubens	Vermilion snapper	Snapper Unit 1	Snapper 1
Pristipomoides aquilonaris	Wenchman	Snapper Unit 1	Snapper 1
Pristipomoides macrophthalmus	Cardinal snapper	Snapper Unit 2	Snapper 2
Etelis oculatus	Queen snapper	Snapper Unit 2	Snapper 2
Lutjanus synagris	Lane snapper	Snapper Unit 3	Snapper 3
Lutjanus analis	Mutton snapper	Snapper Unit 3	Snapper 3
Lutjanus jocu	Dog snapper	Snapper Unit 3	Snapper 3
Lutjanus apodus	Schoolmaster	Snapper Unit 3	Snapper 3
Lutjanus griseus	Gray snapper	Snapper Unit 3	removed
Lutjanus mahogani	Mahogany snapper	Snapper Unit 3	removed
Ocyurus chrysurus	Yellowtail snapper	Snapper Unit 4	Snapper 4
Lutjanus cyanopterus	Cubera snapper	not managed	Cubera snapper
Epinephelus striatus	Nassau Grouper	Grouper Unit 1	Grouper 1
Epinephelus itajara	Goliath grouper	Grouper Unit 2	Grouper 2
Cephalopholis fulva	Coney	Grouper Unit 3	Grouper 3
Cephalopholis cruentata	Graysby	Grouper Unit 3	Grouper 3
Epinephelus guttatus	Red hind	Grouper Unit 3	Grouper 3

Scientific name	Common name	Reef Fish FMP	Alternative 1 (no action)
Epinephelus adscensionis	Rock hind	Grouper Unit 3	Grouper 3
Mycteroperca bonaci	Black grouper	Grouper Unit 4	Grouper 4
Epinephelus morio	Red grouper	Grouper Unit 4	Grouper 4
Mycteroperca tigris	Tiger grouper	Grouper Unit 4	Grouper 4
Mycteroperca venenosa	Yellowfin grouper	Grouper Unit 4	Grouper 4
Hyporthodus mystacinus	Misty grouper	Grouper Unit 5	Grouper 5
Hyporthodus flavolimbatus	Yellowedge grouper	Grouper Unit 5	Grouper 5
Mycteroperca interstitialis	Yellowmouth grouper	not managed	Yellowmouth grouper
Scarus coeruleus	Blue parrotfish	Parrotfish	Parrotfish
Scarus coelestinus	Midnight parrotfish	Parrotfish	Parrotfish
Scarus taeniopterus	Princess parrotfish	Parrotfish	Parrotfish
Scarus vetula	Queen parrotfish	Parrotfish	Parrotfish
Scarus guacamaia	Rainbow parrotfish	Parrotfish	Parrotfish
Sparisoma rubripinne	Redfin parrotfish	Parrotfish	removed
Sparisoma chrysopterum	Redtail parrotfish	Parrotfish	Parrotfish
Sparisoma viride	Stoplight parrotfish	Parrotfish	Parrotfish
Sparisoma aurofrenatum	Redband parrotfish	Parrotfish	Parrotfish
Scarus croicensis	Striped parrotfish	Parrotfish	Parrotfish
Holacanthus ciliaris	Queen angelfish	Angelfish	Angelfish
Pomacanthus arcuatus	Gray angelfish	Angelfish	Angelfish
Pomacanthus paru	French angelfish	Angelfish	Angelfish
Acanthurus coeruleus	Blue tang	Surgeonfish	Surgeonfish
Acanthurus bahianus	Ocean surgeonfish	Surgeonfish	Surgeonfish
Acanthurus chirurgus	Doctorfish	Surgeonfish	Surgeonfish
Haemulon plumieri	White grunt	Grunts	Grunts
Haemulon sciurus	Bluestriped grunt	Grunts	removed
Haemulon album	Margate	Grunts	removed
Haemulon aurolineatum	Tomtate	Grunts	removed
Haemulon flavolineatum	French grunt	Grunts	removed
Anisotremus virginicus	Porkfish	Grunts	removed
Canthidermis sufflamen	Ocean triggerfish	Triggerfish	Triggerfish
Balistes vetula	Queen triggerfish	Triggerfish	Triggerfish
Xanthichthys rigens	Sargassum triggerfish	Triggerfish	removed
Melichthys niger	Black durgon	Triggerfish*	removed
Balistes capriscus	Gray triggerfish	not managed	Gray triggerfish
Lachnolaimus maximus	Hogfish	Wrasses	Wrasses
Halichoeres radiatus	Puddingwife	Wrasses	Wrasses
Bodianus rufus	Spanish hogfish	Wrasses	Wrasses
Caranx crysos	Blue runner	Jacks	removed
Caranx latus	Horse-eye jack	Jacks	removed
Caranx lugubris	Black jack	Jacks	removed
Seriola rivoliana	Almaco jack	Jacks	removed

Scientific name	Common name	Reef Fish FMP	Alternative 1 (no action)
Caranx ruber	Bar jack	Jacks	removed
Seriola dumerili	Greater amberjack	Jacks	removed
Caranx bartholomaei	Yellow jack	Jacks	removed
Caranx hippos	Crevalle jack	not managed	Crevalle jack
Elagatis bipinnulata	Rainbow runner	not managed	Rainbow runner
Alectis ciliaris	African pompano	not managed	African pompano
Calamus bajonado	Jolthead porgy	Porgies	removed
Archosargus rhomboidalis	Sea bream	Porgies	removed
Calamus penna	Sheepshead porgy	Porgies	removed
Calamus pennatula	Pluma	Porgies	removed
Myripristis jacobus	Blackbar soldierfish	Squirrelfish	removed
Priacanthus arenatus	Bigeye	Squirrelfish	removed
Holocentrus rufus	Longspine squirrelfish	Squirrelfish	removed
Holocentrus adscensionis	Squirrelfish	Squirrelfish	removed
Acasthostracion polygonius	Honeycomb cowfish	Boxfish	removed
Acasthostracion quadricornis	Scrawled cowfish	Boxfish	removed
Lactophrys trigonus	Trunkfish	Boxfish	removed
Lactophrys bicaudalis	Spotted trunkfish	Boxfish	removed
Lactophrys triqueter	Smooth trunkfish	Boxfish	removed
Aluterus scriptus	Scrawled filefish	Filefish	removed
Cantherhines macrocerus	Whitespotted filefish	Filefish	removed
Pseudupeneus maculatus	Spotted goatfish	Goatfish	removed
Mulloidichthys martinicus	Yellow goatfish	Goatfish	removed
Caulolatilus cyanops	Blackline tilefish	Tilefish	removed
Malacanthus plumieri	Sand tilefish	Tilefish	removed
Sphyraena barracuda	Great barracuda	not managed	Great barracuda
Lobotes surinamensis	Tripletail	not managed	Tripletail
Coryphaena hippurus	Dolphin	not managed	Dolphin
Coryphaena equiselis	Pompano dolphin	not managed	Pompano dolphin
Euthynnus alletteratus	Little tunny	not managed	Little tunny
Thunnus atlanticus	Blackfin tuna	not managed	Blackfin tuna
Scomberomorus cavalla	King mackerel	not managed	King mackerel
Scomberomorus regalis	Cero mackerel	not managed	Cero mackerel
Acanthocybium solandri	Wahoo	not managed	Wahoo
Manta birostris	Giant manta ray	not managed	Giant manta ray
Aetobatus narinari	Spotted eagle ray	not managed	Spotted eagle ray
Hypanus americanus	Southern stingray	not managed	Southern stingray

**previously listed as filefish*

The organization of the stock complexes under the extant FMPs was based on biological, geographic, ecological, and/or economic characteristics. For some previously managed stocks, the stock/stock complex organization that would result under **Alternative 1** may not be based on the best currently available information, even if it was the best scientific information available at the time the complexes were established.

Additionally, stocks new to management under Action 2, Preferred Alternative 2 would be managed as individual stocks rather than grouped in a complex. Those new stocks may have similar biological characteristics to stocks previously managed in a complex, which under guidelines on implementing NS1 would suggest that it may be appropriate to manage them within that stock complex. However, under **Alternative 1**, they would not be included in a stock complex, but would be managed as individual stocks.

Alternative 1 would not be a preferred alternative if the Council implements Preferred Alternative 2 in Action 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. 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. Action 2, Preferred Alternative 2 includes additional species for management. Those species that would be newly added to the Puerto Rico FMP may share biological, geographic, ecological, 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 into stock complexes.

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 management 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 (50 CFR 600.310(d)(2)(i)).

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 SDC 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 and accepted by the Council at their April 2017 regular meeting.

Preferred Alternative 3 would result in 18 single species/individual stocks and 19 stock complexes (Table 2.3.2). A discussion of how the stocks were composed under **Preferred Alternative 3** and how that organization compares to results from **Alternative 1** and **Alternative 2** can be found below (Table 2.3.3).

Table 2.3.2. 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

Family or Class	Stock/Stock Complexes	Species Name	Common Name; Nombre en español
		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	Dog snapper; pargo colorao
		Lutjanus apodus	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
	Grouper 2	*Epinephelus itajara*	Goliath grouper; mero batata
	Grouper 3	*Cephalopholis cruentata*	Graysby; mantequilla
		Cephalopholis fulva	Coney; mantequilla
	Grouper 4	*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
	Grouper 5	*Hyporthodus flavolimbatus*	Yellowedge grouper; guajil amarillo
		Hyporthodus mystacinus	Misty grouper; guasa
	Grouper 6	*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

Family or Class	Stock/Stock Complexes	Species Name	Common Name; Nombre en español
		Sparisoma viride	Stoplight parrotfish ; loro verde
		Sparisoma aurofrenatum	Redband parrotfish; loro banda colorada
		Scarus iseri	Striped parrotfish; loro rayado
Acanthuridae -- Surgeonfishes	Surgeonfish	*Acanthurus coeruleus*	Blue tang; barbero
		Acanthurus bahianus	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	Wrasses 1	*Lachnolaimus maximus*	Hogfish; capitán
	Wrasses 2	*Halichoeres radiatus*	Puddingwife; capitán de piedra
		Bodianus rufus	Spanish hogfish; loro capitán
Pomacanthidae -- Angelfishes	Angelfish	*Holacanthus ciliaris*	Queen angelfish; isabelita
		Pomacanthus arcuatus	Gray angelfish; isabelita gris
		Pomacanthus paru	French angelfish; isabelita negra
Sphyraenidae -- Barracuda	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*	Giant manta; mantarraya
	Rays 2	*Aetobatus narinari*	Spotted eagle ray; chucho
Dasyatidae – Stingrays	Rays 3	*Hypanus americanus*	Southern stingray; 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*	Dolphin; dorado
		Coryphaena equiselis	Pompano dolphin; doradito
Scombridae –	Tuna	*Euthynnus alletteratus*	Little tunny; bonito

Family or Class	Stock/Stock Complexes	Species Name	Common Name; Nombre en español
Mackerels and tunas		*Thunnus atlanticus*	Blackfin tuna; albacora
	Mackerel	*Scomberomorus cavalla*	King mackerel; sierra carite
		Scomberomorus regalis	Cero mackerel; sierra alasana
	Wahoo	*Acanthocybium solandri*	Wahoo; peto
Class Holothuroidea – Sea Cucumbers	Cucumbers	All (See Appendix E)	Sea cucumbers; pepinos de mar
Class Echinoidea* – Sea Urchins	Urchins	All (See Appendix E)	Sea urchins; erizos
All Corals (soft, hard, mesophotic, deep-water)	Corals	All (See Appendix E)	Corals; corales

* Orders Arbacioida, Camarodonta, Cassiduloida, Cidaroida, Diadematoida, Echinolampadoida, Echinoneoida, Echinothurioida, Pedinoida, Salenioida, and Spatangoida.

Table 2.3.3. Comparison of stock and stock complex organization for each species included in the Puerto Rico FMP under each Alternative in Action 3. Species new to federal management (see Action 2) are in bold.

Scientific name	Common Name	Alternative 1 (no action)	Alternative 2	Preferred Alternative 3
Lobatus (Strombus) gigas	Queen conch	Queen conch	Queen conch	Queen conch
Panulirus argus	Spiny lobster	Spiny lobster	Spiny lobster	Spiny lobster
Apsilus dentatus	Black snapper	Snapper 1	Black snapper	Snapper 1
Lutjanus buccanella	Blackfin snapper	Snapper 1	Blackfin snapper	Snapper 1
Lutjanus vivanus	Silk snapper	Snapper 1	Silk snapper	Snapper 1
Rhomboplites aurorubens	Vermilion snapper	Snapper 1	Vermilion snapper	Snapper 1
Pristipomoides aquilonaris	Wenchman	Snapper 1	Wenchman	Snapper 1
Pristipomoides macrophthalmus	Cardinal snapper	Snapper 2	Cardinal snapper	Snapper 2
Etelis oculatus	Queen snapper	Snapper 2	Queen snapper	Snapper 2
Lutjanus synagris	Lane snapper	Snapper 3	Lane snapper	Snapper 3
Lutjanus analis	Mutton snapper	Snapper 3	Mutton snapper	Snapper 4
Lutjanus jocu	Dog snapper	Snapper 3	Dog snapper	Snapper 4
Lutjanus apodus	Schoolmaster	Snapper 3	Schoolmaster	Snapper 4
Ocyurus chrysurus	Yellowtail snapper	Snapper 4	Yellowtail snapper	Snapper 5
Lutjanus cyanopterus	**Cubera snapper**	Cubera snapper	Cubera snapper	Snapper 6
Epinephelus striatus	Nassau Grouper	Grouper 1	Nassau Grouper	Grouper 1
Epinephelus itajara	Goliath grouper	Grouper 2	Goliath grouper	Grouper 2

Scientific name	Common Name	Alternative 1 (no action)	Alternative 2	Preferred Alternative 3
Cephalopholis fulva	Coney	Grouper 3	Coney	Grouper 3
Cephalopholis cruentata	Graysby	Grouper 3	Graysby	Grouper 3
Epinephelus guttatus	Red hind	Grouper 3	Red hind	Grouper 6
Epinephelus adscensionis	Rock hind	Grouper 3	Rock hind	Grouper 6
Mycteroperca bonaci	Black grouper	Grouper 4	Black grouper	Grouper 4
Epinephelus morio	Red grouper	Grouper 4	Red grouper	Grouper 4
Mycteroperca tigris	Tiger grouper	Grouper 4	Tiger grouper	Grouper 4
Mycteroperca venenosa	Yellowfin grouper	Grouper 4	Yellowfin grouper	Grouper 4
Hyporthodus mystacinus	Misty grouper	Grouper 5	Misty grouper	Grouper 5
Hyporthodus flavolimbatus	Yellowedge grouper	Grouper 5	Yellowedge grouper	Grouper 5
Mycteroperca interstitialis	**Yellowmouth grouper**	Yellowmouth grouper	Yellowmouth grouper	Grouper 4
Scarus coeruleus	Blue parrotfish	Parrotfish	Blue parrotfish	Parrotfish 1
Scarus coelestinus	Midnight parrotfish	Parrotfish	Midnight parrotfish	Parrotfish 1
Scarus guacamaia	Rainbow parrotfish	Parrotfish	Rainbow parrotfish	Parrotfish 1
Scarus taeniopterus	Princess parrotfish	Parrotfish	Princess parrotfish	Parrotfish 2
Scarus vetula	Queen parrotfish	Parrotfish	Queen parrotfish	Parrotfish 2
Sparisoma chrysopterum	Redtail parrotfish	Parrotfish	Redtail parrotfish	Parrotfish 2
Sparisoma viride	Stoplight parrotfish	Parrotfish	Stoplight parrotfish	Parrotfish 2
Sparisoma aurofrenatum	Redband parrotfish	Parrotfish	Redband parrotfish	Parrotfish 2
Scarus iseri	Striped parrotfish	Parrotfish	Striped parrotfish	Parrotfish 2
Holacanthus ciliaris	Queen angelfish	Angelfish	Queen angelfish	Angelfish
Pomacanthus arcuatus	Gray angelfish	Angelfish	Gray angelfish	Angelfish
Pomacanthus paru	French angelfish	Angelfish	French angelfish	Angelfish
Acanthurus coeruleus	Blue tang	Surgeonfish	Blue tang	Surgeonfish
Acanthurus bahianus	Ocean surgeonfish	Surgeonfish	Ocean surgeonfish	Surgeonfish
Acanthurus chirurgus	Doctorfish	Surgeonfish	Doctorfish	Surgeonfish
Haemulon plumieri	White grunt	Grunts	White grunt	Grunts
Canthidermis sufflamen	Ocean triggerfish	Triggerfish	Ocean triggerfish	Triggerfish
Balistes vetula	Queen triggerfish	Triggerfish	Queen triggerfish	Triggerfish

Scientific name	Common Name	Alternative 1 (no action)	Alternative 2	Preferred Alternative 3
Balistes capriscus	**Gray triggerfish**	Gray triggerfish	Gray triggerfish	Triggerfish
Lachnolaimus maximus	Hogfish	Wrasses	Hogfish	Wrasses 1
Halichoeres radiatus	Puddingwife	Wrasses	Puddingwife	Wrasses 2
Bodianus rufus	Spanish hogfish	Wrasses	Spanish hogfish	Wrasses 2
Caranx hippos	**Crevalle jack**	Crevalle jack	Crevalle jack	Jacks 1
Alectis ciliaris	**African pompano**	African pompano	African pompano	Jacks 2
Elagatis bipinnulata	**Rainbow runner**	Rainbow runner	Rainbow runner	Jacks 3
Sphyraena barracuda	**Great barracuda**	Great barracuda	Great barracuda	Barracuda
Lobotes surinamensis	**Tripletail**	Tripletail	Tripletail	Tripletail
Coryphaena hippurus	**Dolphin**	Dolphin	Dolphin	Dolphinfish
Coryphaena equiselis	**Pompano dolphin**	Pompano dolphin	Pompano dolphin	Dolphinfish
Euthynnus alletteratus	**Little tunny**	Little tunny	Little tunny	Tuna
Thunnus atlanticus	**Blackfin tuna**	Blackfin tuna	Blackfin tuna	Tuna
Scomberomorus cavalla	**King mackerel**	King mackerel	King mackerel	Mackerel
Scomberomorus regalis	**Cero mackerel**	Cero mackerel	Cero mackerel	Mackerel
Acanthocybium solandri	**Wahoo**	Wahoo	Wahoo	Wahoo
Manta birostris	**Giant manta ray**	Giant manta ray	Giant manta ray	Rays 1
Aetobatus narinari	**Spotted eagle ray**	Spotted eagle ray	Spotted eagle ray	Rays 2
Hypanus americanus	**Southern stingray**	Southern stingray	Southern stingray	Rays 3
Corals		One stock complex and multiple individual stocks	Multiple invidual stocks	Corals stock complex
Sea urchins		One stock complex and multiple individual stocks	Multiple invidual stocks	Sea urchins stock complex
Sea cucumbers		One stock complex and multiple individual stocks	Multiple invidual stocks	Sea cucumbers stock complex

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 G) 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, it is useful 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 G) 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 G). Evaluating the complexes in view of the productivity and susceptibility scores ensures that, to the greatest possible extent, the resultant stock complex arrangements met Magnuson-Stevens Act 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 complex is described and compared relative to the applicable productivity and susceptibility scores (Table 2.3.4).

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.

Table 2.3.4. Results of the PSA for stocks included in the Puerto Rico FMP. Stocks in bold represent the indicator stock selected for the complex based on Action 3, Preferred Sub-alternative 4a.

Scientific Name	Common Name	Stock / Complex	Productivity	Susceptibility
Panulirus argus	Caribbean spiny lobster	Spiny Lobster	High	Low/Moderate

Scientific Name	Common Name	Stock / Complex	Productivity	Susceptibility
Lobatus gigas	Queen conch	Queen Conch	Low/Moderate	High
Apsilus dentatus	Black snapper	Snapper 1	Moderate/High	Low/Moderate
Lutjanus buccanella	Blackfin snapper	Snapper 1	Moderate/High	Low/Moderate
Lutjanus vivanus	**Silk snapper**	**Snapper 1**	**Moderate/High**	**Low/Moderate**
Rhomboplites aurorubens	Vermilion snapper	Snapper 1	Moderate/High	Low/Moderate
Pristipomoides aquilonaris	Wenchman	Snapper 1	Moderate/High	Low/Moderate
Pristipomoides macrophthalmus	Cardinal	Snapper 2	High	Low/Moderate
Etelis oculatus	**Queen snapper**	**Snapper 2**	**High**	**Low/Moderate**
Lutjanus synagris	Lane snapper	Snapper 3	Moderate	Moderate
Lutjanus analis	**Mutton snapper**	**Snapper 4**	**Low/Moderate**	**Low/Moderate**
Lutjanus jocu	Dog snapper	Snapper 4	Low/Moderate	Low/Moderate
Lutjanus apodus	Schoolmaster	Snapper 4	Low/Moderate	Low/Moderate
Ocyurus chrysurus	Yellowtail snapper	Snapper 5	Moderate/High	Moderate
Lutjanus cyanopterus	Cubera	Snapper 6	Moderate	Moderate
Epinephelus striatus	Nassau Grouper	Grouper 1	Low	High
Epinephelus itajara	Goliath grouper	Grouper 2	Low	High
Cephalopholis fulva	**Coney**	**Grouper 3**	**High**	**Low/Moderate**
Cephalopholis cruentata	Graysby	Grouper 3	Moderate/High	Low
Mycteroperca bonaci	Black grouper	Grouper 4	Low	Moderate/High
Epinephelus morio	Red grouper	Grouper 4	Low	Moderate/High
Mycteroperca tigris	Tiger grouper	Grouper 4	Low	Moderate/High
Mycteroperca venenosa	Yellowfin grouper	Grouper 4	Low	Moderate/High
Mycteroperca interstitialis	Yellowmouth grouper	Grouper 4	Low	Moderate/High
Hyporthodus mystacinus	Misty grouper	Grouper 5	Low	Moderate
Hyporthodus flavolimbatus	Yellowedge grouper	Grouper 5	Low	Low
Epinephelus guttatus	**Red hind**	**Grouper 6**	**Moderate/High**	**Low/Moderate**
Epinephelus adscensionis	Rock hind	Grouper 6	Moderate/High	Low
Scarus coeruleus	Blue parrotfish	Parrotfish 1	Moderate	High
Scarus coelestinus	Midnight parrotfish	Parrotfish 1	Moderate	High
Scarus guacamaia	Rainbow parrotfish	Parrotfish 1	Moderate	High
Scarus taeniopterus	Princess parrotfish	Parrotfish 2	High	Low
Scarus vetula	Queen parrotfish	Parrotfish 2	High	Low
Sparisoma chrysopterum	Redtail parrotfish	Parrotfish 2	High	Low
Sparisoma viride	Stoplight parrotfish	Parrotfish 2	High	Low
Sparisoma aurofrenatum	Redband parrotfish	Parrotfish 2	High	Low
Scarus iseri	Striped parrotfish	Parrotfish 2	High	Low
Acanthurus coeruleus	Blue tang	Surgeonfish	High	Low
Acanthurus bahianus	Ocean surgeonfish	Surgeonfish	High	Low
Acanthurus chirurgus	Doctorfish	Surgeonfish	High	Low

Scientific Name	Common Name	Stock / Complex	Productivity	Susceptibility
Canthidermis sufflamen	Ocean triggerfish	Triggerfish	Moderate	Low
Balistes vetula	**Queen triggerfish**	**Triggerfish**	**Moderate**	**Low/Moderate**
Balistes capriscus	Gray triggerfish	Triggerfish	Moderate	Low
Lachnolaimus maximus	Hogfish	Wrasses 1	Moderate	Moderate
Halichoeres radiatus	Puddingwife	Wrasses 2	High	Low
Bodianus rufus	Spanish hogfish	Wrasses 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	Giant manta	Rays 1	Low	Moderate/High
Aetobatus narinari	Spotted eagle ray	Rays 2	Low	Moderate/High
Hypanus americanus	Southern stingray	Rays 3	Low	High
Haemulon plumieri	White grunt	Grunts	High	Moderate
Caranx hippos	Crevalle	Jacks 1	High	Moderate
Alectis ciliaris	African Pompano	Jacks 2	Moderate/High	Low
Elagatis bipinnulata	Rainbow runner	Jacks 3	High	Low
Coryphaena hippurus	**Dolphin**	**Dolphinfish**	**High**	**Low**
Coryphaena equiselis	Pompano dolphin	Dolphinfish	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	Mackerel	Moderate/High	Low
Acanthocybium solandri	Wahoo	Wahoo	Moderate/High	Low
-	Sea cucumbers	Sea cucumbers	Low	High
-	Sea urchins	Sea 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 three individual stocks and three 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 (160th 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 biologically and 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**)[14]. 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

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.

Snapper 5

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

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[14] 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 groups species selected for management in Action 2. **Alternative 1** maintains the complex groupings, as applied to the stocks for which management is continued under the Puerto Rico FMP.

also consistent with **Alternative 2** because both outcomes result in individual stock management.

Snapper 6

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 be the same as the approach under **Alternative 1,** as cubera snapper is new to management and **Alternative 1** does not group stocks that are new to management, resulting in individual 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.

<u>Grouper 4</u>

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** and would be managed individually. 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.

<u>Grouper 5</u>

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 deep-water 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 2.2.2). 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 **Alternative 1** does not include the newly added gray triggerfish in the triggerfish complex, but manages it individually. The complex composition resulting from **Preferred Alternative 3** also differs from **Alternative 2**, where all species would be managed as individual stocks.

Wrasses Stocks/Stock Complexes

Under **Preferred Alternative 3**, the three wrasses 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 wrasses 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.

<u>Wrasses 2</u>
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.

Angelfish Stock Complex

Under **Preferred Alternative 3**, the gray, queen, and French angelfish (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). **Preferred Alternative 3** also is the same as **Alternative 1.** The jacks to be managed under Action 2, Preferred Alternative 2 are new to management and thus would be managed individually under **Alternative 1**. The Jacks complex from the Reef Fish FMP is not retained in **Alternative 1** as the Council determined the previously managed stocks in the jacks complex (blue runner, horse-eye jack, black jack, almaco jack, bar jack, greater amberjack, and yellow jack) were no longer in need of conservation and management.

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 for this unique mid-level sit-and-wait predator. This stock arrangement would be the same as management resulting from **Alternative 2** (individual management) and **Alternative 1** (stocks new to management would be managed individually).

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 the same as management resulting from **Alternative 2** (individual management) and **Alternative 1** (stocks new to management would be managed individually).

Dolphinfish Stock Complex

Under **Preferred Alternative 3**, the dolphin (dorado) 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. **Alternative 1** does not group species that are new to management, resulting in individual management.

Tuna, Mackerel, Wahoo Stocks/Stock Complexes

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

Tunas

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. Managing the tuna stocks as a stock complex differs from **Alternative 2**, which proposes stocks to be managed individually. **Alternative 1** does not group any of these stocks as they would be new to management under the Puerto Rico FMP; thus, under **Alternative 1**, these stocks would be managed individually.

Mackerels

Under **Preferred Alternative 3**, the king mackerel and the cero mackerel 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, which is supported by outcomes from the PSA, as both species are moderately productive (cero mackerel ranked moderate to high) and both possess low susceptibility to the fishery. Managing the mackerel stocks as a stock complex differs from **Alternative 2**, which proposes the stocks to be managed individually. **Alternative 1** does not group these stocks as all would be new to management under the Puerto Rico FMP; thus, under **Alternative 1**, these stocks would be managed individually**.**

<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 wahoo be managed individually and the SSC agreed. The SSC emphasized wahoo being a less "coastal" pelagic species than the tunas and particularly the mackerels. Specifically, the SSC considered wahoo to be an insular "slope" species common in the Mona Passage whereas the cero mackerel 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 wahoo individually under **Preferred Alternative 3**, however, is the same outcome as **Alternative 2** and **Alternative 1**. **Alternative 1** does not group wahoo as it would be new to management under the Puerto Rico FMP; thus, under **Alternative 1**, wahoo would be managed individually**.**

Rays 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 (giant manta ray), Rays 2 (spotted eagle ray), and Rays 3 (southern stingray).

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 (giant manta ray and spotted eagle ray) to high (southern stingray) fishery susceptibility. For these three stocks, the **Preferred Alternative 3** outcome would be the same as that resulting from **Alternative 2** (individual stock management) and **Alternative 1.** All three species would be new to management under the Puerto Rico FMP and thus are not grouped under **Alternative 1**, resulting in individual management.

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 many of these species are currently managed as a stock complex as part of the aquarium trade complex within the Coral FMP. **Preferred Alternative 3**, however, manages all sea cucumbers. Those new to management would be managed individually under **Alternative 1**, to the extent possible. 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. Under **Preferred Alternative 3**, all sea urchins (see Appendix E) would be managed in the sea urchins stock complex. 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** would result in management of additional sea urchins in the stock complex than under **Alternative 1** because only select urchin species were previously included in the aquarium trade unit within the Coral FMP. **Preferred Alternative 3** is not 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, as proposed under **Alternative 2**. Stocks new to management would be managed individually under **Alternative 1**, but individual management is not possible for the same reasons described for **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 deep-water 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 constitutes 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 of all corals is essential. 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**. **Alternative 1** retains the stock complex composition from the Coral FMP, which includes only a select number of coral species, and would manage newly added coral species as individual stocks. **Preferred Alternative 3** includes all coral species in the Puerto Rico EEZ in a single stock complex. Thus, the coral stock complex under **Preferred Alternative 3** would be more comprehensive than the coral stock complex under **Alternative 1**. **Preferred Alternative 3** also differs from **Alternative 2**, which would manage each coral species an individual stock.

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)[15] 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

[15]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)).

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 it is not possible to use the most vulnerable stock within a complex as an indicator (81 FR 71858 Oct. 18, 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, as those complexes were established under **Preferred Alternative 3**. 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 acceptable biological catch (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 5).

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 the Snapper 1 stock complex, 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.

Queen snapper was recommended by the SSC as an appropriate indicator for the Snapper 2 stock complex. That stock represents a substantial majority of the reported Snapper 2 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 stock complex, (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 30 each year. This measure 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. The PSA revealed equal productivity (low/moderate) and fishery susceptibility (low/moderate) for all three stocks constituting the Snapper 4 complex.

The Grouper 3 stock complex 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.

The Grouper 6 stock complex 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 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 stock 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 triggerfish is the only triggerfish species that appears in the catch report forms. Thus, the best scientific information available upon which to manage the complex comes from the queen triggerfish, making queen triggerfish an appropriate indicator.

For the Dolphinfish stock complex, which is composed of dolphin and pompano dolphin, the SSC determined that dolphin met all seven criteria listed above, and strongly recommended this species as the indicator stock for this complex. Dolphin 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 dolphin 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 the Grouper 4 and Grouper 5 complexes, no indicator species was selected because some of 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 prohibition for each of the species. 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; 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 mackerel) because, neither would be a good proxy for the other. **Preferred 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.

<u>Comparison of Action 3 Alternatives and Summary of Effects</u>

Alternative 1 would continue management of stocks and stock complexes as previously managed under the U.S. Caribbean-wide FMPs. However, species that would no longer be managed as a result of Action 2 would be removed from the previously managed complexes, and species that are new to management as a result of Action 2 would be managed as individual stocks.

Alternative 1 is not expected to have direct physical, biological/ecological, economic, or social effects because how the stocks are grouped, as opposed to how they are managed, is not expected to change fishing behavior. We expect direct effects to the administrative environment as additional resources will be expended to reflect the change to the managed stock complexes. However, **Alternative 1** could have indirect biological effects as it would not update those stocks/stock complexes 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 that disrupt current fishing patterns, or they may not result in closures when appropriate, with effects to the physical, biological/ecological, socio-economic, and administrative environments.

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 complex. When compared to **Alternative 1** and **Preferred Alternative 3**, **Alternative 2** would likely have the greatest direct effects on the administrative environment. Indirect effects of fishing activities on the physical environment (i.e., the habitat, particularly that constituting the coral reef) would depend on whether and how individual management affects fishing effort. Where precautionary management of individual stocks results in additional closures, fishing effort may be reduced, which could reduce the potential for physical effects to the environment.

Effects 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 scientific information available. 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 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 stock 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 stocks that is targeted by the fishery, best represents the vulnerability of the other stocks 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 stock, 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 stock 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 stock 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 stocks 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.

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 MSY and 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)).

SDC and Management Reference Points

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.

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, the Council should explain how the approach would promote sustainability of the stock or stock complex on a long-term basis. Chapter 5 provides information about the resulting SDC and management reference points for stocks in the Puerto Rico FMP.

Action 4 describes different approaches for establishing SDC (e.g., OFL, MFMT, MSST) and management reference points (e.g., MSY, ABC, ACL) for the stocks/stock complexes and indicator stocks that were selected in Action 3. Four alternatives are included. **Alternatives 1** and **4**, and **Preferred Alternative 3**, provide different approaches to setting SDC and management reference points. Both **Preferred Alternative 3** and **Alternative 4** include a stepwise process with multiple sub-alternatives. **Preferred Alternative 2** provides an approach to use sector-specific information to establish SDC and management reference points for the stock or stock complex as a whole, and to set separate ACLs for the commercial and recreational fishing sectors.

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 definition for the MSST specified in the Sustainable Fisheries Act (SFA) Amendment (CFMC 2005), as applicable.

Preferred Alternative 2. Where data are available, use sector (i.e., commercial, recreational) information to derive and establish reference points and SDC for the stock/stock complex as a whole and set ACLs by sector. Where sector ACLs have been set, but landings data for one sector are not available for comparison to that sector's ACL, the ACL for the sector with available landings data would be the applicable ACL for the stock or stock complex.

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

Preferred Alternative 3 - <u>Step 1.</u> Adopt and apply the ABC Control Rule (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 MSST = 0.75*long-term Spawning Stock Biomass at MFMT (SSB_{MFMT}) 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 (σ), where the PDF is determined from the assessment (where $\sigma > \sigma_{min}$) [3]. ABC= d * OFL where $d = \begin{cases} \text{Scalar} & \text{if } B \geq B_{MSY} \\ \text{Scalar} * (B-B_{critical}) / (B_{MSY}-B_{critical}) & \text{if } B < B_{MSY} \end{cases}$ Scalar = 1 if acceptable probability of overfishing is specified (<0.5), < 1 if not specified (=0.5). $B_{critical}$ is defined as the minimum level of depletion at which fishing would be allowed.
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 (σ) must be greater than 1.5 σ_{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 MSST = 0.75* SSB_{MFMT} or proxy OFL = Catch at MFMT
ABC	ABC determined from OFL as reduced (buffered) by scientific uncertainty[4] and reflecting the acceptable probability of overfishing[2] a. Where the buffer is applied to the PDF of OFL when the PDF is determined from the assessment (with $\sigma \geq 2\sigma_{min}$) **OR** b. Where ABC = buffer * OFL, where buffer must be ≤ 0.9
Tier 4: Data Limited: No Accepted Assessment Available	
MSY	MSY proxy = long-term yield at proxy for F_{MSY}.
SDC	MFMT = F_{MSY} proxy MSST = 0.75* SSB_{MFMT} Sustainable yield level (SYL)[5] = a level of landings that can be sustained over the long-term. OFL proxy = SYL
Tier 4a **Conditions for Use**	No accepted[6] 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[7] cannot be reached on the use of Tier 4a, Tier 4b should be used.

SYL	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. 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[8].
Tier 4b	No accepted[6] 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.
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. Scalar < 2 depending on perceived degree of exploitation, life history, and ecological function.
ABC	ABC[9] = 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[8].
Footnotes	[1]Scientific uncertainty would take into account, but not be limited to, the species life history and ecological function. [2]Acceptable probability of overfishing determined by Council. [3]σ_{min} could be equal to coefficient of variation; σ_{min} is in a log scale. [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. [5]MSY ≥ SYL. See Appendix G for a detailed explanation of SYL. [6]Accepted means that the assessment was approved by the SSC as being appropriate for management purposes. [7]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. [8]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. [9]The ABC for a Tier 4b stock should not exceed mean landings during the reference period.

Preferred Alternative 3 - Step 2. 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[16] landings data available to set management reference points, as applicable.

Sub-alternative 4b. Use the longest time series of pre-Caribbean SFA Amendment (CFMC 2005) landings data that is considered to be consistently reliable[17] 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*. MSY proxy**: establish the MSY proxy for the stock or stock complex as described by any of the sub-alternatives below. A different sub-alternative can be chosen for each stock or stock complex 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 for the stock or stock complex 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.

[16] 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.
[17] 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.

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.

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 for the stock or stock complex 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

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) for those stocks or stock complexes that would be managed under the Puerto Rico FMP as a result of Actions 2 and 3, as applicable (see discussion below). **Alternative 1** would also retain the definition for MSST that was specified in the Caribbean SFA Amendment (CFMC 2005) for those stocks or stock complexes that would be managed under the Puerto Rico FMP under Actions 2 and 3. These reference points were brought into the Puerto Rico FMP in Action 1.

Alternative 1 would only be applicable if the managed stocks stayed the same following Action 2 and, for some stocks, if the complex organization stayed the same following Action 3. Under the 2010 and 2011 Caribbean ACL Amendments to the U.S. Caribbean-wide FMPs, the Council established SDC, management reference points, and ACLs for all stock aggregations except Puerto Rico snappers (e.g., for groupers, parrotfishes, angelfishes, etc.). For Puerto Rico snappers, the Council established SDC and reference points for all managed snappers as an aggregate, but established ACLs for the identified complexes (i.e., Snapper Units 1-4). If a species was removed from management, or a new species was added, then the SDC, reference points, and ACLs previously established and retained under **Alternative 1** would not be applicable. Additionally, under **Alternative 1**, SDC and management reference points would not be set for species new to management, in violation of the Magnuson-Stevens Act. Only a few stock complexes have the same organization under Puerto Rico FMP as under the Reef Fish FMP (see Appendix D). Although the Snapper Unit 1/Snapper 1 and Snapper Unit 2/Snapper 2 complexes are unchanged between the Reef Fish FMP and the Puerto Rico FMP (based on the Preferred Alternatives in Actions 2 and 3), certain snappers were removed from management (gray snapper and mahogany snapper) and others added (cubera snapper), making the aggregate MSY and SDC for snappers from the Reef Fish FMP inapplicable.

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)[18] 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

[18] Starting in 2017, the MRIP in Puerto Rico has been put on hold.

management approach to require that an AM be applied only in the event that both the sector and the total (combined commercial and recreational) ACL were exceeded (CFMC 2017).

Preferred Alternative 3 reflects a refined approach to developing reference points in the data-limited context. 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, the Council should rely on proxies for MSY and MFMT based on qualitative estimates of fishing mortality rates and biomass expected when achieving MSY, and proxies for MSY and OFL based on a newly-developed metric called the sustainable yield level (SYL). Application of **Alternative 1** establishes a numeric MSY proxy for previously managed species aggregations and equates OFL to that MSY proxy without first establishing an SYL. Such outcomes do not reflect current thinking on the ways to set reference points in the data limited context in the Puerto Rico EEZ. Additionally, under **Alternative 1**, MSY proxies and OFLs would not be set for species new to management, which is not consistent with the Magnuson-Stevens Act.

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 (Table 2.4.1). 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 H) 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 G) is a 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 under the methods available in the higher tiers, the SYL would be used as a proxy for OFL, and MSY would be greater than or equal to the SYL.

The SYL is based on an equilibrium (long-term) concept. In both Tier 4a and Tier 4b, it is set based on long-term landings (i.e., the 75th percentile of landings during the reference period in Tier 4a, and the mean of the landings during the reference period in Tier 4b). MSY is an equilibrium concept, but OFL 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, though based on long-term landings, accounts for the potential variability in annual landings. To calculate SYL, the control rule allows a scalar to be applied to the landings during the reference period, which accounts for variability around the long-term landings. Thus, SYL is similar to an OFL. In addition, in the absence of better information, it can be considered to be a minimum estimate of MSY. In fact, the SYL was developed 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 as an indicator of the sustainability of the fishery. While landings in excess of SYL would not establish that overfishing is occurring, they would indicate that harvest could be above a sustainable level. Therefore, when landings exceed the SYL, those landings would need to be investigated to determine whether overfishing is occurring and whether, as a result of continued SYL exceedance, the stock or stock complex would become overfished. Because an SYL exceedance would trigger the stock status review, SYL would also be considered an OFL proxy.

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 Tiers 1, 2, or 3.

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

Preferred Alternative 3 would define a *three-step process* to establish SDC and allowable harvest levels (i.e., ACLs) for managed stocks and stock complexes 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/stock complex. *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:

<u>Step 1</u> 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 via Tiers 1-3. Within Tier 4, a SYL would first be defined based on the product of the 75th percentile (Tier 4a) or mean (Tier 4b) of the landings during a reference period and an adjustment scalar (See Appendix G). 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 applied to Tier 4 can be found in Appendix G.

Preferred Alternative 3, Step 2:

In the ABC CR specified in Step 1 of **Preferred Alternative 3**, MSY is equal to the long-term 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 U.S. Caribbean-wide 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, if managing via sector (**Preferred Alternative 2**), each fishing sector (see Appendix G), 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 (or total ACL when setting ACL by sector).

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/stock complexes 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 reference 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/stock complexes. This contrasts with **Alternative 1**, which results in the direct transfer of SDC and/or reference points established in the 2010 and 2011 Caribbean ACL Amendments, as applicable. As mentioned above, **Alternative 1** would not establish reference points for stocks new to management, but **Alternative 4** would allow for the development of those reference points. It is important to note that, similar to the outcomes from **Preferred Alternative 3**, most of the SDC and reference points that would result from **Alternative 4** apply at the stock/stock complex level, not the sector level. The exception is the ACLs, for which sector level assignments are appropriate. The determination as to whether sector-level ACLs are applied depends upon the Council's choice in **Alternative 2**. The Council's **Preferred Alternative 2** would apply sector-level ACLs when sector-specific landings data are available. However, all SDC and reference points can be calculated using sector-level data when available, and therefore **Alternative 4** reflects the option to apply different sub-alternative choices at the sector level. If **Alternative 2** is selected with the **Alternative 3** or **Alternative 4**, when sector-specific information is available and used, for all but the ACLs, those sector-level SDC and reference points are simply summed to determine the stock/stock complex-level SDCs and reference points.

<u>Step 1</u> of **Alternative 4** would identify a year sequence of 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. A different year sequence could be chosen for each stock or stock complex and/or for each fishing sector, where separate sector landings are available. 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, 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. MRIP was suspended since late 2017 due to impacts from Hurricane María. 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/stock complex. 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 2010 and 2011 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 or stock complex. 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 or stock complex as described by any of the sub-alternatives described below. A different sub-alternative could be chosen for each stock or stock complex, and/or for each sector (where applicable). As discussed above, if sub-alternatives were selected at the sector level, that information would be combined to establish the MSY proxy, which is applied at the stock/stock complex level (i.e., MSY proxy for a stock/stock complex = contribution from the commercial sector + contribution from the recreational sector). Following the procedures described in the 2010 and 2011 Caribbean ACL Amendments, the OFL for the stock/stock complex 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/stock complexes in the 2011 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/stock complexes. 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.

<u>Step 3</u> 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 sector (where applicable). As discussed above, ABC is established for each stock or stock complex. Therefore, if sub-alternatives were selected at the sector level, the ABC is derived from the sector contributions (i.e., ABC for a stock/stock complex = contribution from the commercial sector + contribution from the recreational 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/stock complex. The SSC previously used this approach in the 2010 Caribbean ACL Amendment when recommending 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 **Preferred Alternative 3**. This sub-alternative was previously used by the SSC when recommending management reference points for most stocks/stock complexes (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 G.

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 (where applicable). If sub-alternatives were selected at the sector level for conducting the calculations, but **Preferred Alternative 2** was not selected, meaning the Council did not choose to manage with separate sector ACLs, the ACL would be applied at the stock/stock complex level (i.e., ACL for a stock/stock complex = contribution from the commercial sector + contribution from the recreational sector). If **Alternative 4** and **Preferred Alternative 2** were selected together, and if sector-specific data were available, then the ACL would be calculated and applied at the sector level, not the stock/stock complex level.

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 and Summary of Effects

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 (CFMC 2011a, b) and the Caribbean SFA Amendment (CFMC 2005), as applicable. 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. **Alternative 1** does not respond to availability of additional data or additional expert opinion on setting SDC and management reference points, 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**. This is not in compliance with the Magnuson-Stevens Act.

Preferred Alternative 2 applies only at the level of ACLs, because SDC, MSY, and ABC 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 ACLs applied as a result of choosing **Alternative 1** already would be allocated between the recreational and commercial sectors. The decision to establish sector-specific ACLs 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 resulting ACLs among fishing sectors. As with **Preferred Alternative 3**, the SDC and management references points established in **Alternative 4** would apply at the stock/stock complex level, unless **Preferred Alternative 2** was also selected and sector-specific data were available, at which point the ACLs would be established at the sector level.

Establishing sector-specific ACLs 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 reference 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 **Alternative 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 (**Sub-alternatives 4a-4d**) for choosing a year-sequence of landings, including optional outcomes that could be identical to the year-sequence outcome applied in **Preferred Alternative 3 (**for Tier 4), 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.

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 **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 environments both directly by managing fishing effort and associated gear impacts and indirectly by managing the ecological integrity of the coral reef ecosystem. 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. By being more conservative, **Sub-alternative 3b** of Step 2 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.

With the series of sub-alternatives included in **Preferred Alternative 3** Step 3, progressing from **Sub-alternative 3d** to **Sub-alternative 3i**, each sub-alternative progressively identified a more restrictive OY and ACL, with **Sub-alternative 3i** as the most restrictive (no catch). As the sub-alternatives progress to a larger buffer and lower ACL and OY, the biological effects would become increasingly positive in the short-term as catch limits would be increasingly lower (reduced fishing mortality). The long-term biological/ecological effects would also be likely positive if the OY and ACLs provide protection for the stocks and ensure the sustainability of stocks and stock complexes. In this case, 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 in the short term with a larger buffer. In the long term, a larger buffer, in providing protection for the stock, may allow the greatest continued use of the resources. In all cases, the OY would be set equal to the ACL. 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. The substantial differences between **Alternative 1** and **Alternative 4** include that the former is number-based, carrying over established measures as applicable, 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 whereas the former is constrained to only those stocks already under management in the Puerto Rico EEZ.

The effects to the physical, biological/ecological, social, and economic environments from **Alternative 4**, Step 1 (**Sub-alternatives 4a-4d**), Step 2 (**Sub-alternatives 4e-4g**), and Step 3 (**Sub-alternatives 4h-4l**) 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**. The extent of the positive effects would be limited through time as this control rule does not provide a mechanism to consider and apply the best scientific information available (e.g., data and methods for calculating MSY) and to update management as those data expand and improve. Instead, the Council would have to amend the FMP to specify an alternative control rule. Short-term administrative effects of **Alternative 4** (all sub-alternatives considered) would be negative but minor, due to the additional administrative effort to update regulations and public awareness documents. The range of reduction buffers to determine the ACL included in **Sub-alternatives 4m-4r** of **Alternative 4**, Step 4, is identical to the range of buffers included in **Preferred Alternative 3**, Step 3 (**Sub-alternatives 3d-3i**). The effects would be expected to be the same as for **Preferred Alternative 3** discussed above.

2.5 Action 5: Establish 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 + 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 two-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 two-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 two-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 pelagic stocks/stock complexes (dolphinfish, tuna, mackerel, tripletail, barracuda, and wahoo) only, apply a two-step process to establish an annual catch target (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 - <u>Step 1</u>. 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 - <u>Step 2</u>. 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 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 two-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 two-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 applicable landings, using landings from 2019; then a two-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.

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. The Magnuson-Stevens Act requires that AMs be established for all federally managed stocks. 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)).

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, 18 species would be new to federal management in the Puerto Rico FMP, as would be a number of sea cucumbers, sea urchins, and corals that were not managed in the Coral FMP. In addition, the 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 on a continuing basis.

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 be applied to the stocks/stock complexes in the Puerto Rico FMP. However, AMs would not be established for those stocks/stock complexes newly added to the Puerto Rico FMP, nor would a trigger for applying an AM be defined.

Under **Alternative 1**, an AM would be triggered for reef fish when the average of the most recent three years of landings[19] 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 and a sector ACL are both exceeded, rather than simply when the sector 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 both a sector ACL and 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

[19] 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.

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 determines the ACL exceedance (either the total or the sector) 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 to continuing efforts by the Council, Commonwealth 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. 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 1** (and **Alternative 5** as discussed below).

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.

Preferred Sub-alternative 2d differs from **Sub-alternatives 2a-2c** in that **Preferred Sub-alternative 2d** calls for a modified stepwise approach to determine if an AM would be triggered. Under **Preferred 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)[20] 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.

[20]As described in Preferred Sub-alternative 2d, the actual year(s) will be determined by the RA in consultation with the Council.

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 would 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 would 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 socio-economic 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 would 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 **Preferred Alternative 3**) sub-alternatives.

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[21]). 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 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 and indicator selection), newly added pelagic stocks to which this alternative would apply include dolphin, pompano dolphin (Dolphinfish stock complex), little tunny, blackfin tuna (Tuna stock complex), king mackerel, cero mackerel (Mackerel stock complex), tripletail, great barracuda, 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, dolphin 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.

Three sub-alternatives are provided in Step 1 of **Preferred Alternative 3** for setting the ACT relative to the applicable ACL. **Preferred Sub-alternative 3a** would set the ACT at 90% of the applicable ACL, **Sub-alternative 3b** would set the ACT at 80% of the applicable ACL, and

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

Sub-alternative 3c would set the ACT at 70% of the applicable ACL (Tables 2.5.1 [commercial] and 2.5.2 [recreational]). 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 for pelagic stocks and stock complexes for the commercial sector in the Puerto Rico FMP, based on **Preferred Alternative 3**, **Sub-alternatives 3a-3c**.

Stock/Stock Complex	Commercial ACL	Sub-alt 3a (Preferred) ACT = ACL * 0.90	Sub- alt 3b ACT = ACL * 0.80	Sub- alt 3c ACT = ACL * 0.70
Dolphin (Indicator)	232,173	208,956	185,738	162,521
Wahoo	25,911	23,320	20,729	18,138
Mackerel complex	232,422	209,180	185,938	162,696
Tunas complex	82,779	74,501	66,223	57,945
Great barracuda	495	445	396	346
Tripletail	270	243	216	189

Table 2.5.2. Annual catch targets for pelagic stocks and stock complexes for the recreational sector in the Puerto Rico FMP, based on **Preferred Alternative 3**, **Sub-alternatives 3a-3c**.

Stock/Stock Complex	Recreational ACL	Sub-alt 3a (Preferred) ACT = ACL * 0.90	Sub- alt 3b ACT = ACL * 0.80	Sub- alt 3c ACT = ACL * 0.70
Dolphin (Indicator)	1,513,873	1,362,485	1,211,098	1,059,711
Wahoo	210,737	189,664	168,590	147,516
Mackerel complex	129,180	116,262	103,344	90,426
Tunas complex	34,485	31,036	27,588	24,139
Great barracuda	167,693	150,924	134,154	117,385
Tripletail	39,005	35,104	31,204	27,303

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-3f** and **Preferred Sub-alternative 3g** of **Preferred Alternative 3** would use the same approach proposed in **Sub-alternatives 2a-2c** and **Preferred Sub-alternative 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-2c** and **Preferred Sub-alternative 2d**, and the reader is referred to that discussion as it would similarly apply to **Sub-alternatives 3d-3f** and **Preferred Sub-alternative 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 would 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 ACL of zero. This alternative would apply to 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 all managed corals. Under **Preferred Alternative 5** the harvest prohibition would serve as the required AM.

<u>Comparison of Action 5 Alternatives and Summary of Effects</u>

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 U.S. Caribbean-wide FMPs. However, **Alternative 1** would not be compliant with the requirements of the Magnuson-Stevens Act because it would not establish AMs for the stocks that are new to management. The U.S. Caribbean-wide FMPs do not contain AMs for stocks or stock complexes that are new to management (e.g., tuna, mackerel), and thus the AMs that are carried over would not address those entities. This would likely negatively affect the socio-economic and biological/ecological environments by potentially failing to achieve OY on a continuing basis or to minimize the risk of stock depletion due to a failure to properly manage harvest.

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. However, 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 when the AM is properly applied; in that instance, 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 socio-economic benefits resulting from a reliable and sustained resource base.

Preferred Alternative 2 would use a stepwise temporal approach to calculate average landings for comparison against the applicable ACL and the choice of years varies under each of **Sub-alternatives 2a-2c** and **Preferred Sub-alternative 2d**. A comparison of these sub-alternatives was included in the discussion of **Preferred Alternative 2** above. This approach to calculate landings for comparison against the ACL contrasts with **Alternative 1**, which would use the most recent three years of landings data as the determinant to trigger an AM. 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 greater benefits relative to **Alternative 1** 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.

Under **Preferred Alternative 3**, biological/ecological effects would likely be less beneficial relative to the other alternatives because the AM would not require future fishing season reductions or close harvest when triggered, risking potential depletion of the resource. Instead, it requires further action from the Council, as discussed above. In contrast, socio-economic 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 may 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 socio-economic environments. From the three sub-alternatives proposed under **Preferred Alternative 3** for setting the ACT relative to the applicable ACL (i.e., commercial and recreational), **Sub-alternative 3c** is the most conservative (smallest percentage of the ACL at 70%) and provides the greatest likelihood that the AM would be triggered followed by **Sub-alternative 3b** (80% of ACL) and lastly, **Preferred Sub-**

alternative 3a, which is the least conservative (90% of ACL). The choice of years to compare against the applicable ACT and trigger an AM (if needed) proposed in **Sub-alternatives 3d-3f** and **Preferred Sub-alternative 3g** could influence the frequency with which an AM is triggered, but the specific effects associated with each of those sub-alternatives depend on the pelagic stock and the variability in landings associated with that stock. Without that information, it is difficult to assess the relative effects of each sub-alternative.

Preferred Alternative 5 equates the AM with a complete prohibition on harvest, as would result for several stocks based on 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 ACL 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. For those stocks to which **Preferred Alternative 5** would apply, socio-economic effects would could arise over the long-term, as the harvest prohibition is designed to allow for the recovery of overfished stocks or those with ecological importance.

In summary, **Alternative 4** of Action 5 (in-season AM) 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 fisheries. **Preferred Alternative 5** also prevents rather than responds to an ACL overage, relying on a harvest prohibition. Given the absence of in-season landings data, which renders Alternative 4 infeasible, **Preferred Alternative 2** would provide the greatest overall benefit for those stocks for which harvest is allowed to ensure a balanced approach to biological/ecological and socio-economic outcomes. Lastly, **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.

2.6 Action 6: Describe and Identify EFH for Species Not Previously Managed in the Puerto Rico EEZ

Through Action 6, the Council would describe and identify EFH for species that would be new to federal management in the Puerto Rico FMP following Action 2.

All species previously managed under the U.S. Caribbean-wide FMPs have EFH designations (CFMC 2005), and this action does not address species for which EFH was previously identified, with the exception of previously managed sea urchins, sea cucumbers, and corals (see discussion below). For the remainder of the previously managed species that were retained in the Puerto Rico FMP under Action 2 (spiny lobster, queen conch, and 45 reef fish), EFH was described and identified as follows. For previously managed reef fish, EFH consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae) and all substrates from mean high water to 100 fathoms depth (habitats used by other life stages). Identified substrates included wetlands, mangroves, seagrass, benthic algal plains, mixed submerged aquatic vegetation, drift algae, coral reefs, sand-shell, mud and soft bottom habitats, hard bottom habitat and rubble. For spiny lobster, all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by phyllosome larvae) and seagrass, benthic algae, mangrove, coral, and live/hard bottom substrates from mean high water to 100 fathoms depth (habitats used by other life stages). For queen conch, all waters from mean high water to the outer boundary of the EEZ (habitats used by eggs and larvae) and seagrass, benthic algae, coral, live/hard bottom and sand/shell substrates from mean high water to 100 fathoms depth (habitats used by other life stages). Existing designations are being evaluated during the ongoing EFH Five-Year Review and the Council's ongoing data analysis efforts.

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 scientific information available from the literature, landings data, fishery-independent surveys, and expert opinion (See Appendix I).

Alternative 3. Use the highest level of detailed information below 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, FMPs must "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 above identify different approaches that the Council could use to describe and identify EFH for species new to federal management. The Council previously evaluated the approaches within these alternatives when describing and identifying EFH for all species managed under the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs (CFMC 2004).

As identified in Action 2 (Preferred Alternative 2), species to be managed under the Puerto Rico FMP would include queen conch, spiny lobster, 63 finfish species, and all species of sea cucumbers, sea urchins, and coral. From these, 18 species of finfish would be new to federal management: cubera snapper, yellowmouth grouper, gray triggerfish, crevalle jack, African pompano, rainbow runner, giant manta ray, spotted eagle ray, southern stingray, little tunny, blackfin tuna, king mackerel, cero mackerel, wahoo, tripletail, great barracuda, dolphin, and pompano dolphin. The Puerto Rico FMP would also include a number of new sea cucumbers, sea urchins, and corals that were not previously included under the Coral FMP. The sea urchin and sea cucumber species previously managed as Aquarium Trade species under the Coral FMP would be combined with the newly added species that occur in the Puerto Rico EEZ and managed in the Sea urchins and Sea cucumbers stock complexes under the Puerto Rico FMP. Similarly, the corals previously managed under the Coral FMP would be combined with newly added species that occur in the Puerto Rico EEZ and managed under the coral stock complex. To ensure effective management of all species of sea urchins, sea cucumbers, and corals that occur in the Puerto Rico EEZ, all species of sea urchins, sea cucumbers, and corals are being managed in stock complexes, each of which contains species new to management. It is not possible to describe and identify EFH individually for the managed species of corals, sea urchins, and sea cucumbers. Therefore, the resulting EFH descriptions in **Alternative 2** below for sea urchins, sea cucumbers, and corals apply to each of the managed species in the managed complexes, whether newly included in the FMP or previously managed. The habitat and life history information for all new species is included in Appendix I.

Alternative 1 (no action), would not comply with the requirements of the Magnuson-Stevens Act, as it would not identify EFH for the new species proposed for federal management in the Puerto Rico FMP. Six of the new finfish species (cubera snapper, yellowmouth grouper, gray triggerfish, crevalle jack, African pompano, rainbow runner) co-occur with the reef fish species managed under the Reef Fish FMP, but the EFH identified for the previously managed, co-occurring species would not be applied to the new species.

Other finfish species proposed for management and for which EFH designations would not be determined under **Alternative 1** (great barracuda, dolphin, pompano dolphin, tripletail, little tunny, blackfin tuna [bonito in Spanish], king mackerel, cero mackerel, and wahoo) were identified as coastal migratory pelagic fish. Although their habitat also overlaps that of the previously managed reef fish (as well as the newly proposed reef fish species), the EFH designated for the previously managed reef fish would not be automatically applicable to the pelagic species; the Council would need to identify EFH for these new species.

Alternative 1 would not identify EFH for the three new species of rays (spotted eagle ray, giant manta ray, and southern stingray) proposed for federal management. Additionally, **Alternative 1** would not identify EFH for any of the new species of sea cucumbers, sea urchins, or corals that were included for management in Action 2. Some of those new invertebrate species occur in substrates found at greater depths than those previously identified as EFH in the Coral FMP.. Previously identified EFH includes coral and hard bottom substrates from mean low water to 100 fathoms depth (CFMC 2005) and these newly managed invertebrate species have been found in substrates at depths greater than 100 fathoms. Thus, the Council may need to identify substrates at greater depths (e.g., substrates out to the outer boundary of the EEZ) as EFH for these invertebrate species that are new to management.

Preferred Alternative 2 would describe and identify EFH for species new to management according to functional relationships between life history stages and Puerto Rico marine and estuarine habitats based on best scientific information available from the literature, landings data, fishery-independent surveys and expert opinion. This alternative follows the same approach as the preferred alternative in the Caribbean SFA Amendment (CFMC 2005).

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). The most significant impediments to describing and identifying EFH and mapping the extent of EFH in the U.S. Caribbean have been the lack of information on species distributions and the paucity of habitat mapping information deeper than about 82 ft (25 m), the limited information available from mesophotic reefs (98-164 ft [30-50 m]), and the limited data on pelagic species in the region. In instances where information is limited, **Preferred Alternative 2** uses information on ecological relationships to infer the distribution for the species. Little information exists on relationships between habitat, abundance, and distribution for many of the life stages of managed species in the U.S. Caribbean, and therefore EFH would be identified as all areas where the species are distributed. For practical purposes, and in accordance with the precautionary approach, describing and identifying EFH under this **Preferred Alternative 2** would be applied as broadly as possible. For each species, the habitats used by species and life stage are presented in Appendix I and summarized in Tables 2.6.1 and 2.6.2.

Table 2.6.1. Summary of species new to management under the Puerto Rico FMP and information on their habitats per life stage. Complete information per species included in Appendix I. Values denoted with dash (-) indicate information that was not available.

Species Name	Common Name	Eggs	Larvae	Post larvae	Juveniles	Adults	Spawning Adults
Lutjanus cyanopterus	Cubera snapper	Pelagic	Pelagic	-	Mangrove, reef	Rocky bottom, reef, El Seco	Coral reefs
Mycteroperca interstitialis	Yellowmouth grouper	Pelagic	Pelagic	Pelagic	Mangrove, reef	Rocky, coral; Mona Island;	Reef, rocky, coral;
Balistes capriscus	Gray triggerfish	Demersal/ Nests	Pelagic	-	Sargassum, reefs, pelagic, flotsam	Reefs, marine and brackish	Nest building/reefs
Sphyraena barracuda	Great barracuda	Pelagic	Pelagic	Pelagic	Mangrove/pelagic	Mangrove/Pelagic	Pelagic
Lobotes surinamensis	Tripletail	Pelagic	Pelagic	Pelagic	Pelagic	Pelagic	Pelagic
Manta birostris	Giant manta ray	Ovoviparity	-	-	Pelagic	Pelagic	Internal fertilization/pelagic
Aetobatus narinari	Spotted eagle ray	Ovoviparity	-	-	Pelagic/epibenthic feeding	Pelagic/epibenthic feeding	Internal fertilization/pelagic
Hypanus americanus	Southern stingray	Ovoviparity	-	-	Sand/silt/ epibenthic feeding	Sand/silt bottoms/epibenthic feeding/euryhaline/ esturine	Sand/silt bottoms; pairs
Caranx hippos	Crevalle jack	Pelagic	Pelagic	-	Pelagic, reef, muddy bottom, seagrass, brackish	Pelagic, reef, seagrass, brackish	-
Alectis ciliaris	African Pompano	Pelagic	Pelagic	-	Pelagic, reef	Pelagic, reef	-
Elagatis bipinnulata	Rainbow runner	Pelagic	Pelagic, floatsam	-	Pelagic, reef, flotsam	Pelagic, reef, flotsam	-

Species Name	Common Name	Eggs	Larvae	Post larvae	Juveniles	Adults	Spawning Adults
Coryphaena hippurus	Dolphin	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	Pelagic	Pelagic	Pelagic	Pelagic/migratory	Pelagic	Pelagic
Euthynnus alletteratus	Little tunny	Pelagic	Pelagic/ oceanic	Pelagic	Pelagic/prey aggregations	Pelagic/prey aggregations	Pelagic
Thunnus atlanticus	Blackfin tuna	Pelagic	Pelagic/ oceanic	Pelagic	Pelagic/prey aggregations	Pelagic/prey aggregations	Pelagic
Scomberomorus cavalla	King 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	Pelagic	Pelagic/ oceanic	Pelagic	Pelagic	Pelagic	Pelagic
-	Sea cucumbers	Pelagic/ Internal	Pelagic/ brooding/ live young	-	Sand, seagrass, pelagic	Sand, seagrass, pelagic	Sand, seagrass, pelagic
-	Sea urchins	Pelagic/ brooding	Pelagic/ brooding	-	Sand, seagrass	Sand, seagrass	Sand, seagrass, coral
-	Corals	Pelagic	Pelagic	Hard substrate	Coral, hard substrate	Sand, coral, hard substrate	Sand, coral, hard substrate

Table 2.6.2. Summary of functional relationship (feeding [F], growth [G], spawning [S], breeding [B]) by habitat type utilized by life history stages (egg [E], larvae [L], juvenile [J], adult [A]) for each new species proposed for federal management in the Puerto Rico FMP. Complete information per species included in Appendix I. Values denoted with dash (-) indicate information that was not available.

Species Name	Common Name	Mangrove	Seagrass	Coral Reef	Hard Bottom	Sand	Mud	Algal Plains	Water Column	Sargassum
Lutjanus cyanopterus	Cubera snapper	J F/G	-	J/A F/G	A F/G	-	-	-	E/L F/G	-
Mycteroperca interstitialis	Yellowmouth grouper	J F/G	-	J/A S	J/A F/G	-	-	-	E/L F/G	-
Balistes capriscus	Gray triggerfish	-	-	E/J/A F/G/S	-	-	-	-	L F/G	L/J/A F/G
Sphyraena barracuda	Great barracuda	J F/G	J F/G	A F/G	A F/G	-	-	-	E/L/J/A F/G/S	E/L F/G
Lobotes surinamensis	Tripletail	-	-	-	-	-	-	-	E/L/J/A F/G/S	E/L F/G
Manta birostris	Giant manta ray	-	-	-	-	-	-	-	J/A F/G/B	-
Aetobatus narinari	Spotted eagle ray	-	-	J/A F/G	J/A F/G	J/A F/G	-	-	J/A F/G/B	-
Hypanus americanus	Southern stingray	J/A F/G	J/A F/G	J/A F/G	-	J/A F/G	-	-	J/A F/G/B	-
Caranx hippos	Crevalle jack	-	J/A F/G	J/A F/G	J/A F/G		J F/G	-	E/L/J/A F/G/S	-
Alectis ciliaris	African Pompano	-	-	J/A F/G	J/A F/G	-	-	-	E/L/J/A F/G/S	-
Elagatis bipinnulata	Rainbow runner	-	-	J/A F/G	J/A F/G	-	-	-	E/L/J/A F/G/S	-

Species Name	Common Name	Mangrove	Seagrass	Coral Reef	Hard Bottom	Sand	Mud	Algal Plains	Water Column	Sargassum
Coryphaena hippurus	Dolphin	-	-	J/A F/G	J/A F/G	-	-	-	E/L/J/A F/G/S	L/J/A F/G
Coryphaena equiselis	Pompano dolphin	-	-	J/A F/G	J/A F/G	-	-	-	E/L/J/A F/G/S	L/J/A F/G
Euthynnus alletteratus	Little tunny	-	-	-	-	-	-	-	E/L/J/A F/G/S	E/L F/G
Thunnus atlanticus	Blackfin tuna	-	-	-	-	-	-	-	E/L/J/A F/G/S	E/L F/G
Scomberomorus cavalla	King mackerel	-	-	-	-	-	-	-	E/L/J/A F/G/S	E/L F/G
Scomberomorus regalis	Cero mackerel	-	-	-	-	-	-	-	E/L/J/A F/G/S	E/L F/G
Acanthocybium solandri	Wahoo	-	-	J/A F/G	J/A F/G	-	-	-	E/L/J/A F/G/S	L/J/A F/G
-	Sea 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 F/G	-
-	Sea 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 F/G	-
-	Corals	-	-	J/A F/G/S	J/A F/G/S	-	-	-	E/L F/G	-

Under **Preferred Alternative 2**, based on the functional relationships between life history stages of the species new to management and Puerto Rico marine and estuarine habitats (see Appendix I), EFH would be identified as follows (See Tables 2.6.1. and 2.6.2):

EFH for cubera snapper (*Lutjanus cyanopterus*) (Snapper 6 stock) in the Puerto Rico FMP consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae) and mangroves, coral reefs, and rocky hard bottom substrates from mean high water to 100 fathoms (habitats used by juveniles [mangroves, and coral reefs] and adults [coral reefs, and hardbottom]).

EFH for yellowmouth grouper (*Mycteroperca interstitialis*) (Grouper 4 stock complex) in the Puerto Rico FMP consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae) and mangroves, coral reefs, and rocky hard bottom substrates from mean high water to 100 fathoms (habitats used by juveniles [all] and adults [coral reef, and rocky hardbottom]).

EFH for the gray triggerfish (*Balistes capriscus)* (Triggerfish stock complex) in the Puerto Rico FMP consists of all waters and sargassum from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by the larvae) and coral reefs and sargassum substrates from mean high water to 100 fathoms (habitats used by eggs (only the coral reef substrate where the nest are built) and juveniles and adults).

EFH for the African pompano (*Alectis cilaris*) (Jacks 2 stock) and rainbow runner (*Elegastis bipinnulata*) (Jacks 3 stock) in the Puerto Rico FMP consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae) and all waters and coral reefs and hard bottom substrates from mean high water to 100 fathoms (habitats used by juveniles and adults).

EFH for the crevalle jack (*Caranx hippos*) in the Puerto Rico FMP consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae) and all waters and coral reefs, hard bottom, mud, and seagrass substrates from mean high water to 100 fathoms (habitats used by juveniles and adults; only juveniles use the mud).

EFH for little tunny (*Euthynnus alleteratus*) and blackfin tuna (*Thunnus atlanticus*) (Tuna stock complex); king mackerel (*Scomberomus cavalla*) and cero mackerel (*Scomberomus regalis*) (Mackerel stock complex) in the Puerto Rico FMP consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs, larvae, juveniles, and adults) and sargassum substrate from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae). All life stages of these species are pelagic.

EFH for wahoo (*Acanthocybium solandri*) (Wahoo stock) in the Puerto Rico FMP consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs, larvae, juveniles, and adults) and sargassum, coral reef, and hard bottom substrates from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by juveniles, adults, and larvae [for larvae, sargassum substrates only]).

EFH for dolphin (*Coryphaena hippurus*) and pompano dolphin (*Coryphaena equiselis*) (Dolphinfish stock complex) in the Puerto Rico FMP consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs, larvae, juveniles, and adults) and coral reefs, hard bottom, and sargassum substrates from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by juveniles, adults, and larvae [for larvae, sargassum substrates only]).

EFH for great barracuda (*Sphyraena barracuda*) (Barracuda stock) in the Puerto Rico FMP consists of all waters and sargassum substrates from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae), and all waters and mangroves, seagrass, coral reefs, and hard bottom substrates from mean high water to 100 fathoms (habitats used by juveniles [water column, mangrove, seagrass] and adults [water column, coral, hard bottom]).

EFH for tripletail (*Lobotes surinamensis*) (Tripletail stock) in the Puerto Rico FMP consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs, larvae, juveniles, and adults) and sargassum substrates from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae).

EFH for the giant manta ray (*Manta birostris*) (Rays 1 stock) in the Puerto Rico FMP consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by juveniles and adults).

EFH for the spotted eagle ray (*Aetobatus narinari*) (Rays 2 stock) in the Puerto Rico FMP consists of all waters and coral reefs, hard bottom, and sand substrates from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by juveniles and adults).

EFH for the southern stingray (*Hypanus americanus*) (Rays 3 stock) in the Puerto Rico FMP consists of all waters and mangroves, seagrass, coral reefs, and sand substrates from mean high water to 100 fathoms (habitats used by juveniles and adults).

EFH for sea urchins (Sea urchins stock complex) in the Puerto Rico FMP consists of all waters from mean low water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae) and mangrove, seagrass, coral reef, hard bottom, sand, mud, and algal plain substrates from mean low water to the outer boundary of the U.S. Caribbean EEZ (habitats used by juveniles and adults).

EFH for sea cucumbers (Sea cucumbers stock complex) in the Puerto Rico FMP consists of all waters from mean low water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae) and mangrove, seagrass, coral reef, hard bottom, sand, and algal plain substrates from mean low water to the outer boundary of the U.S. Caribbean EEZ (habitats used by juveniles and adults).

EFH for corals (Coral stock complex) in the Puerto Rico FMP consists of all waters from mean low water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae) and coral reef and hard bottom substrates from mean low water to the outer boundary of the U.S. Caribbean EEZ (habitats used by juveniles and adults).

NMFS EFH guidelines require maps depicting the geographic location or extent of habitats described as EFH. Maps for those EFH were included in the Final Environmental Impact Statement (FEIS) for the Generic EFH Amendment (Figures 2.38 – 2.42 in CFMC 2004). Since limited habitat distribution information beyond 82 ft (25 m) depth existed then, the potential habitat occurrence was considered to extend from the shallowest depth to the maximum depth on the shelf that a habitat could occur, which was determined to be 100 fathoms depth. Mapping out to that depth limit was considered likely to include the habitats used by federally managed species, and thus was a proxy for the fishable habitat where a species could be found. Information on where the species could be found was then used to determine whether those areas qualified as essential fish habitat.

This estimate of fishable habitat, and the presumed maximum depth habitat could occur, is being re-evaluated as the fisheries have been expanding into deeper waters and as research and exploration continue in the deep-waters around the USVI and Puerto Rico. However, the majority of the exploration being conducted in the U.S. Caribbean is well beyond the 100-fathom depth, leaving an information gap between the 100-fathom limit and those deeper waters. Species and habitat information from within that depth gap would be needed to re-evaluate the definition of fishable habitat from the 100-fathom depth. Although data are not available to re-define fishable habitat at this time,, research into deeper-waters could help identify the maximum depth where the species occurs that could be used to inform inferences about their habitat usage. For example, recent exploration of the deep-sea around the USVI and Puerto Rico have shown presence of sea cucumbers, sea urchins and corals to depths of over 9,843 ft (3,000 m) in areas not currently fished. This information was considered and used to identify EFH for those invertebrate groups under **Preferred Alternative 2**. However, because neither habitat- nor species-specific spatial distributions were updated during those explorations, the full extent of the species' habitat in waters deeper than 100 fathoms is not fully known. Using the precautionary approach, and identifying as EFH all waters and substrates in which the species has been found, **Preferred Alternative 2** identified substrates in deeper waters as EFH for sea cucumbers, sea urchins, and corals. Under **Preferred Alternative 2**, substrates from mean low water to the outer boundary of the EEZ, not just substrates from mean low water to 100 fathoms depth (the EFH for the previously managed species of sea cucumbers, sea urchins, and corals under the Coral FMP), was identified as EFH. Likewise, for dolphin, pompano dolphin, wahoo, and spotted eagle ray, wide-ranging pelagic species, EFH identified under **Preferred Alternative 2** would include substrates, including coral reefs and hard bottom, from mean high water to the outer boundary of the U.S. Caribbean EEZ. The EFH maps included in the FEIS for the Generic EFH Amendment (Figures 2.38 – 2.42 in CFMC 2004) show the geographic boundaries of the EFH. For example, previously identified EFH for reef fish species included all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ, thus the maps showed the mean high water line and the outer boundary of the U.S. Caribbean EEZ. Previously identified EFH for the coral, sea urchin, and sea cucumbers included all waters from mean low water to the outer boundary of the U.S. Caribbean EEZ, and thus the maps additionally showed the mean low water line. Substrates were identified as EFH from mean high water to 100 fathoms (reef fish) and from mean low water to 100 fathoms (corals, sea urchins, and sea cucumbers), and thus the maps also showed the 100 fathom line. The mean high water line and the outer boundary of the U.S. Caribbean EEZ define the boundaries of EFH identified for dolphin, wahoo, and the mean low water line and the outer boundary of the U.S. Caribbean EEZ define the boundaries of EFH identified for sea urchins, sea cucumbers, and corals. Thus, the maps included in the FEIS for the Generic EFH Amendment still encompass and depict the geographic boundaries where EFH would be identified for species new to management under **Preferred Alternative 2**.

Alternative 3 would allow the Council to choose between approaches to describe EFH (see Section 2.6.1). These approaches, and how the sources of information within each, would be used to describe and identify EFH were discussed in the FEIS for the Generic EFH Amendment (CFMC 2004), and that discussion is incorporated here by reference. Under **Alternative 3** the Council would determine which approach uses the most complete information available that could be used to determine EFH for each species and life stage. However, at this time, the Council lacks the information to describe and identify EFH using any of the approaches described in **Alternative 3,** thus this alternative would not result in EFH for the species new to management.

The Council is engaged in endorsing projects to further data collection and analysis that could be used in one of the approaches under **Alternative 3**, which would result in more-refined EFH designations. 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 ongoing Five-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 database of the reported commercial landings to determine the feasibility to use spatial data in the description and identification of EFH. All these efforts could provide the information required under one or more of the approaches under **Alternative 3** that would result in changes to EFH designations for species managed under the Puerto Rico FMP.

<u>Comparison of Action 6 Alternatives and Summary of Effects</u>

Describing and identifying EFH would not have direct effects to the physical, biological/ecological, economic, or social environments. Indirect effects to those environments could occur if the EFH designation leads to future regulatory actions or future EFH consultations. The extent of these effects depends on whether the EFH identified for the species new to management was the same as, or different from, the previously identified EFH. Minor direct effects to the administrative environment would result from identifying EFH for species newly added to management. In addition, indirect effects to the administrative environment could occur due to consultation requirements, again to the extent that new EFH areas are designated. Indirect effects on the social environment could result if there are differences in desired methodologies for designating EFH.

Alternative 1 is less beneficial when compared to **Preferred Alternative 2** and **Alternative 3** in that it would not address the legal mandate to describe and identify EFH for the species new to management. **Preferred Alternative 2** incorporates available information (i.e., functional life history and habitat relationships) to identify EFH for all species new to management. The EFH identified for species new to management under **Preferred Alternative 2** includes the EFH described in the U.S. Caribbean-wide FMPs, plus additional substrate areas, namely substrates found at depths greater than 100 fathoms. Newly identified EFH includes substrates in all waters out to the outer boundary of the U.S. Caribbean EEZ (for example, for the sea urchins, sea cucumbers, and corals). Although **Alternative 3** includes approaches that would provide the most refined description of EFH for all species under management, these data are not currently available, thus **Alternative 3** would not result in EFH identified for the species new to management. In the future, the approaches under **Alternative 3** would likely have positive benefits as a more refined description of EFH could allow the Council to take more protective actions or could allow for more robust EFH consultations and potentially more tailored mitigation.

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

Through Action 7, the Council would establish the framework procedure to be included 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 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.

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. **Preferred Alternative 2** proposes a framework procedure that includes both closed and open framework procedures 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.

2.7.1 Proposed Alternatives for Action 7

Alternative 1. No action. In the Puerto Rico FMP, retain the framework procedures presently included under the Reef Fish, Spiny Lobster, Queen Conch, and Coral 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 procedures included under Action 7, Alternative 1.

Framework Procedures Available Under Alternative 1
Framework Measures in the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs: a. Quota Requirements b. Seasonal Closures c. Area Closures d. Fishing Year e. Trip/Bag Limit f. Size Limits g. Gear Restrictions or Prohibitions h. Fishery Management Unit (FMU)

Framework Procedures Available Under Alternative 1
i. Total Allowable Catch (TAC) j. Annual Catch Limits (ACLs) k. Accountability Measures (AMs) l. Annual Catch Targets (ACTs) m. Maximum Sustainable Yield (MSY) n. Optimum Yield (OY) o. Minimum Stock Size Threshold (MSST) p. Maximum Fishing Mortality Threshold (MFMT) q. Overfishing Limit (OFL) r. Acceptable Biological Catch (ABC) control rules s. Actions to Minimize the Interaction of Fishing Gear with Endangered Species or Marine Mammals
Establish an assessment group and adjustments: 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. 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. 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 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;

Framework Procedures Available Under Alternative 1
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.

Table 2.7.2. Base framework procedures included under Action 7, Preferred Alternative 2.

Framework Procedures Available Under Preferred Alternative 2
OPEN FRAMEWORK
1. Situations under which this open framework procedure can be used: 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. • 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. • 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:** A. Standard Framework • Changes that do not qualify as routine or insignificant. • Requires a completed framework document with supporting analyses. B. Abbreviated Framework • Can be used for routine or insignificant changes • Request is made with letter or memo from the Council to the RA with supporting analyses (biological, social, economic). • If RA concurs and approves action, it will be implemented through publication of FR Notice.

Framework Procedures Available Under Preferred Alternative 2

3. Actions available under the different open frameworks:

A. Abbreviated Framework

i. Gear marking requirements
ii. Vessel marking requirements
iii. Restrictions related to maintaining fish in a specific condition (whole condition, filleting, use as bait, etc.)
iv. Recreational bag and possession limit changes of not more than 1 fish per boat
v. Size limit changes of not more than 1-inch of the prior size limit for reef fish.
vi. Commercial vessel trip limit changes of not more than 10% of the prior trip limit
vii. Changes to the length of an established closed season by no more than 1 day of the existing season.
viii. Minor changes to gear modifications to address conservation issues including to respond to interactions with listed species.

B. Standard Framework

In addition to making changes specified under Abbreviated Framework (above) that exceed the established thresholds, the following actions can be completed via a standard framework:

i. Re-specify ABC
ii. Re-specify MSY and OY, and SDC
iii. Re-specify SYL
iv. Re-specify ACLs
v. Re-specify ACTs
vi. Rebuilding plans and revisions to approved rebuilding plans
vii. Revise accountability measures (e.g., change AM triggers and AM timing)
viii. Modify reporting and monitoring requirements
ix. Modify seasonal or year-round closures and closure procedures
x. Modify area closures and closure procedures

4. Open Framework Steps:

- 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.
- 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.
- 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.
- 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:

- Reopen any sector of the fishery that had been prematurely closed.
- 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 procedures included under **Alternative 3** in Action 7.

Framework Procedures Available Under Alternative 3
OPEN FRAMEWORK
1. Situations Under Which This Open Framework Procedure Can Be Used A. The Council may utilize open framework procedures to implement management changes in response to any additional information or changed circumstances. • 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. B. Open framework actions may be implemented at any time based on information supporting the need for adjustment of management measures or management parameters. **2. Actions Available Under the Open Framework:** i. Re-specify ABC ii. Re-specify MSY and OY, and SDC iii. Re-specify SYL iv. Re-specify ACLs v. Re-specify ACTs vi. Rebuilding plans and revisions to approved rebuilding plans vii. Revise accountability measures (e.g., change AM triggers and AM timing) viii. Modify reporting and monitoring requirements ix. Modify seasonal or year-round closures and closure procedures x. Modify area closures and closure procedures xi. Modify recreational bag and possession limits xii. Modify commercial trip limits xiii. Modify size limits xiv. Modify gear restrictions and marking requirements (ranging from altering current regulations to a complete prohibition, including to respond to interactions with listed species) xv. Other adjustment to management measures within the scope and criteria established by the FMP and implementing regulations deemed appropriate by the Council **3. Open Framework Steps:** • 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. • 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. • 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: • Reopen any sector of the fishery that had been prematurely closed. • 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. • Take any other immediate action specified in the FMP and implementing regulations.

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

Framework Procedures Available Under Alternative 4
OPEN FRAMEWORK
1. Situations Under Which This Open Framework Procedure Can Be Used 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 below should be changed.
2. Actions Available Under the Open Framework: i. Re-specify ABC ii. Re-specify MSY and OY, and SDC iii. Re-specify SYL iv. Re-specify ACLs v. Re-specify ACTs vi. Modify recreational bag and possession limits vii. Modify size limits viii. Modify seasonal or year-round closures and closure procedures ix. Modify reporting and monitoring requirements x. Modify reporting and monitoring requirements
3. Open Framework Steps: • 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: • Reopen any sector of the fishery that had been prematurely closed. • 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 7 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 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

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 or 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 management measures, 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 an ACL, adjustment of trip limits or hours of fishing, based on actual effort, or adjustment of ACLs, based on computational errors or late reporting.

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 procedures for implementing management measures in the Puerto Rico FMP, as established in Action 1 of this document. 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 SFA 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 2.7.1 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 being structured 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 2.7.2, 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 2.7.2, and include, among others, making changes specified under the abbreviated framework that exceed the established thresholds; 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, which is similar to **Alternative 1,** although only for convening the SSC because the appointment of an AP is a requirement under **Alternative 1**.

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 1**, **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.

Actions that can be taken under a standard open framework in **Alternative 3** are similar to those proposed in **Preferred 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 (similar to **Alternative 1**) 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. Both alternatives differ from **Alternative 1** as **Alternative 1** requires convening an AP.

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 the Council to take any other immediate action specified in the regulations and **Preferred Alternative 2** does not provide for that. Although the procedure under **Alternative 1** is not explicitly identified as a "closed framework", actions related to the closure of a fishery (i.e. revert any bag limit to zero and close any commercial fishery) once an established quota has been met are comparable to those in both **Alternative 2** (**Preferred**) and **3**, however **Alternative 1** does not allow any other changes through the "closed" process.

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 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 2.7.4 should be changed. The narrow list of measures that can be adjusted with limited conditions for use makes **Alternative 4** less efficient 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 1**, **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)** and at least one action in **Alternative 4** is comparable to the "closed" framework action in **Alternative 1,** but differs from **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.

Description	Preferred Alternative 2 (base)	Alternative 3 (broad)	Alternative 4 (narrow)
When Open Framework Can 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 • New information or circumstances • When changes are required to comply with applicable law or court order. * Abbreviated Open Framework can be used for minor or insignificant changes and 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. • New information or circumstances indicates management measures listed should be changed.

Description	Preferred Alternative 2 (base)	Alternative 3 (broad)	Alternative 4 (narrow)
Actions That Can Be Taken	• Abbreviated Open Framework can be used for actions that are considered minor and insignificant • Standard Open Framework. List of actions that can be taken under Abbreviated and Standard Open Framework are given. • Closed Framework can be used for a specific list of actions.	• Open Framework can be used for a representative list of actions, plus other measures deemed appropriate by the Council. • Closed Framework can be used for a specific list of actions, plus any other immediate actions specified in the FMP and implementing regulations.	• Open Framework can only be used for specific listed actions. • Closed Framework 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.
AP/SSC Participation	• The Council may convene its SSC or an AP(s), as appropriate	• Council may convene its SSC or an AP(s) at its discretion	• The Council shall convene its SSC and an AP(s).

Comparison of Action 7 Alternatives and Summary of Effects

A comparison of the alternatives can be found in the discussion above and is summarized as follows. 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. **Alternative 3** provides a broader suite of options that can be implemented under the framework procedure than either **Alternative 1** or **Preferred Alternative 2**. Lastly, **Alternative 4** provides a narrower set of options that can be implemented under framework than under **Alternative 1**, **Preferred Alternative 2** or **Alternative 3**.

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.

Positive 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 protected species such as listed habitat-forming corals (e.g., *Orbicella annularis*, *Orbicella franski*) found in **Alternatives 1**, **2 (Preferred)**, and **3**, with **Preferred Alternative 2** being the more beneficial for ESA-listed species than the other two alternatives because changes can be made faster through an abbreviated framework. Positive effects could also be expected from those actions that close/open areas to fishing, 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. Given that **Alternative 3** provides a broader suite of options that can be implemented under the framework procedure than either **Alternative 1** or **Preferred Alternative 2**, indirect economic benefits from **Alternative 3** would be expected 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 from **Alternative 4** are likely to be less than those from either **Preferred Alternative 2** or **Alternative 3**.

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 (e.g., due to option of both abbreviated and standard frameworks) 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.

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 in the 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 only applies 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).

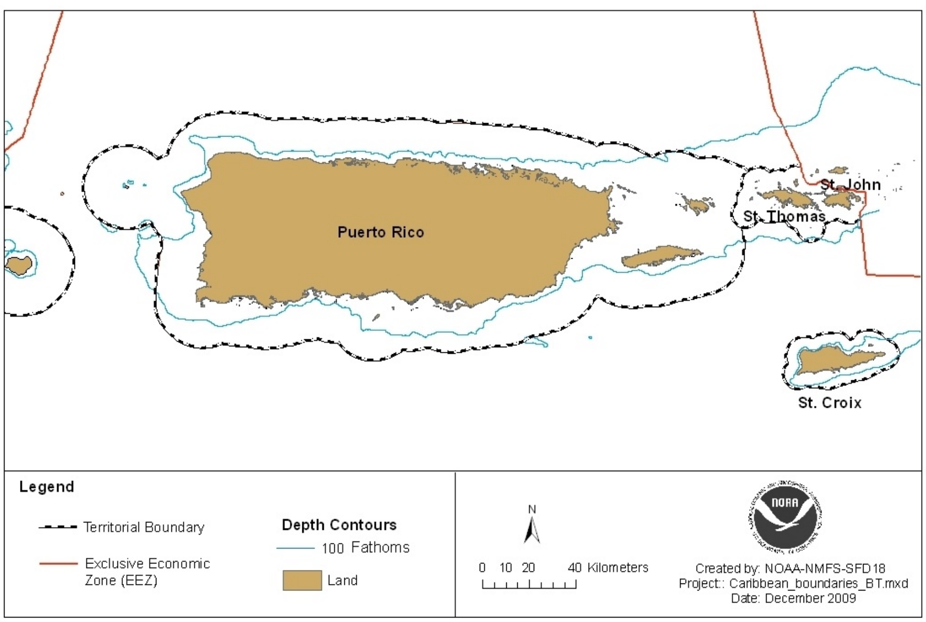


Figure 3.1.1. Location of Puerto Rico and the U.S. Virgin Islands. (Source: CFMC 2011a, b).

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 USVI in the Lesser Antilles island chains (Figure 3.1.1), both of which separate the Caribbean Sea from the western central Atlantic Ocean. The U.S. Caribbean 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.

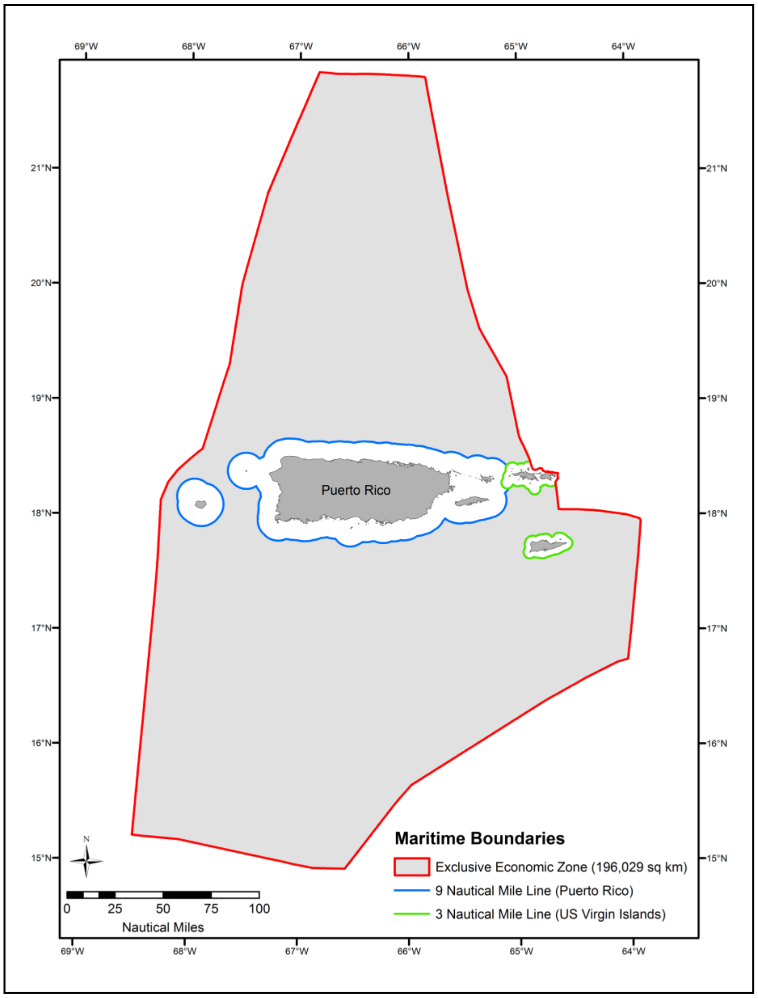


Figure 3.2.1. Boundaries of the U.S. Caribbean EEZ, Puerto Rico waters, and USVI waters.
(Source: NMFS 2014)

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).

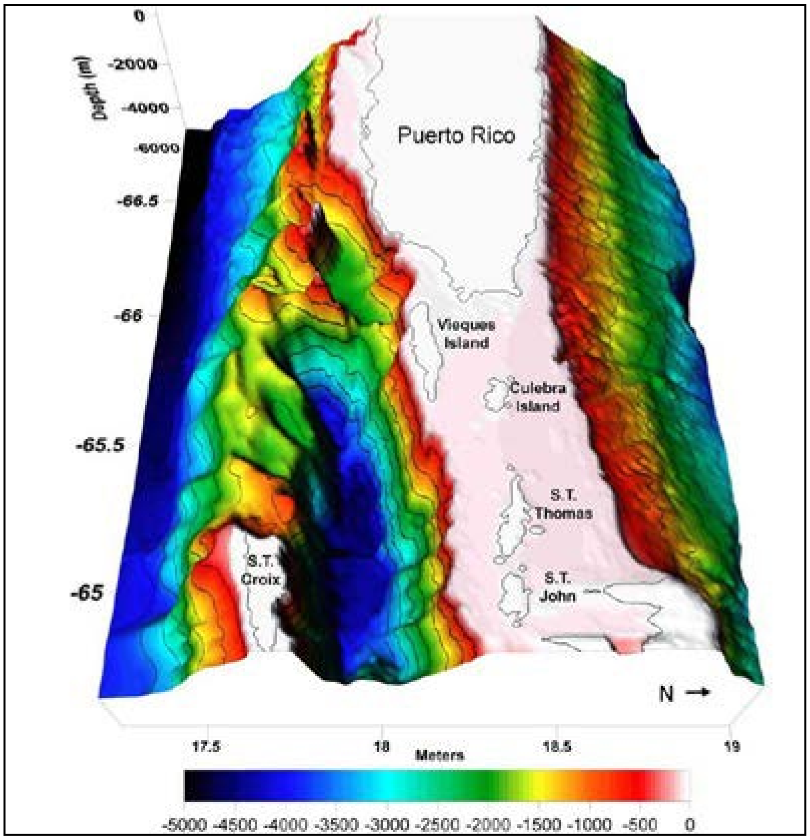


Figure 3.2.2. Shared platform between the east coast of Puerto Rico and St. Thomas/St. John. The deep trough between the Puerto Rico/St. Thomas/St. John platform and St. Croix is clearly seen in this graphic representation of depth. (Source: García-Sais et al. 2005)

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[22]. 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 CFMC (2012a) 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 exhibit unique differences. For instance, mangroves, seagrasses, coral reefs, and estuaries are

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

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 10 miles of shore 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 Puerto Rico constitute an important part of the ecosystems in the U.S. Caribbean. The National Marine Fisheries Service (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 Sustainable Fisheries Act (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 2,121 mi^2 (5,494 km^2) of total bottom area mapped from aerial photographs. This total included both Puerto Rico (1,934 mi^2 [5,009 km^2]) and the USVI (187 mi^2 [485 km^2]), and covered from the shore line to about 66 ft (20 m) depth.

In Puerto Rico, 19 mi^2 (49 km^2) of unconsolidated sediment, 278 mi2 (721 km^2) of submerged aquatic vegetation, 28 mi^2 (73 km^2) of mangroves, and 756 292 mi^2 (km^2) of coral reef and colonized hard bottom were mapped over an area of 1,934 mi2 (5,009 km^2)(CFMC 2013a).

3.2.3.1 Essential Fish Habitat

The Magnuson-Stevens Act requires that FMPs describe and identify EFH in text that clearly states the habitats determined to be EFH for each life stage of the managed species. Additionally, FMPs must identify the specific geographic location or extent of habitats described as EFH and include maps of these geographic locations or boundaries within which EFH for each species and life stage is found.

EFH for life stages of species previously managed under the U.S. Caribbean-wide FMPs and retained in the Puerto Rico FMP was identified in the Caribbean SFA Amendment (CFMC 2005) and mapped in the EFH-FEIS (CFMC 2004). EFH for species new to management is identified in Action 6 of this document according to functional relationships between life stages of the new federally-managed species and marine and estuarine habitats, as based on best scientific information available from the literature, landings data, fishery-independent surveys, and expert opinion (Section 2.6.2, Tables 2.6.1 and 2.6.2, and Appendix I).

The habitats described for the species new to management overlap with and occur within the same geographic extent as the habitats previously described for species managed under the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs. The highest degree of overlap occurs in the pelagic environment (i.e., the water column), because most of the species proposed for management share this habitat as eggs, larvae, juveniles, or adults.

Specific EFH identified for all species in the Puerto Rico FMP 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 (Figures 3.2.3 and 3.2.4).

Due to the steep continental slopes that occur off Puerto Rico and the USVI, the majority of fish habitat occurs within the 100 fathoms (183 m) contour line, as does the majority of fishing activity for Council-managed species. Beyond 100 fathoms, the sea bed drops off dramatically and is difficult to fish, as it requires larger vessels and more gear (e.g., more line for fish traps, handlines, etc.), both of which are not typical of U.S. Caribbean fisheries.

As a result of the lack of discrete habitat mapping, as well as explicit spatial effort information, especially in the area between the 100-fathom contour and the outer boundary of the U.S. Caribbean EEZ, assumptions had to be made regarding the distribution of species with deep-water or pelagic life stages. Thus, for those deep-water species, in instances when the literature, data, or expert opinion reported the presence of one or more life stage occurring deeper than 100 fathoms (183 m), EFH was assumed to extend to the outer boundary of the U.S. Caribbean EEZ.

For a complete list of EFH per species included in the Puerto Rico FMP, specified by life stage, see Section 5.14.

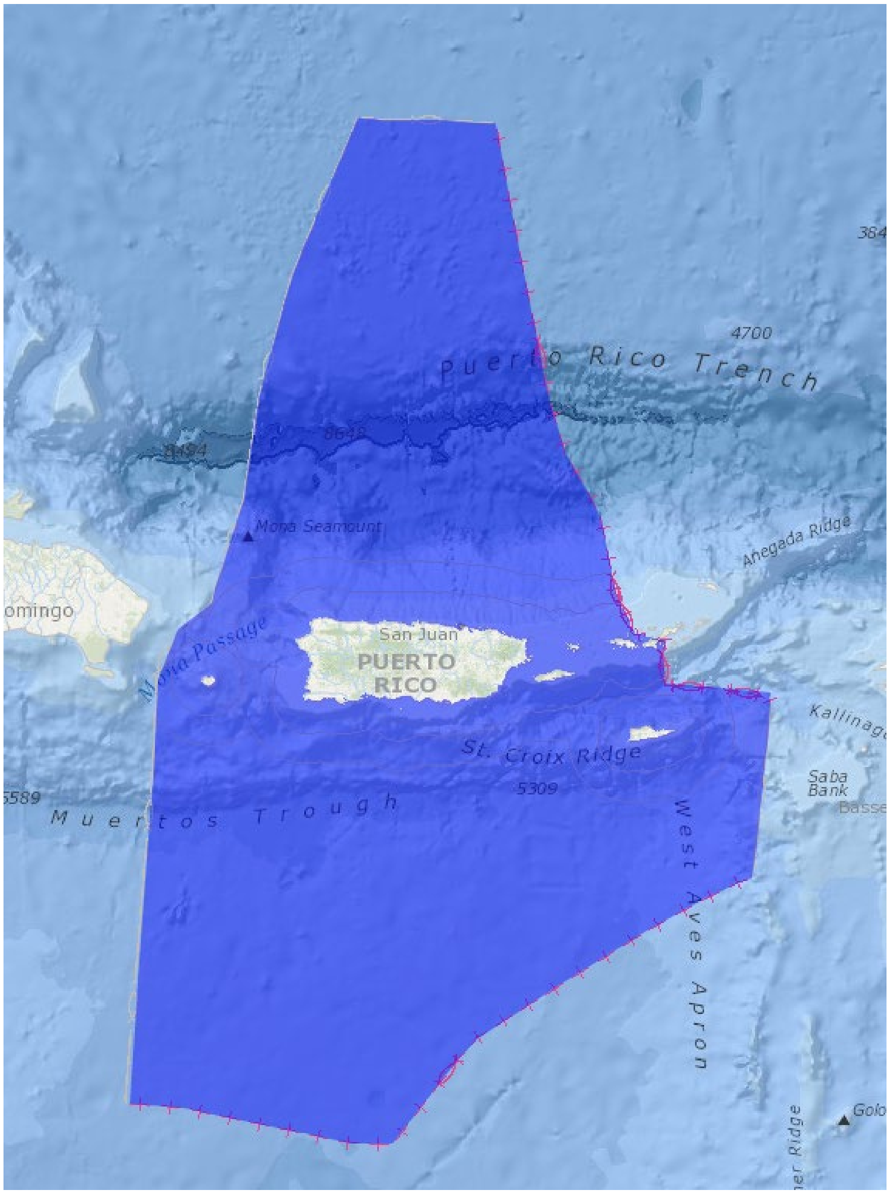


Figure 3.2.3. Shaded area representing EFH that ranges from the mean high water to the outer boundary of the U.S. Caribbean EEZ, designated for eggs and larvae for all species[23] included in the Puerto Rico FMP, except for gray triggerfish (the area is EFH larvae) and giant manta ray, spotted eagle ray, and southern stingray. Mean high water to the outer boundary of the U.S. Caribbean EEZ also is EFH for juvenile and adult life stages for all pelagic species[24] (excluding great barracuda), giant manta ray, and spotted eagle ray. For all life stages of corals, sea urchins, and sea cucumbers EFH ranges from the mean low water to the the outer boundary of the U.S. Caribbean EEZ.

[23] For spiny lobster, waters from mean high water to the outer boundary of the U.S. Caribbean EEZ are only designated for the phyllosomae larvae life stage; eggs are not pelagic.
[24] See Section 5.1 for a list of species within the Pelagics functional group.

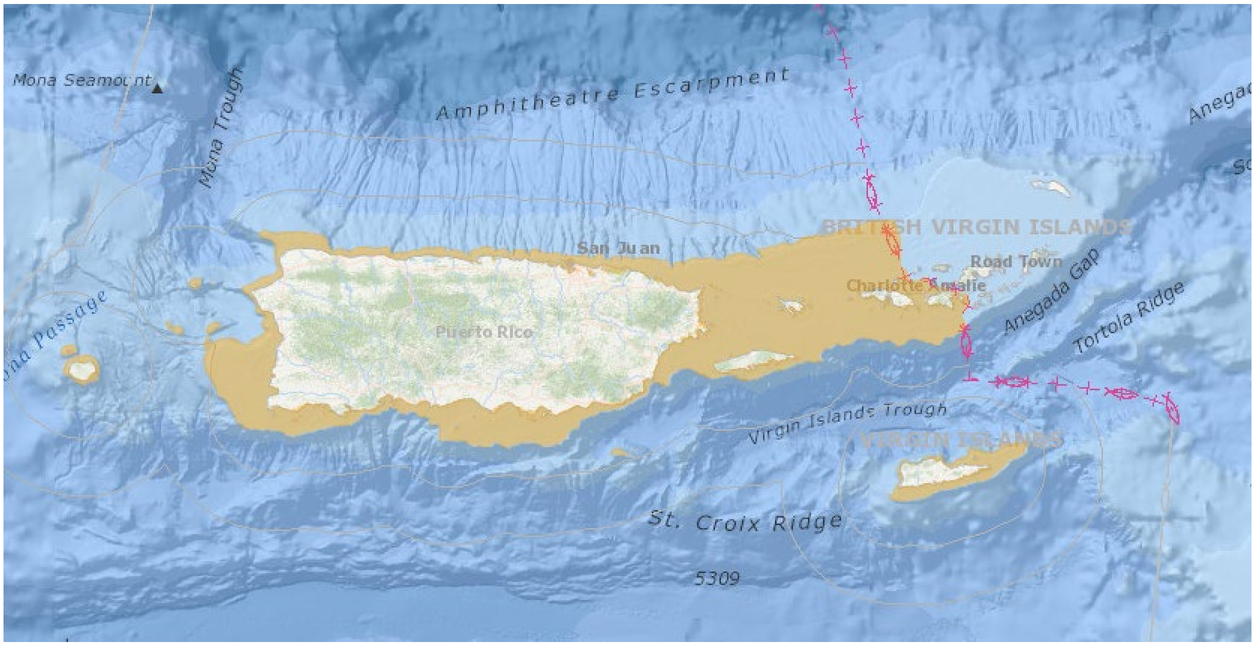


Figure 3.2.4. Shaded area representing EFH that includes all substrates from mean high water to 100 fathoms depth, designated for all life stages (excluding eggs and larvae) for the following species included in the Puerto Rico FMP: great barracuda, all Reef Fish[25] species, and southern stingray.

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.

[25] See Section 5.1 for a list of species within the Reef Fish functional group.

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 U.S. and the U.S. 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 U.S. 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 (the latter when fishing for reef fish or harvesting Caribbean coral reef resources) 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 U.S. 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 98.4 ft (30 m) and 164 ft (50 m) 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. Tropical storms David and Frederic in 1979 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 with an analysis of quantitative data collected before and after the storm, which 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 and in the EFH 5-year Review (2011) and are incorporated herein by reference.

Currently there are two ongoing efforts to expand on the information on non-fishing impacts: the second 5-year EFH Review and the development of a Fishery Ecosystem Plan for the U.S. Caribbean.

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 Waters combined)	Km^2	Nm^2	Km^2	Nm^2	Km^2	Nm^2	13.7	86
	7594	2214.1	1045	304.7	6549	1909.4		
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)

The Council's estimate of fishable habitat existing to 100-fathoms, 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. Data remaine unavailable except those which allowa determination of 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 fully re-evaluate the definition of fishable habitat.

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 37 stocks/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 species with an important ecological function.

Appendices I and J contain specific information about the distribution and habitat, life history, diet, reproduction and spawning characteristics for all species in the Puerto Rico FMP.

3.3.1 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), including waters around Puerto Rico. 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, including Puerto Rico, are also protected under the ESA (Table 3.3.1), 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 3.3.3) also occur within Puerto Rico waters.

[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).

Table 3.3.1. ESA-listed species that occur in U.S. Caribbean federal waters and could interact with fishing authorized under the Puerto Rico FMP.

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

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.

3.3.1.1 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.

3.3.1.2 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 3.3.1). These waters include Culebra's outlying Keys, including Cayo Norte, Cayo Ballena, Cayos Geniquí, 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 3.3.2).

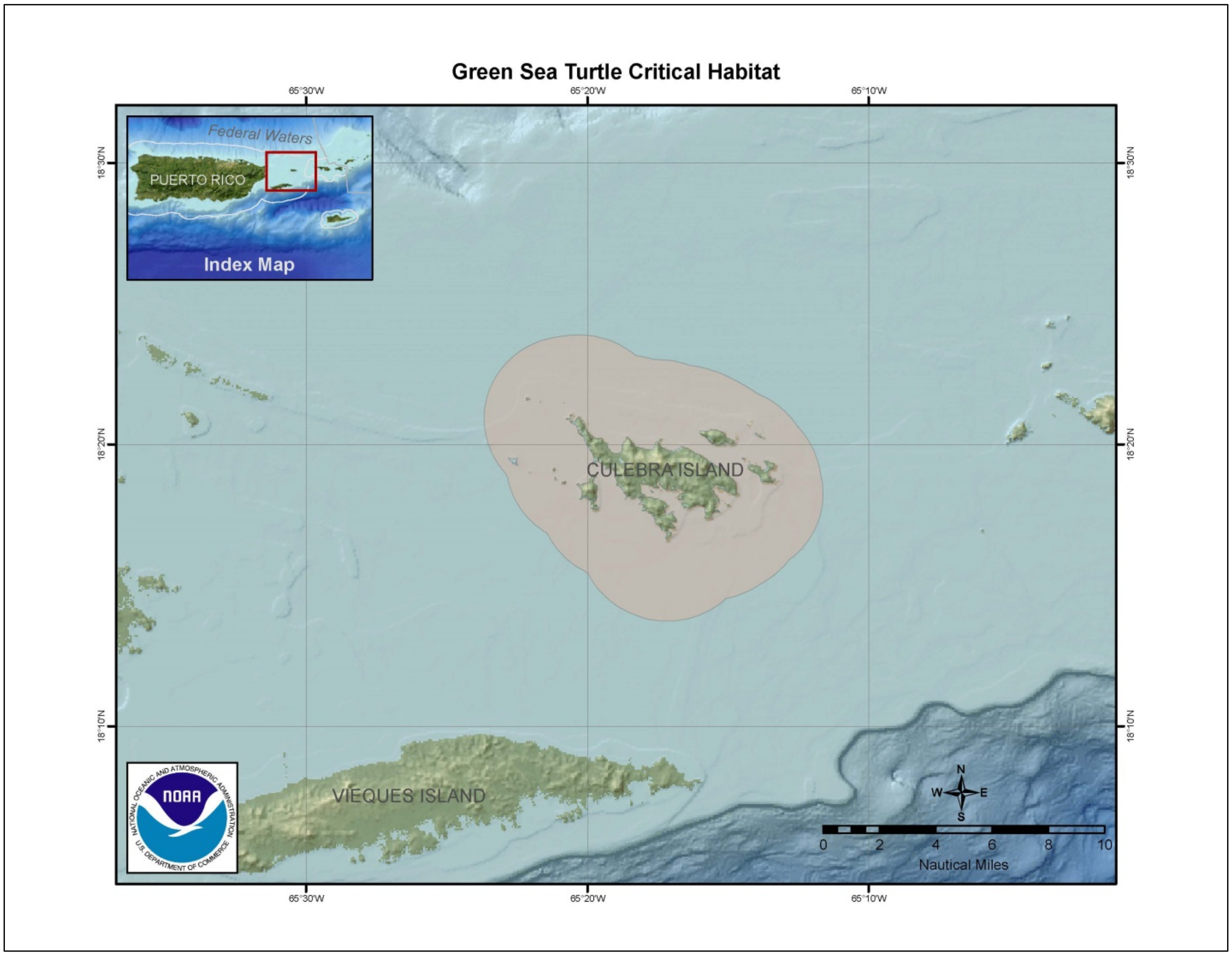


Figure 3.3.1. Area in Puerto Rico designated as green sea turtle critical habitat.

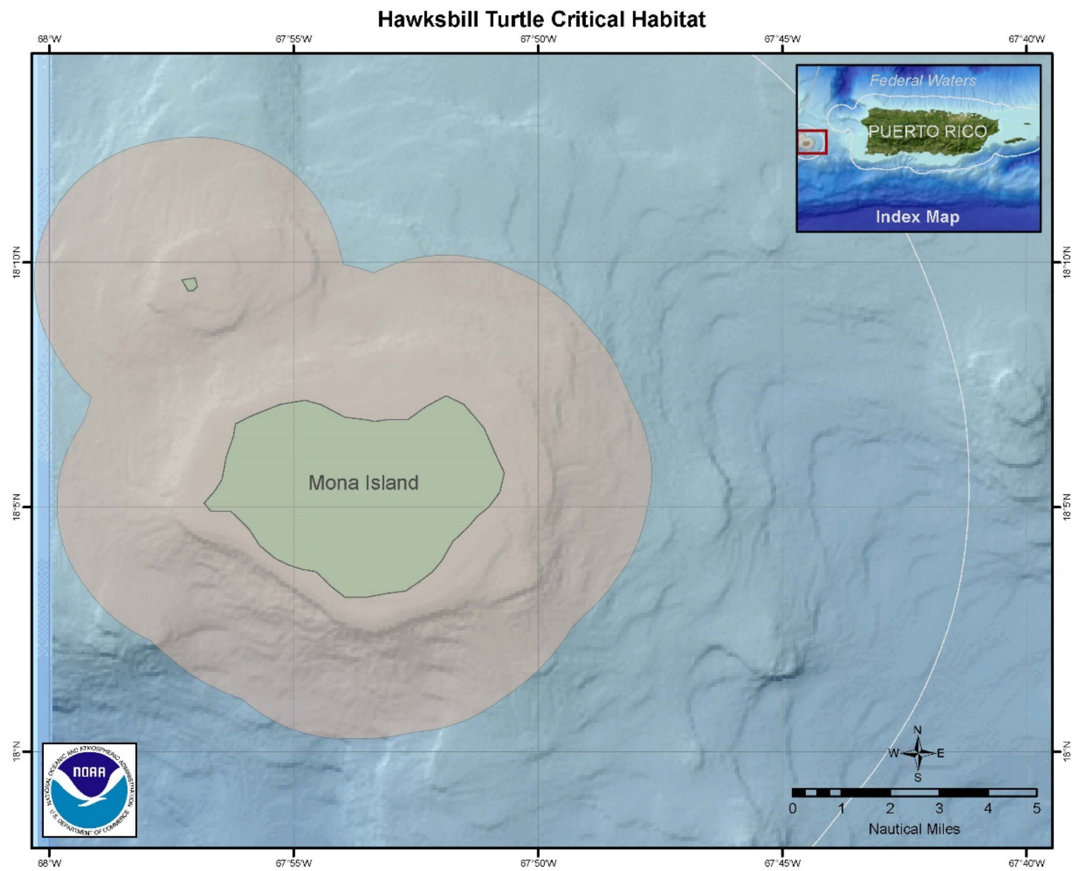


Figure 3.3.2. Area in Puerto Rico designated as hawksbill sea turtle critical habitat.

3.3.1.3 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, 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%. 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).

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. 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 prebleaching 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. 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. 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).

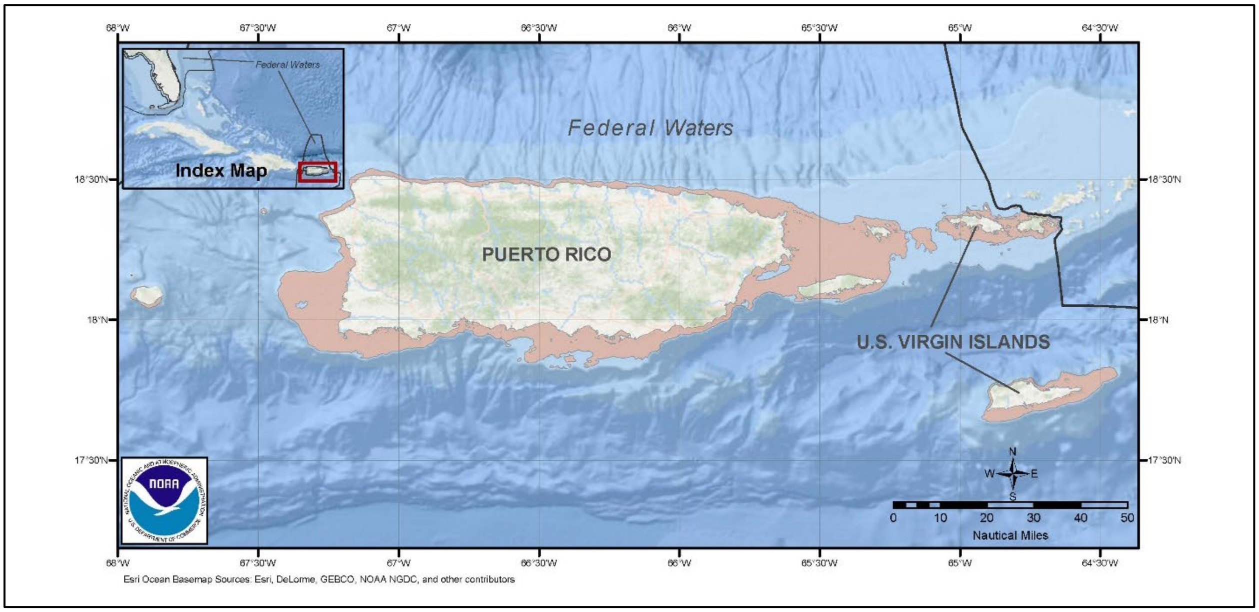


Figure 3.3.3. Area around the U.S. Caribbean region designated as *Acropora* coral critical habitat.

3.3.1.4 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. 2011a). 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.

3.3.1.5 Consultations on ESA-listed species and designated critical habitat

As discussed in Chapter 2, the Puerto Rico FMP would include fishery management measures (e.g., size and bag limits, seasonal and area closures) previously included in the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs that are applicable to the Puerto Rico EEZ. Actions included in the Puerto Rico FMP would modify the composition and organization of, and ACLs for, the stocks and stock complexes included for management in the Puerto Rico EEZ. Those changes would not be expected to substantially change how the fishery operates (e.g., species targeted, amount and type of gear used). Under the Puerto Rico FMP, ACLs for some stocks/stock complexes would increase while ACLs for others would decrease. However, for those stocks/complexes for which allowable catch would increase, that increase would not necessarily translate to increased effort, as fishers are constrained by factors such as vessel size, amount of gear owned, and market demand. Additionally, for those stocks new to management, the gear types used by Puerto Rico fishermen would not be expected to differ from gear types used when fishing for previously managed stocks. Those stocks may be new to management, but they are not new to the fishery. For these reasons, it was assumed that fishing authorized under the Puerto Rico FMP would be very similar to fishing authorized under the four previous FMPs.

NMFS is consulting on the effect of fishing on ESA-listed species under the new Puerto Rico FMP, and has completed consultations on the effect of fishing under each of the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs. As mentioned above, the effects of fishing under the Puerto Rico FMP would be expected to be comparable to effects of fishing under the four previous FMPs, and consultations on those previous FMPs would be informative for the Puerto Rico FMP. Please see Appendix K for additional information on these consultations.

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

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 (Johnson et al. 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.

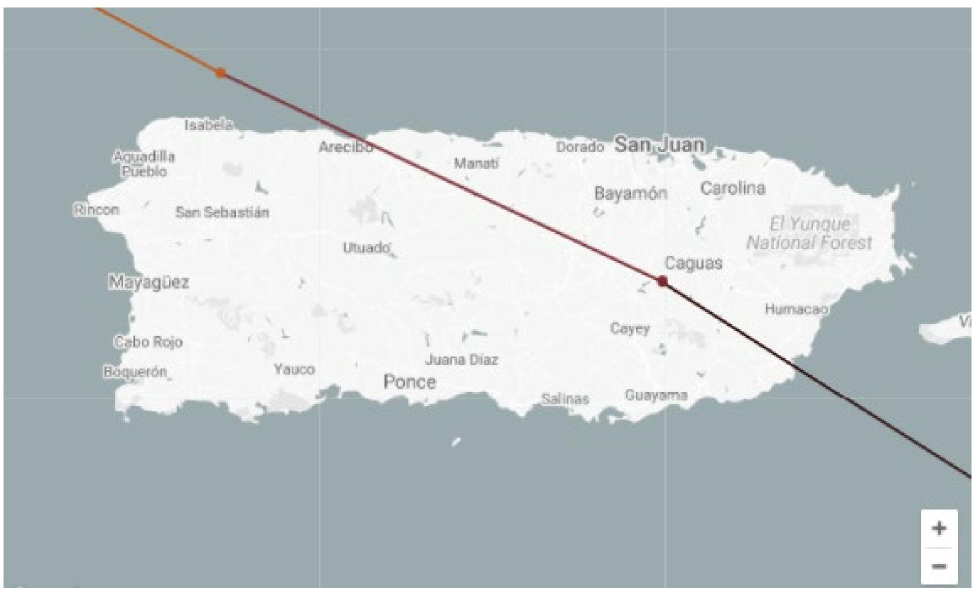


Figure 3.4.1. Path of Hurricane Maria over Puerto Rico.
(Source: NOAA NWS National Hurricane Center September 21, 2017)

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.

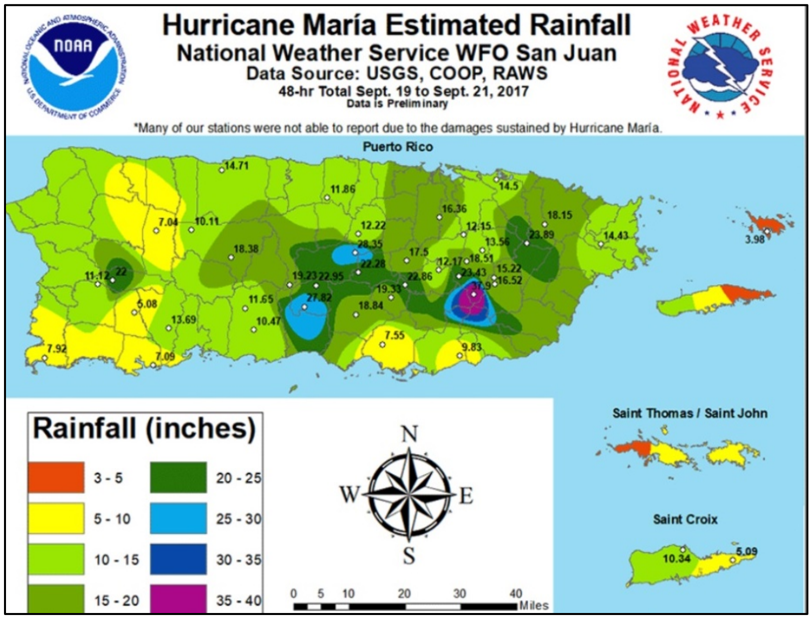


Figure 3.4.2. Map of Hurricane Maria rainfall.
(Source: NOAA NWS, September 21, 2017)

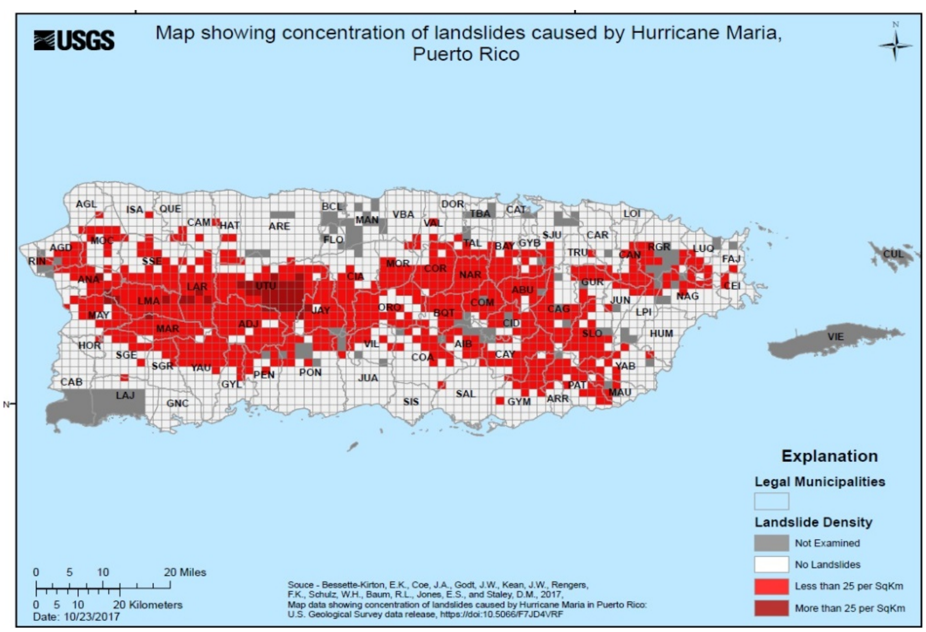


Figure 3.4.3. Map showing concentration of landslides caused by Hurricane Maria.
(Source: U.S. Geological Service (USGS) October 23, 2107).

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]

[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.

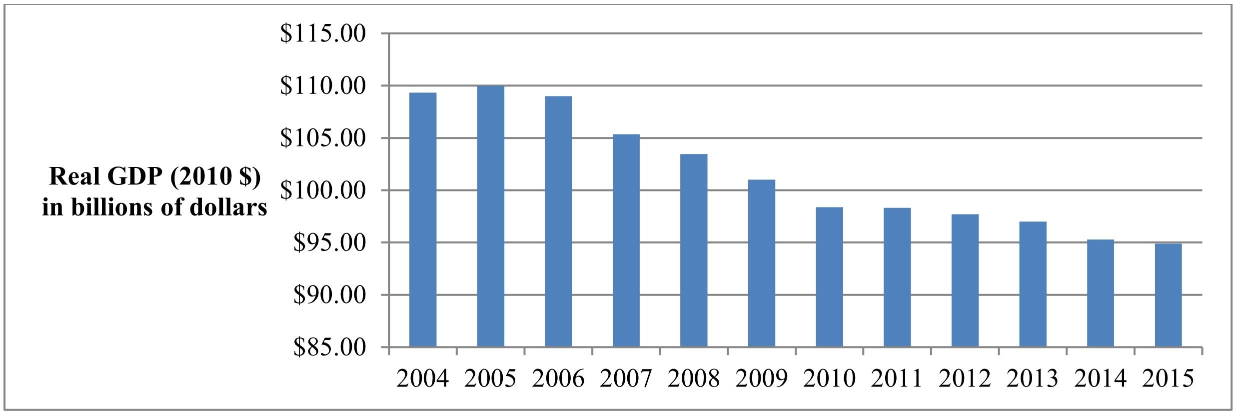


Figure 3.4.4. Puerto Rico's real GDP in 2010 dollars, fiscal year 2004-2015.
(Source: Government Development Bank of Puerto Rico Economic Report for the Governor and U.S. Department of Commerce Bureau of Economic Analysis (BEA) for implicit price deflator)

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 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.

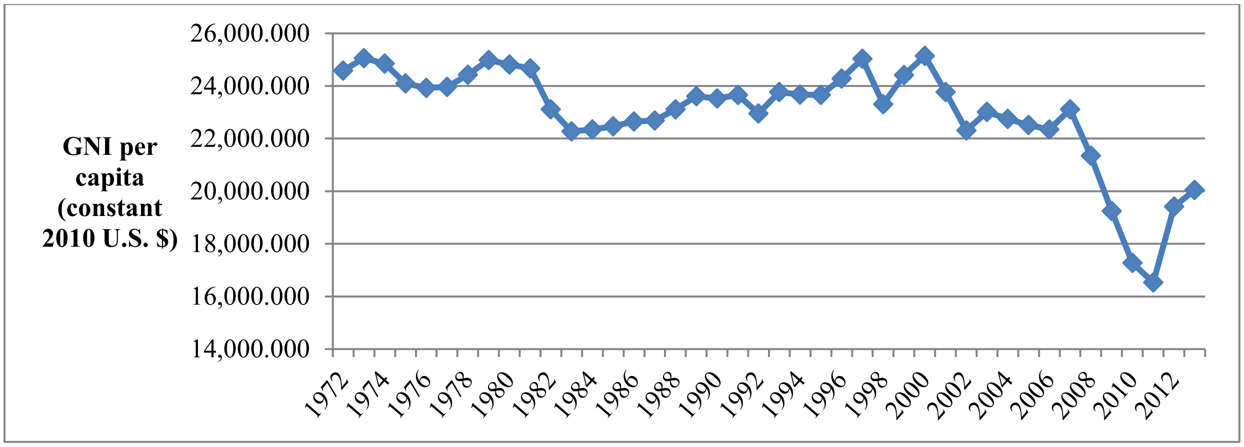


Figure 3.4.5. Puerto Rico's GNI per capita (constant 2010 U.S. dollars), 1972 – 2018.
(Source: World Bank https://data.worldbank.org/indicator/NY.GNP.PCAP.KD?locations=PR.)

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

[28] More information on the subprime mortage crisis can be found at https://en.wikipedia.org/wiki/Subprime_mortgage_crisis.

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

[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.

(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).

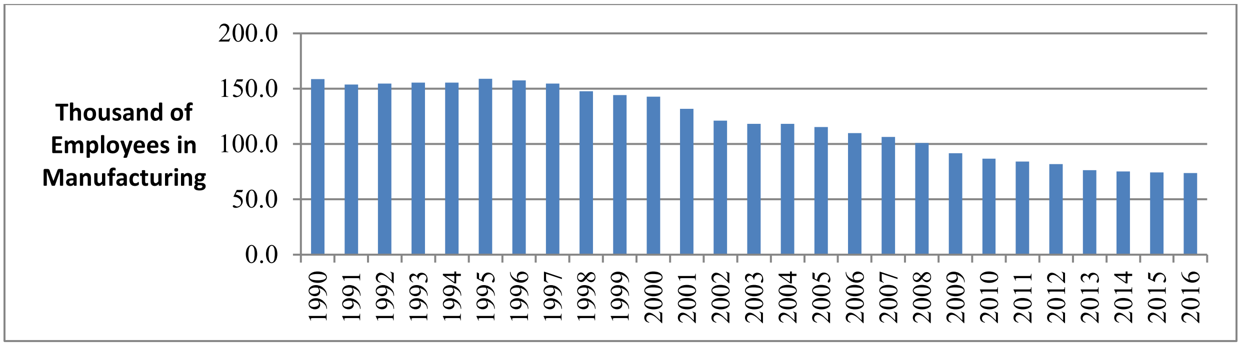


Figure 3.4.6. Average annual employment in Puerto Rico's manufacturing sector, 1990-2016. (Source: U.S. Department of Labor BLS)

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 after that recession, but then rose again during the recession created by the subprime mortgage crisis of the late 2000s (Figure 3.4.7).

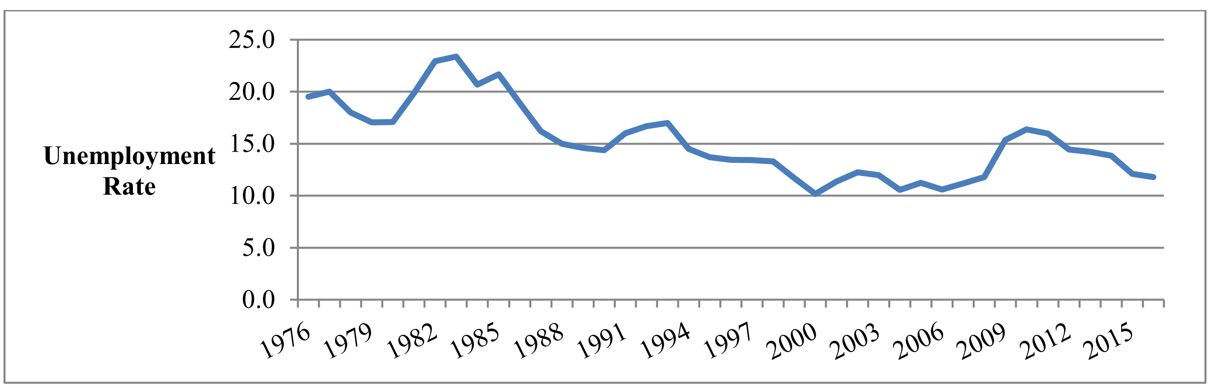


Figure 3.4.7. Annual unemployment rate, 1976-2016. (Source: U.S. Department of Labor BLS)

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).

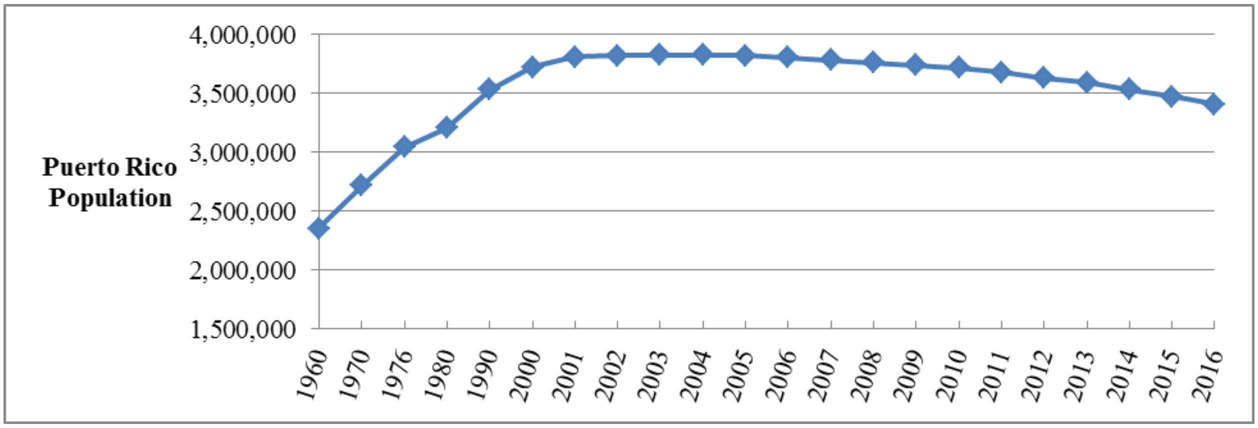


Figure 3.4.8. Population of Puerto Rico, 1960, 1970, 1076, 1980, 1990, 2000– 2016. (Source: World Bank 2017)

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.

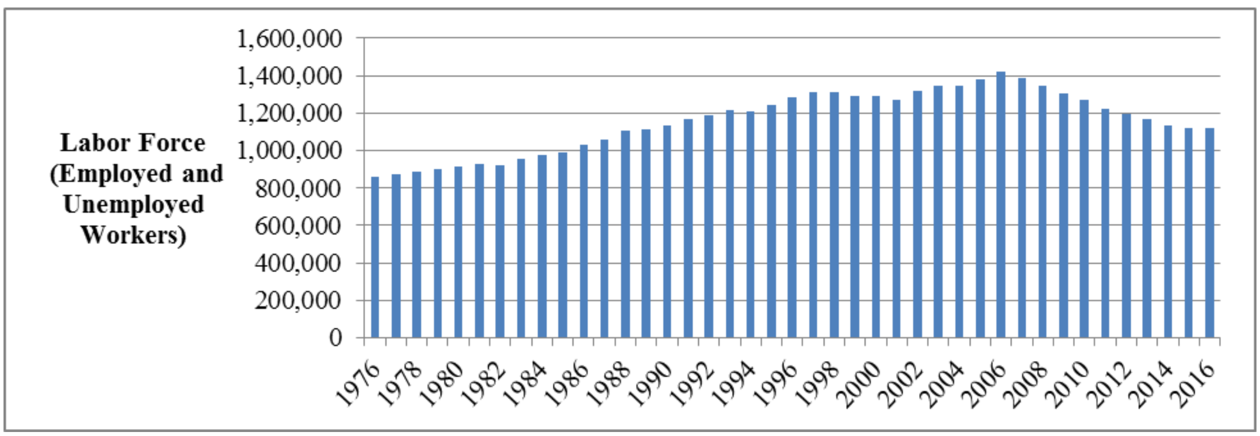


Figure 3.4.9. Annual labor force, 1976-2016. (Source: U.S. Department of Labor BLS).

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 3.4.10). 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.

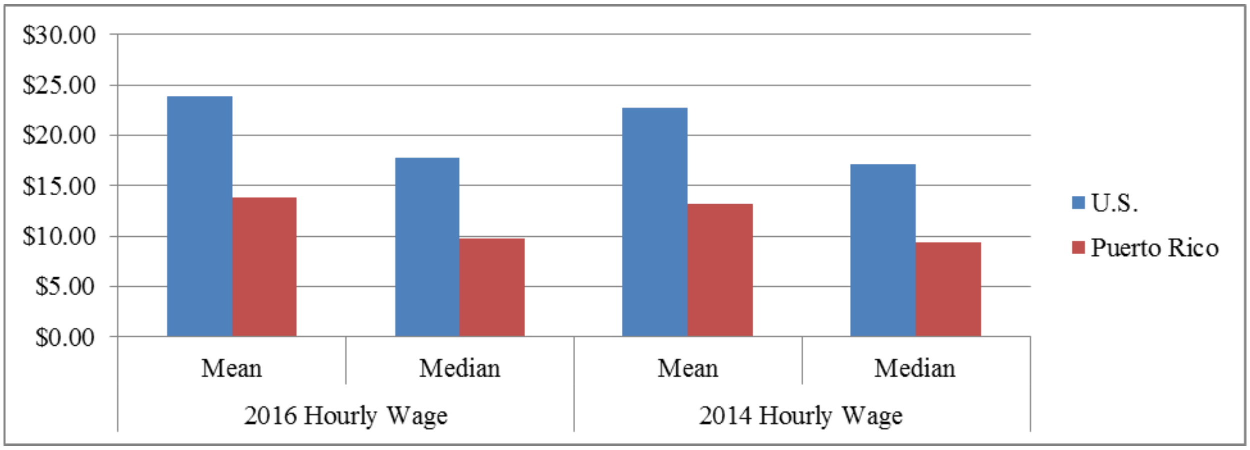


Figure 3.4.10. Nominal mean and median hourly wages in Puerto Rico and U.S, 2014 & 2016. (Source: U.S. Department of Labor BLS 2014 and 2016 National and State Occupational Employment and Wage Estimates)

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 3.4.4). 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 employees by sector, 2011 – 2016; percentage, 2011, 2015.

Sectors	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 3.4.11). From 2008 through 2015, the number of employer establishments declined by approximately 5.9% and the number of employees dropped by approximately 9.5%.

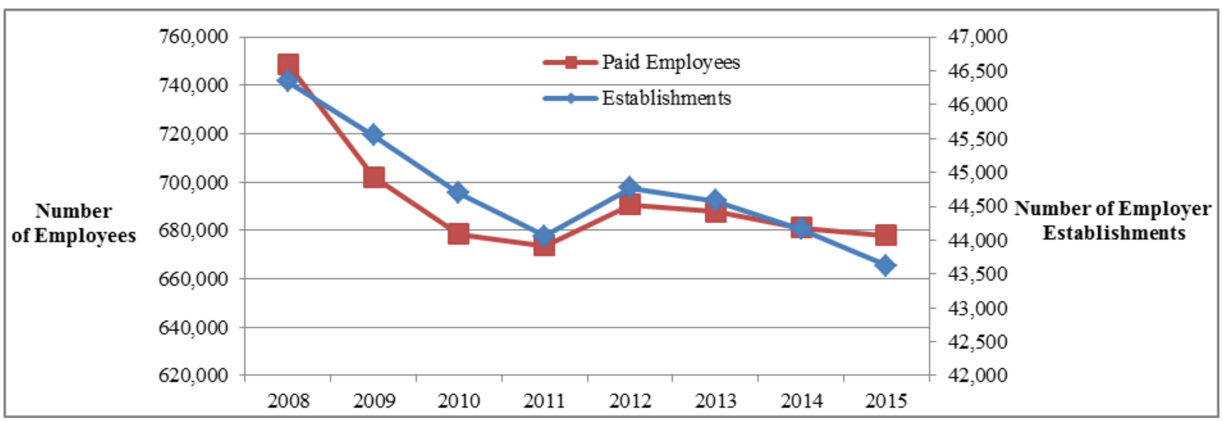


Figure 3.4.11. Numbers of employees and employer establishments, 2008 - 2015. Note: This does not include most government employees, railroad employees and self-employed employees. (Source: Census County Business Patterns)

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 3.4.11).

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.

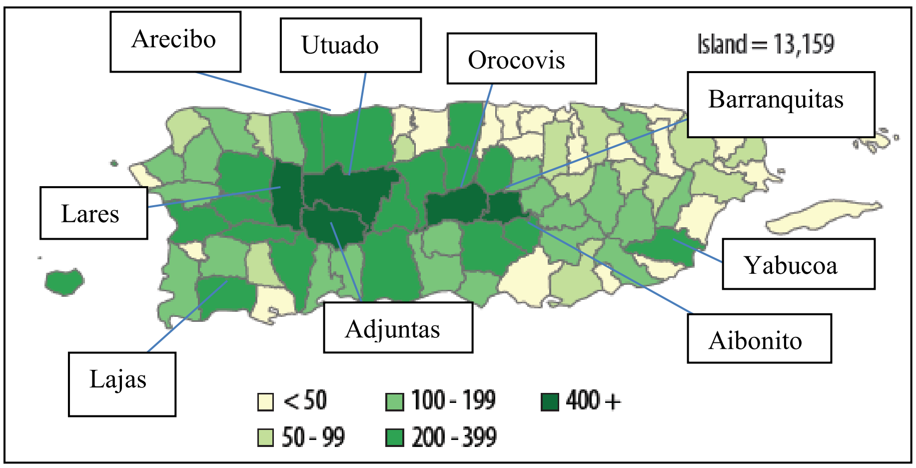


Figure 3.4.12. Number of farms by municipality, 2012.
(Source: USDA 2012 Census of Agriculture Highlights).

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)	
	2010-2014	2015-2016
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 GDB 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

[31] On October 4, 2017, the FOMB withdrew its lawsuit filed against the governor over his refusal to implement the FOMB's furlough program.

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.

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).

[32] https://www.ncdc.noaa.gov/billions/events.pdf

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)

[33] http://www.fldoe.org/hurricaneinfo/

The largest declines in nonfarm employment during the first three months after the September hurricanes were in the leisure & hospitality and trade, transportation and 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.

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 3.4.1). 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].

[34] https://www.congress.gov/bill/115th-congress/house-bill/260
[35] https://juntasupervision.pr.gov/index.php/en/documents/

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 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.

The Puerto Rico Planning Board (December 2018) estimated that Hurricane Maria had a $43.1 billion impact on the island's economy as of October 12, 2018. The Planning Board said losses for the private sector alone totaled $30 billion, with manufacturing reporting the highest loss of income and agriculture among the highest damage to infrastructure and equipment. . After taking FEMA and private insurer disbursements into account, or $8.29 billion, the net impact to the economy was $30.3 billion. Although official GNP figures for FY2018 are not yet available, the Economic Development Bank's Economic Activity Index, a monthly coincident indicator of economic activity based on indicators including payroll employment and electricity generation and which is strongly correlated with real GNP, declined 6.8% in FY2018, consistent with the Revised Fiscal Plan projection of a 6.0% decline in real GNP growth (Governor of Puerto Rico, March 27, 2019).

There is great uncertainty regarding the island's economic future. Complicating its recovery efforts are ongoing out-migration of its residents, declining school enrollment, higher utility rates, and other factors. More than 129,000 people left Puerto Rico between July 1, 2017, and July 1, 2018 according to the U.S. Census Bureau Population Estimates Program (https://www.census.gov/data/tables/time-series/demo/popest/2010s-total-puerto-rico.html). In 2018, Puerto Rico's public schools started off with approximately 40,000 fewer students between 2017 (pre-Hurricane Maria) and 2018 (post-Hurricane Maria) (Hinojosa et al. 2019). Puerto Ricans already had high utility rates before Hurricane Maria, paying twice what the average U.S. customer paid. Electricity customers may have to pay 19% more according to an agreement

[36] http://status.pr/

government officials made to repay bondholders who own the debt of the island's bankrupt power authority (Acevedo 2019).

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, 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

<u>Commercial Fisheries Description</u>
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 Appeldoorn et al. 2015). Although historically, traps have dominated the catch, their use has declined over time leading to a more balanced fishery using nets, lines, traps, and spears (Appeldoorn et al. 2015). 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-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 3.5.2.4 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.

[37] The NOAA Fisheries Glossary Revise Edition June 2006 defines artisanal fishery as a fishery based on traditional or small-scale gear and boats.

Fishing activities are mainly managed through the use of catch limits (in federal waters), closed seasons for some species, area closures, size limits, harvest prohibitions, and trip and bag limits, and in Puerto Rico territorial waters, through the use of fishing licenses, and global quotas (limited entry) for the harvest of deep-water snappers (Keithly et al. 2013) (see Section 3.5.2.6).

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." There are no federal licenses or permits specifically for commercially fishing for Council-managed species in U.S. Caribbean federal waters.

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 3.5.1). 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), with 714 fishermen actively fishing (Table 3.5.1).

Table 3.5.1. Number of commercial fishermen in Puerto Rico*.

Year	Number of licensed fishermen[1]	Number of full time active fishermen	Number of part-time active fishermen
1988[2]	1,731 active	1,306	425
1996[2]	1,758 active	1,262	496
2002[2]	1,163 active	423	740
2008[2]	868 active	650	218
2009[3]	452	No data	No data
2010[3]	670	No data	No data
2011[3]	551	No data	No data
2012[3]	609	No data	No data
2013[3]	647	No data	No data
2014[3]	690	No data	No data
2016[3]	1074 (874 active)	No data	No data
2017-2018[3,4]	1277	764	134

* Information not available for years 1980-1995; 2003-2007, and 2015.
[1] Total number of licensed fishermen; number does not indicate if active or not active fishing status, unless specified.
[2] Source: Census Data in Matos-Caraballo and Agar (2011c).
[3] Source: Puerto Rico Department of Natural and Environmental Resources, Fisheries Laboratory.
[4] Data from Feb 2017 to Feb 2018. Number of licensed fishermen includes 379 beginner fishers but no distinction between active or not active fishing status.

3.5.2.2 Commercial Fishing Vessels

Commercial fishing vessels in Puerto Rico are relatively small, averaging 20 ft in length (Matos-Caraballo and Agar 2011a) with most ranging between 18 ft to 25 ft 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 Matos-Caraballo and Torres Rosado (1989) 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; Matos-Caraballo and Torres Rosado 1989).

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.

Types of Hook- and-Line Gear	Definition
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: Matos-Caraballo and Torres Rosado [1989].

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

Year	By Hand, Diving Gear	Gill Nets, Other	Hook And Line, Bottom	Pots And Traps, Fish	Troll Lines	Total
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.

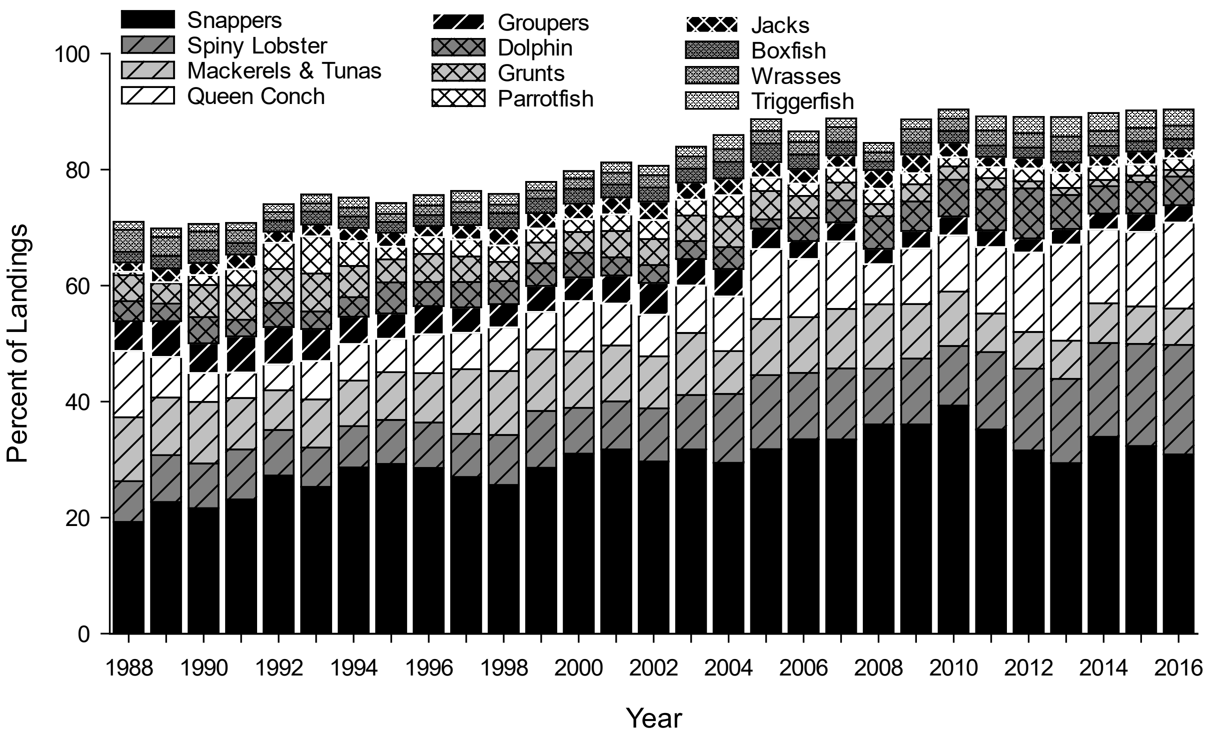


Figure 3.5.1. Most targeted (>70% of commercial landings) catch each year in Puerto Rico. (Source: Southeast Fisheries Science Center, Aug 2018)

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 dolphin (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.

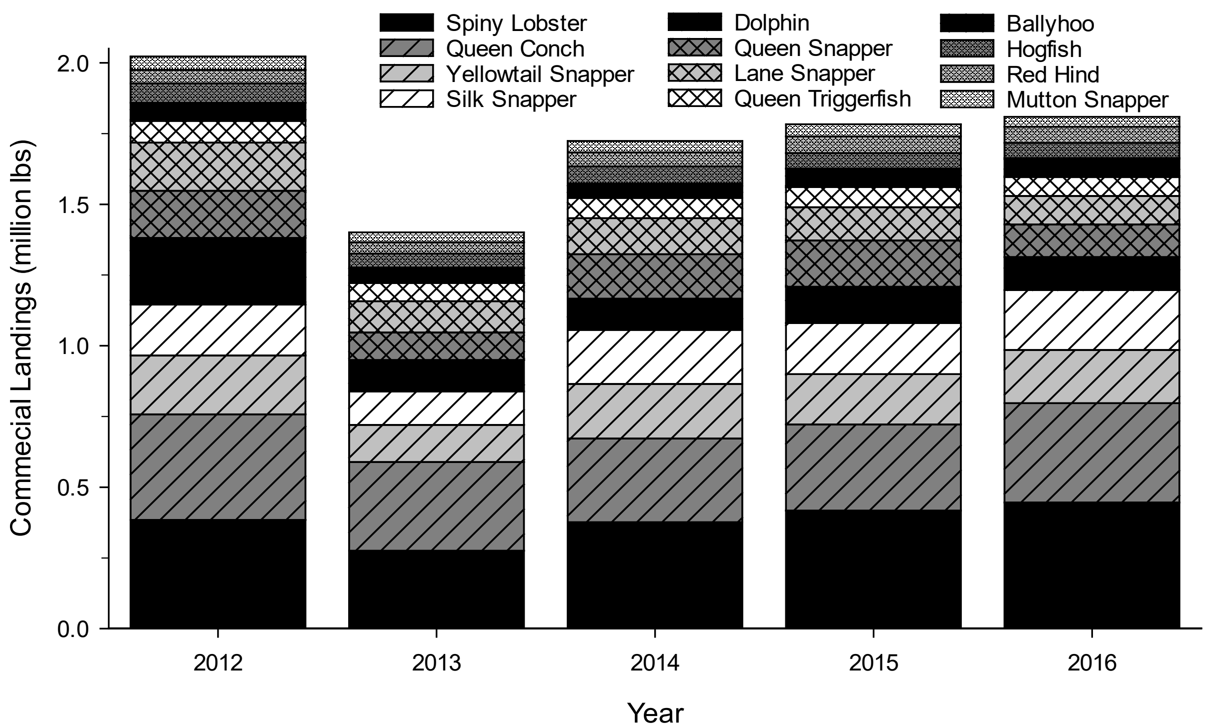


Figure 3.5.2. Most targeted (in million pounds) stocks harvested in 2012-2016 in Puerto Rico. (Source: Southeast Fisheries Science Center, Aug 2018)

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

Dolphinfish (*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).

<u>Other Important Fish Species</u>
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 (*Sphyraena 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, dolphinfish, 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 in the Southwest region in Puerto Rico and gears used for their harvest.

Fish Species	Season (Months)	Gears/Methods used	Other information
Dolphinfish (e.g., dorado)	Jan-March	Rods and reels, hand lines	30-35 miles from coast, deeper waters.
Yellowtail snapper	Jan-March	Rods and reels, hand lines	Close to shore (3-4 miles out, over platform)
Mutton snapper	Jan-March	Rods and reels, hand lines	-
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

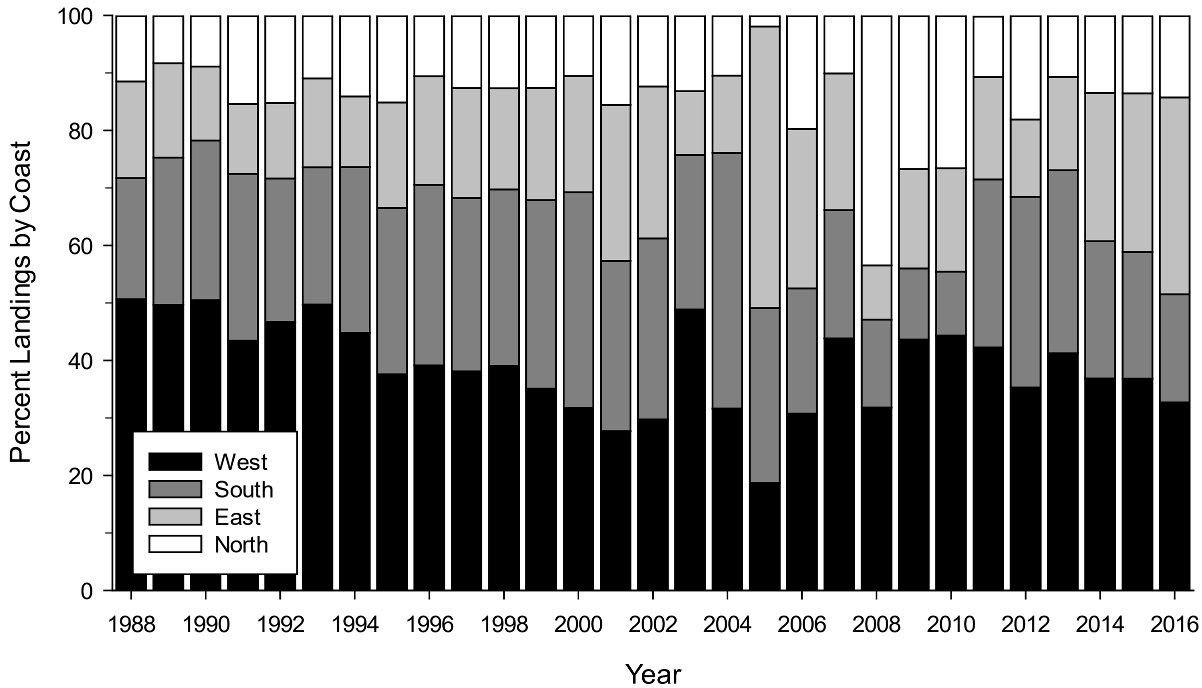


Figure 3.5.3. Percent of annual commercial landings by coast for Puerto Rico, 1988-2016. (Source: Southeast Fisheries Science Center, Aug 2018)

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, dolphinfish, 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 dolphinfish (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 3.5.3). 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 dolphinfish, 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 3.5.3). The percent of annual commercial landings from the east coast has steadily increased in recent years (2014-2016) from 26% to 34%.

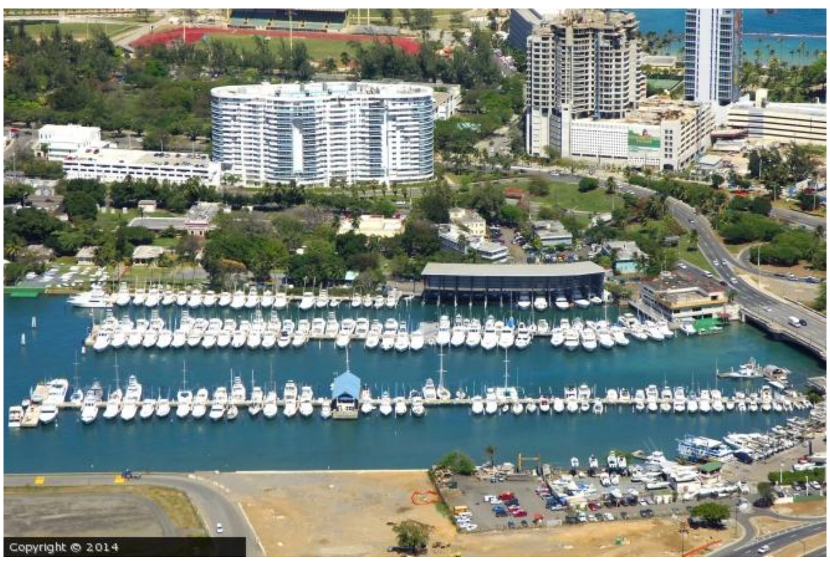
Because of the shallow shelf, fishermen can harvest multiple species with different gear types such as lines, traps, and SCUBA (Matos-Caraballo and Agar 2008). The most targeted species are the reef fish yellowtail, lane, and mutton snappers, hogfish, porgies, white grunt, and parrotfish (Matos-Caraballo 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, dolphinfish, 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.

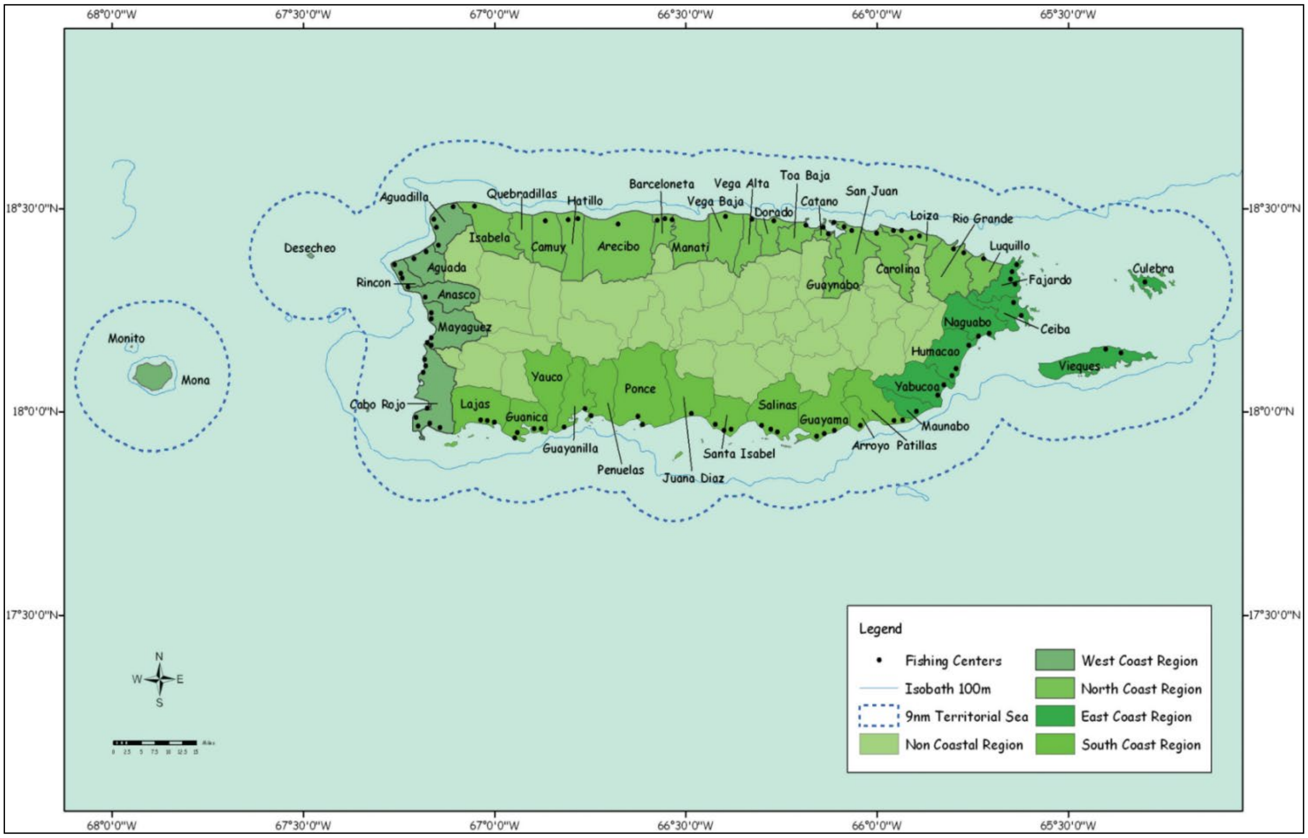


Figure 3.5.4. Distribution of fishing centers in the Commonwealth of Puerto Rico by region. (Source: Matos-Caraballo and Agar 2011a)

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. 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
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.

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.

[40] For purposes of this FMP, subsistence fishing will be treated as a separate group of fishers.

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
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 dolphinfish, 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 mackerel, 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
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 mackerel	46,880	1
Red hind	38,268	1
Yellowtail snapper	36,929	1
Subtotal	*3,590,570*	*89*

(Source: 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. Dashes indicate no reported landings.

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

Species	2014	2015	2016	3-year average
Yellowfin tuna	32,304	12,516	66,813	37,211
Yellowtail snapper	9,365	27,992	36,929	24,762

(Source: Mrcat_all00_17wv5_12Mar18)

The stocks with the highest average number of pounds harvested recreationally from 2014 through 2016 are dorado, wahoo, yellowtail snapper (Snapper 5 under the Puerto Rico FMP, based on Action 3, Preferred Alternative 3, and Snapper Unit 4 under the Reef Fish FMP), mutton, dog, schoolmaster (Snapper 4 under the Puerto Rico FMP, based on Action 3, Preferred Alternative 3, and components of Snapper Unit 3 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/stock complexes listed are those established by Action 3 of the Puerto Rico FMP.

Stock/Complex	2014	2015	2016
Snapper 1	11,299	10,968	25,089
Snapper 2	-	794	11,623
Snapper 3	29,484	7,671	14,327
Snapper 4	13,602	46,192	119,307
Snapper 5	9,365	27,992	36,929
Snapper 6	-	-	2,834
Grouper 1	6,717	-	-
Grouper 2	-	-	-
Grouper 3	171	3,959	14,202
Grouper 4	-	-	11,794
Grouper 5	-	-	-
Grouper 6	19,407	4,529	38,268
Parrotfish 1	32,566	-	-
Parrotfish 2	10,210	19,394	1,315
Surgeonfish	-	-	-
Angelfish	-	-	-
Grunts	2,512	905	4,466
Triggerfish	36,978	27,577	2,714
Wrasses 1	42,881	-	2,004
Wrasses 2	1,010	1,495	-
Dolphin	493,751	507,507	2,630,162
Barracuda	202,059	295,301	330,174
Jacks 1	76,847	32,155	27,770
Jacks 2	-	-	4,916
Jacks 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

Stock/Complex	2014	2015	2016
Rays 1	-	-	-
Rays 2	-	-	-
Rays 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, dolphinfish, 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).

Location	Species	Area	Seasonality
Inshore	Tarpon	Northeast Coast – State Waters	Most available all year, demand driven by tourism
	Snook		
	King mackerel		
	Jacks		
	Bonefish		
	Reef Fish (Snappers and Groupers)		
	Other species		
Offshore	Tunas - Blackfin tuna	Northeast Coast (Atlantic Ocean) - 50% federal waters, 50% state waters	All year
	Dorado (Dolphin)		November - March
	Wahoo		June - December
	Billfishes		-
	- Sailfish - White marlin	-	October – December
	- Blue marlin		July - December
	Rainbow runner		-
	King mackerel		April and May
	Groupers - 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 U.S. Caribbean federal waters, including the Puerto Rico EEZ, are required to register through the National Angler Registry. 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	Number of Fishermen from Puerto Rico
2018	0
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	Number of Registered Fishermen in Puerto Rico
2018	4

Year	Number of Registered Fishermen in Puerto Rico
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 https://www.fisheries.noaa.gov/resource/educational-materials/atlantic-hms-recreational-compliance-guide.

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 (OY). Therefore, all management measures apply to the domestic fishermen and no portion of the OY 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 of 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]

The following describes the historical economic characteristics of Puerto Rico fisheries because landings revenues and other official economic statistics are currently not available post-Hurricane Maria.

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. In 2015, the $6.13 million in ex-vessel revenue represented approximately 0.01% of the island's GDP[42] (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)).[43]

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 GDP
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%

[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] Official figures are unavailable after 2017 to estimate post-hurricane percentages.
[43] 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.

Region	Landings (lbs)	Ex-Vessel Revenue (2015 $)	GDP (2015 $)	Ex-Vessel Revenue Percentage of GDP
USVI	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).[44]

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 GDP
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[45]; 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 (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

[44] Sales impacts are not the only economic impacts produced by these landings. There are also income, total value added, and jobs.
[45] http://www.elnuevodia.com, May 16, 2016.

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.[46]

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 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.

[46] 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.

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.

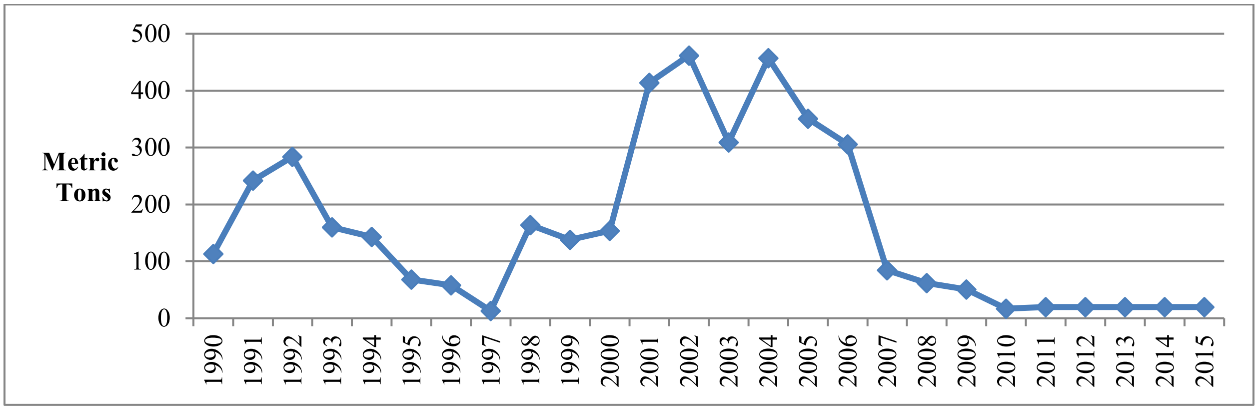


Figure 3.5.5. Aquaculture production in Puerto Rico, 1990 – 2015.
(Source: World Bank)

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 regularly occurring electrical blackouts before Hurricane Maria 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.[47]

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.

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).

[47] 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.

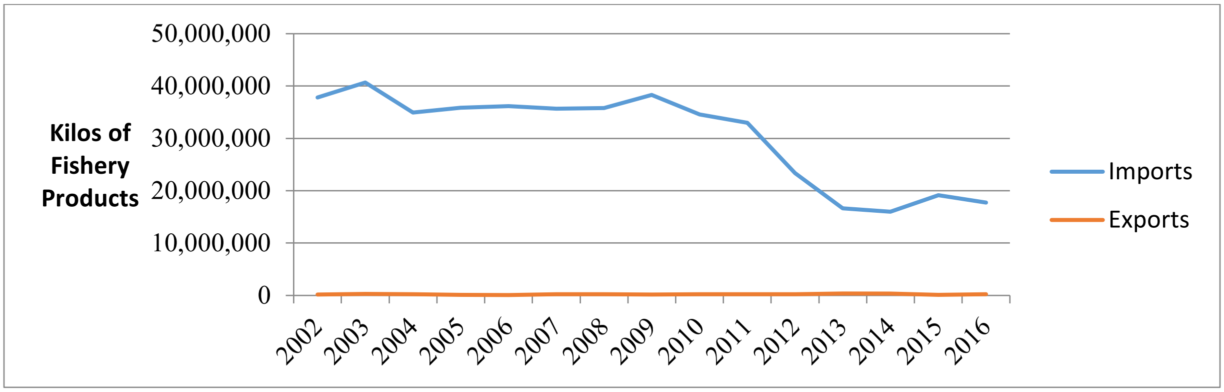


Figure 3.5.6. Kilos of fishery products imported and exported through the Port of San Juan, 2002 – 2016.
(Source: NMFS Office of Science & Technology, Commercial Fisheries Statistics)

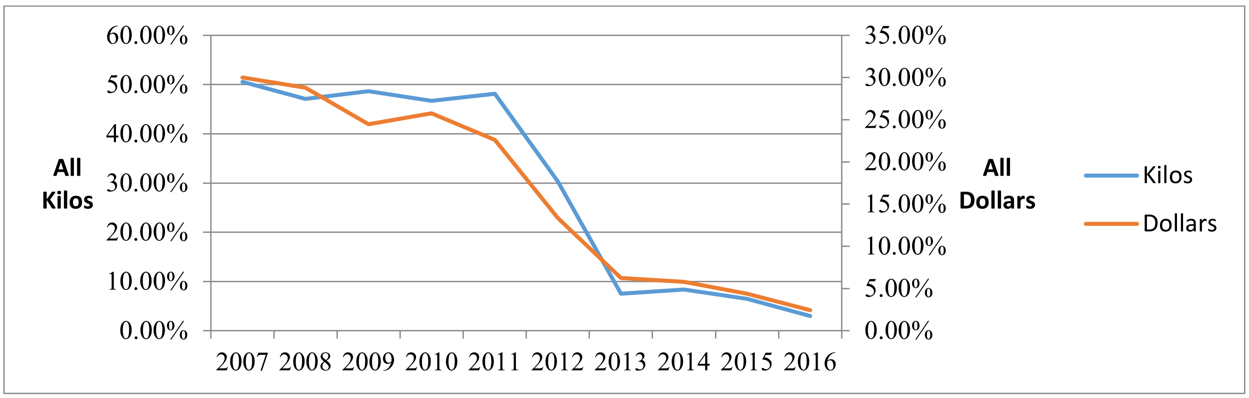


Figure 3.5.7. Tuna's percentage of all imported fishery products, by weight and dollars, 2002 – 2016.
(Source: NMFS Office of Science & Technology, Commercial Fisheries Statistics)

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. Section 3.5.11 describes the impacts of hurricanes Maria and Irma on the island and its fisheries and follows 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.).

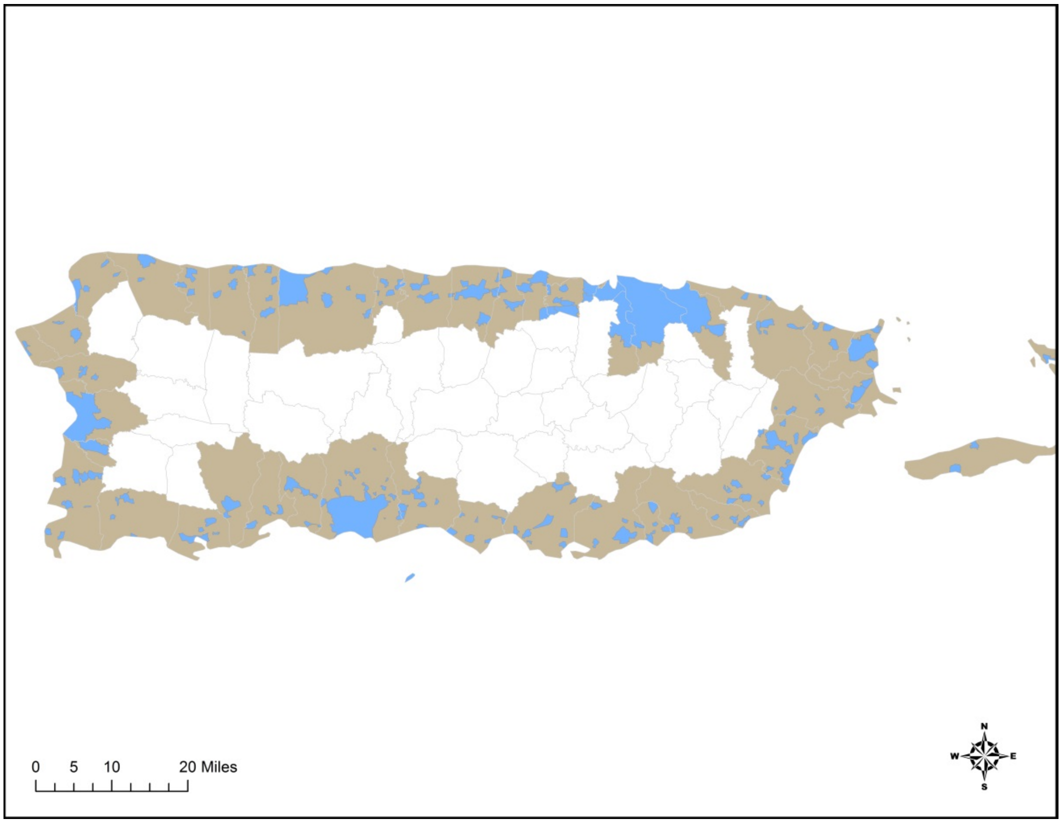


Figure 3.5.8. Puerto Rico coastal municipalities with census designated places.

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).

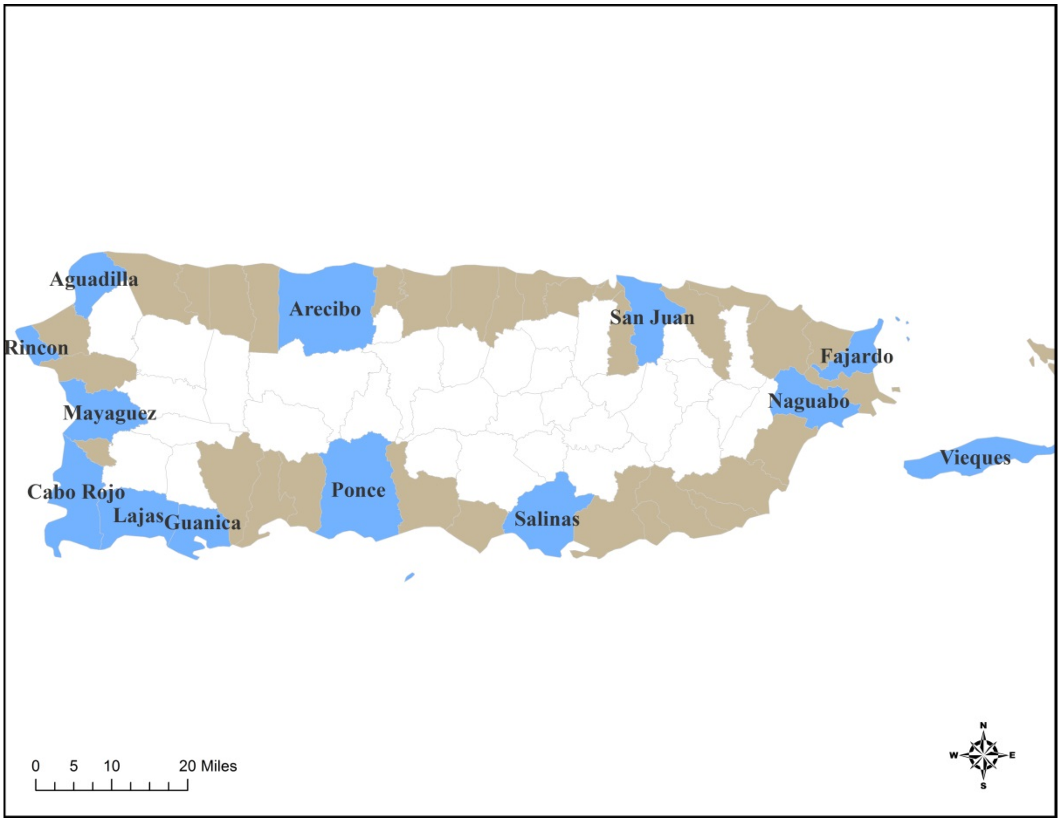


Figure 3.5.9. Puerto Rico coastal municipalities with most fishing engagement.
(Source: SERO Social Science Branch/US Census Bureau Tigerline Shapefiles 2018)

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 3.5.2.5, 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. 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 3.5.10). 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[48]. 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).

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).

[48] 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.

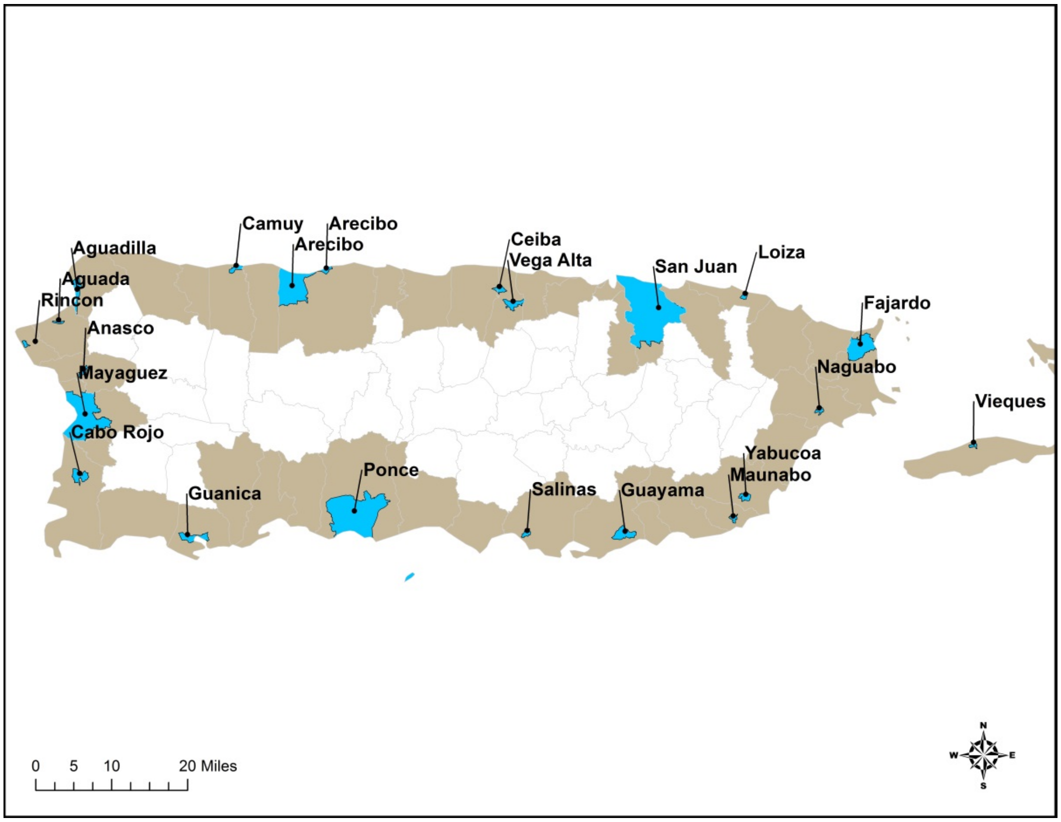


Figure 3.5.10. Puerto Rico coastal communities with villas pesqueras.
(Source: SERO Social Science Branch/U.S. Census Bureau Tigerline Shapefiles 2018)

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).

Family Income

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 3.5.2.2.

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 3.5.3 and 3.5.8.3. 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 FR 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 2017 (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 3.5.11, 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.

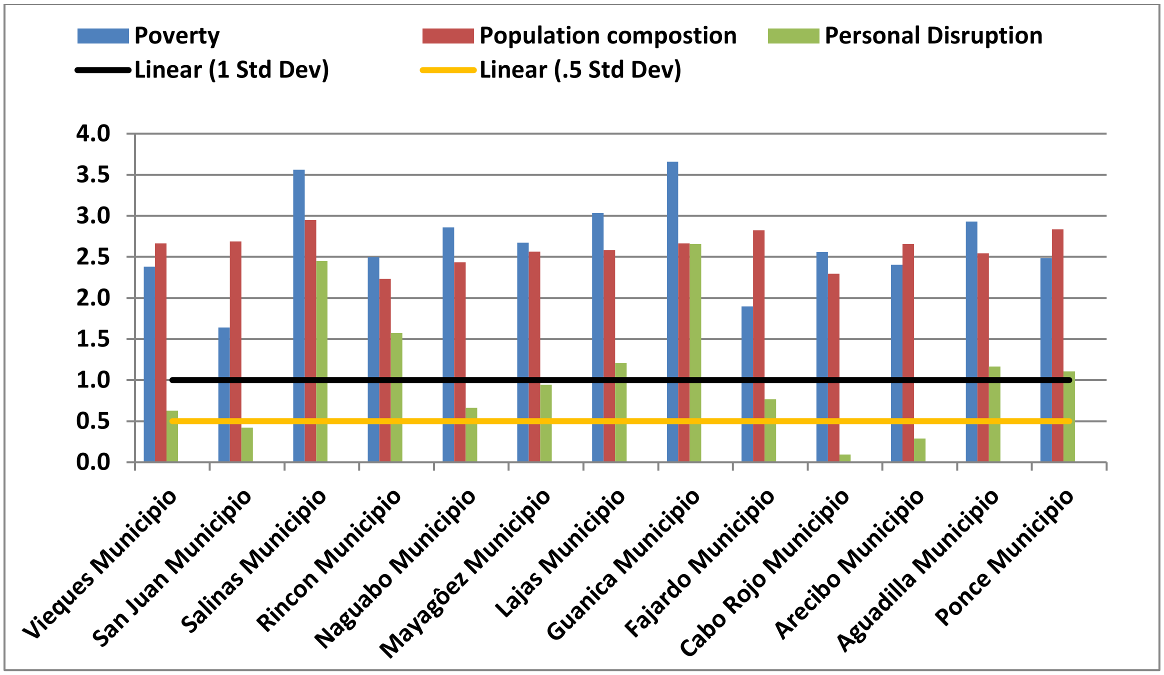


Figure 3.5.11. Social vulnerability for Puerto Rico coastal municipalities with most fishing engagement.
(Source: SERO County Social Vulnerability Indicators database (ACS 2010) 2018)

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[49]) barely missed Puerto Rico and the USVI with 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

[49] https://www.nhc.noaa.gov/aboutsshws.php

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 3.5.12-3.5.15 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 3.5.12. Effects of Hurricane Maria in Playa Húcares, Naguabo, eastern Puerto Rico. (Source: C. Velazquez 2017)

Figure 3.5.13. Effects of Hurricane Maria on fishing vessels and launching ramps in Los Machos, Ceiba, eastern Puerto Rico.
(Source: C. Velázquez 2017)

Figure 3.5.14. Effects of Hurricane Maria in Crashboat, Aguadilla, in northern Puerto Rico.
(Source: C. Velázquez 2017)

Figure 3.5.15. 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-Caraballo 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[50].

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,

[50] http://www.nmfs.noaa.gov/sfa/management/disaster/index.html

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[51].

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 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 Fisheries 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

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51 https://www.commerce.gov/news/press-releases/2018/02/us-secretary-commerce-declares-fisheries-disasters-following-hurricanes

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 (Regional Fisheries Management) 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).

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 H 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. - Impact of invasive species such as lionfish on target species (Testimony at Council meetings, informational meetings, other venues; Ñeco 2013). - 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).

Resource Health
- 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). - Impact of hurricanes and climate change (Valdés-Pizzini 2011). - 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). - Fear that the fishery is aging out as younger generations are selecting other types of income generating activities. - Displacement of coastal fishing communities due to coastal construction projects and developments. - Potential loss of access to launching and landing sites, and further displacement of commercial fishing and fishing-related activities from coastal communities. - Concern about conservation efforts affecting subsistence and commercial fishermen. - Concern about "global movement" against fishing that would affect subsistence and commercial fishermen (Valdes-Pizzini 2011). - 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). - 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).

Management and Operations
- 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"[52] (Valdés-Pizzini 2011; testimony at Council meetings, informational meetings and others; personal communications with fishermen). - 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). - 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). - 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). - 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). - 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). - 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). - Management regime should be tailored to the reality of the islands and should not try to mimic management in the U.S. mainland. - 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

[52] 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.

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. - 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 - Many fishermen do not understand the scientific and socio-economic importance of fisheries statistics (Valdes-Pizzini 2011) - 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) - 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: Transition Fisheries Management in the Puerto Rico Exclusive Economic Zone (EEZ) from a U.S. Caribbean-wide Approach to an Island-based Approach

Summary of Management Alternatives

Alternative 1: No action. Do not transition management approach from an U.S. Caribbean-wide to an island-based approach. The four Council fishery management plans (FMP) (i.e., Reef Fish, Spiny Lobster, Queen Conch, Coral) 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 by repealing the four Council FMPs as they apply to the Puerto Rico EEZ and replace them with the new Puerto Rico FMP. The Puerto Rico FMP would include previous fishery management measures applicable to the Puerto Rico EEZ.

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 U.S. Caribbean-wide approach to federal fishery management in the U.S. Caribbean EEZ, and would not establish a Puerto Rico approach. 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 Caribbean Fishery Management Council (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 not directly affect the physical environment. Under **Preferred Alternative 2**, regulations would be reorganized from a U.S. Caribbean EEZ domain to a Puerto Rico EEZ domain and these would be placed in the Puerto Rico FMP, 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** (see Chapter 5). However, as discussed in the 2014 Environmental Assessment (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 continue the U.S. Caribbean-wide 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 U.S. Caribbean EEZ domain to a Puerto Rico EEZ domain, and these would be placed in the Puerto Rico FMP, 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/ecological environment from fishing activities by enhancing fisheries management, allowing for an island-based approach. 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 (NMFS 2014). Even if the Council does not choose **Preferred Alternative 2**, it could amend management measures under the U.S. Caribbean-wide FMPs, with certain benefits to the biological/ecological environment, however, the benefit of an island-based approach (i.e., enhance fisheries management) would not be realized.

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 types used or effort expended).

4.1.3 Direct and Indirect Effects on the Economic Environment

To ascertain whether the net benefits associated with **Preferred 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 an U.S. Caribbean-wide approach 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 **Preferred 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 an U.S. Caribbean-wide 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. It is the fishermen who have requested an island-based approach to management in lieu of the current U.S. Caribbean-wide 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 U.S. Caribbean-wide 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 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. 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 environments of Puerto Rico. **Preferred Alternative 2** would create an individual plan for Puerto Rico and would address 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. Thus, 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.

Under **Preferred Alternative 2** regulations would be reorganized from a U.S. 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 (reorganized) regulations are established. However, long-term effects could be positive, though the expected benefits are unknown as future impacts to the human environment depend on the nature of the specific future management actions. Even if the Council does not choose

Preferred Alternative 2, it could amend management measures under the U.S. Caribbean-wide FMPs, with benefits to the administrative environment.

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

Summary of Management Alternatives

Alternative 1. No action. The Puerto Rico FMP would include all species presently managed under the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs.

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

> ***Criterion A.*** Include overfished species in U.S. Caribbean federal waters, species with harvest prohibitions due to their ecological importance, or species with seasonal closures or size limits.
>
> ***Criterion B****.* From the remaining species, <u>exclude</u> species that infrequently occur in federal waters based on expert analysis guided by available data.
>
> ***Criterion C****.* From the remaining species, <u>include</u> 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.
>
> ***Criterion D****.* From the remaining species, <u>include</u> economically important species (to national or regional economy) based on a threshold of landings or value and those that are an important component of bycatch, as established by expert analysis.
>
> ***Criterion E****.* From the remaining species, <u>include</u> any other species that the Council determines are in need of conservation and management.

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, queen conch, 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 effects on the physical environment 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 fish, queen conch, spiny lobster, and all species of coral, sea cucumbers, and sea urchins included for management in the Puerto Rico FMP. Species for which the majority of catch occurs in territorial waters would be removed. As noted in Section 2.2.2, removing species from federal management does not directly affect how the fisheries operate. Fishermen would be expected to continue to fish in Commonwealth waters for those species removed from federal management via **Preferred Alternative 2**, where the majority of fishing effort for these species occurs. If fishing effort and harvest methods remain the same without federal management, then indirect effects to the physical environment from fishing for these species would not be expected to change. The effects to the physical environment could increase, however, if fishing effort, and associated effects from gear interactions, increased without federal oversight, but this is not expected to occur. Most of these species are already managed by the territory. Due to the small amount of fishing effort applied to catching these non-targeted species in federal waters, plus given that the methods used to fish for these species minimally affects the physical environment (e.g., hook and line), impacts to the physical environment are not expected.

Adding species previously not managed would potentially have indirect effects on the physical environment if it changed fishing behavior, for example, if it resulted in new gear types, fishing areas, or fishing effort not previously in use, but these routes are not expected for any of the species added in **Preferred Alternative 2**. This alternative would result in the Council establishing measureable management measures (although not in this action) for the newly added species, and any indirect effects that may occur from interactions between the physical environment and fisheries catching these new species would be limited. For example, including all sea urchins and sea cucumber species in the Puerto Rico FMP could have indirect physical effects. Under the U.S. Caribbean-wide FMPs, only select sea urchins and sea cucumbers are managed. Managing all species allows the Council to ensure that harvest levels and methods are commensurate with the important role that all of the species in these two groups play as ecosystem engineers within the coral reef ecosystem. For example, the Council could prohibit harvest of these species under the Puerto Rico FMP. 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 from the Puerto Rico EEZ is unknown but likely near zero, the physical effects of choosing to manage all of these species and potentially taking action to prohibit all harvest would be expected to be minimal when compared to outcomes expected from **Alternative 1**. Regarding pelagic species to be managed under **Preferred Alternative 2**, such as dolphin and wahoo, these species are already legally harvested from the Puerto Rico EEZ by both commercial and recreational fishermen, generally using common hook-and-line methods. Adding these 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.

4.2.2 Direct and Indirect Effects on the Biological/Ecological 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., amount of fish caught) and is not expected to have direct effects on the biological/ecological environment. Indirect effects may apply depending on the species selected or removed from management, and management measures established or removed.

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 conservation and management. **Alternative 1** would not add new species to the Puerto Rico FMP. On its own, adding species to the plan will not change how the fisheries operate. However, adding these species and managing them could have indirect biological/ecological effects. Without adding these species to the plans, 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, **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 socio-economic benefits. Under **Alternative 1**, the Council would take no action to reevaluate and revise (as appropriate) the species to be included for federal management and the associated benefits to the biological and ecological environment are lost. The Council, could however, take this action in a future amendment.

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**. 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** includes species that that were not included in the previous FMPs, but are currently considered to be biologically vulnerable or ecologically important, such as sea urchins and sea cucumbers. This would include species such as the giant manta ray, which was listed in January 2018 as threatened under the ESA. **Preferred Alternative 2** would also benefit the biological/ecological environment indirectly because, once these species are included in the FMP, the Council must establish catch limits, including limits for the highly targeted stocks that are currently without federal 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.

Not every fishery needs federal regulation. 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.

With respect to ESA-listed species, **Alternative 1** and **Preferred Alternative 2** would both include for management the seven listed coral species (see Table 3.3.1), and Nassau grouper, thus indirect effects to the biological/ecological environment resulting from management of these species would be expected to be similar for these two alternatives. However, **Preferred Alternative 2** also includes for management the giant manta ray, thus it would be more conservative than **Alternative 1** and those indirect biological/ecological effects would be expected to be greater for **Preferred Alternative 2**. In addition, both alternatives would include for management fish species (e.g., parrotfish and surgeonfish) that are ecologically important inhabitants of coral reefs. However, unlike **Alternative 1** which only includes for management a finite number or corals, sea urchins, and sea cucumbers, **Preferred Alternative 2** would include for management all species of corals, sea cucumbers, and sea urchins within the Puerto Rico EEZ. That comprehensive management approach could indirectly affect the amount of habitat available for recruitment of ESA-listed corals. For example, sea urchins graze algae covered substrate completely, leaving clean surfaces for coral recruits to attach. To the extent that management protects these species and allows them to continue to complete this function, then management would have beneficial effects. However, as noted above, considering that harvest from the Puerto Rico EEZ is unknown but likely near zero, the effects to the biological/ecological effects of choosing to manage all species of sea cucumbers and sea urchins and potentially taking action to prohibit all harvest would be expected to be minimal when compared to outcomes expected from **Alternative 1**. Additionally, species new to management proposed under **Preferred Alternative 2** would not be expected to increase impacts to ESA-listed species, as the gear types used in the harvest of these species is the same as is used in the managed fisheries.

In summary, compared to **Alternative 1**, **Preferred Alternative 2** would be more beneficial to the biological/ecological environment because it would include species that have not been previously subject to conservation and management. As a result, the Council must establish ACLs and could establish other measures that would provide a more comprehensive management of the coral reef ecosystem. In addition, the Council could set measures to protect biologically vulnerable species or ecologically important as discussed above. 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) would bring all species previously managed in the Reef Fish, Queen Conch, Spiny Lobster, and Corals FMPs into the new Puerto Rico FMP. Under **Alternative 1** (no action alternative), 81 species of reef fish, 58 species of aquarium trade fish, spiny lobster, queen conch, 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. Since current fishing practices under **Alternative 1** would remain unchanged, no direct economic effects would be forthcoming. While largely administrative, there may be some indirect economic effects associated with **Alternative 1** (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 prevent overfishing while achieving, on a continuing basis, the optimum yield from the fishery.[53]

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.

[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.

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** includes species that that were not included in the previous FMPs, but are currently considered to be biologically vulnerable or ecologically important, such as all sea urchins and sea cucumbers. This would include species such as the giant manta ray, which was listed in January 2018 as threatened under the ESA. **Preferred Alternative 2** would also benefit the biological/ecological environment indirectly because, once these species are included in the FMP, the Council must establish catch limits, including limits for the highly targeted stocks that are currently without federal 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. A more comprehensive management system would, in turn, generate a healthier ecosystem. A healthier ecosystem, in turn, implies a larger carrying capacity for other species dependent upon that ecosystem. Ultimately, this will result in larger stocks (controlling for other factors) and greater fishing opportunities by the commercial and recreational sectors. The benefits of these larger stocks, however, depends on mechanisms in place to control effort. Without effective mechanisms to control effort, producer surplus in the commercial sector resulting from the higher stocks will likely be dissipated over time

Historical landings associated with some of the species which would be added within the framework of **Preferred Alternative 2** are relatively large and are migratory in nature (e.g., dolphin, blackfin tuna, little tunny, wahoo, cero mackerel, and king mackerel). Inclusion of these species, as noted, will provide a more comprehensive management of the Puerto Rico coral reef system. The relatively large landings of some of these species, however, also 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).[54] Finally, to fully consider economic impacts that may, in the long run, be attributable to including these species in the Puerto Rico FMP, one must consider how limited enforcement resources 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.

Not every fishery needs federal regulation. 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

[54] 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.

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. The paucity of landings of these species in federal waters suggests that they are not targeted in federal waters. Hence, one might conclude that direct economic effects associated with exclusion of these species from the Puerto Rico FMP would be minimal. Given limited enforcement resources in the region, furthermore, exclusion of these infrequently harvested species may allow for enhanced enforcement activities associated with those species of greater economic and/or ecological relevance.

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 Reef Fish, Queen Conch, Spiny Lobster, and Coral FMPs will continue to be managed, but the Council would not add new species nor remove species from management. 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 methodical approach that takes into consideration biological, socio-economic, 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. New species identified as having ecological importance and added under Criterion C were cubera snapper, yellowmouth grouper, gray triggerfish, great barracuda, tripletail, giant manta ray, spotted eagle ray, and southern stingray. Other species included under Criterion D were crevalle jack, African pompano, rainbow runner, dolphin, pompano dolphin, little tunny, blackfin tuna, king mackerel, cero mackerel, and wahoo. These species that have economic importance, and will be managed to prevent overfishing while ensuring optimum yield. These species are undoubtedly of social importance also and by including them into management, the Council can tailor management to ensure their continued positive social effects. Furthermore with the addition of all sea cucumbers and sea urchins, there would likely be positive social effects from management and conservation of these species.

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 **Alternative 1** continues management of the species included in the Reef Fish, Spiny Lobster, Queen Conch and Coral FMPs already have the list of species in place.

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, 36 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 or Order level, requiring management measures for only three complexes.

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

Summary of Management Alternatives

Alternative 1. No action. Retain the stock complex organization from 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 four U.S. Caribbean wide FMPs, but which would be managed under the Puerto Rico FMP via Action 2, no stock complexes would be established.

Alternative 2. Do not organize the species in the Puerto Rico FMP into stock complexes.

Alternative 3 (**Preferred**). 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 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:
Sub-alternative 4a (**Preferred**). Indicator stocks would be used. One or more indicator stocks would be assigned within a stock complex based on specific criteria. 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).

Sub-alternative 4b (**Preferred**). 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.

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 as it is not expected to change fishing behavior. Indirect effects on the physical environment would depend on how the stocks, stocks complexes, or indicator stocks are managed and how fishing activities such as fishing effort and gear choice change as a result of that management.

Alternative 1 (no action) would retain the same organization of stocks and stock complexes from the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs, with two exceptions. Stocks that would no longer be managed as a result of Action 2 would be removed from the complexes, and stocks that are new to management would not be organized into complexes but would be managed individually. Indirect effects to the physical environment for those unchanged complexes would continue to occur based on interactions of the fisheries with the sea floor, but the effects would not be expected to be greater than those previously discussed in the 2010 and 2011 Caribbean ACL Amendments (CFMC 2011a, b), if the harvest levels stay the same (see Action 4, Section 4.4 for a discussion of how changing harvest levels could affect the physical environment). For stocks new to management that would be managed individually, indirect effects on the physical environment would be the same as **Alternative 2**, described below.

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 finfish 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, though the amount of fishing effort, and associated effects to the environment, could change. Indirect effects of fishing activities on the physical environment (i.e., the habitat, particularly that constituting the coral reef) would depend on whether and how individual management (e.g., establishment of ACLs and AMs) affects fishing effort. To the extent that it reduces fishing effort, it could reduce physical effects from interactions with fishing gear. ACLs would be set for the individual stock, and AMs would be applied at an individual level, and this could reduce fishing effort on a stock by stock basis. However, in a multi-species fishery where different stocks co-occur, as in Puerto Rico, individual application of AMs might not reduce overall effort in a particular area. For a discussion on how ACLs affects fishing effort see Action 4, Section 4.4.

Following Action 2, the composition of some stocks/stock complexes under **Preferred Alternative 3** would be the same as the composition under **Alternative 1** (see Section 2.3.2). For those stocks/stock complexes, the indirect effects to the physical environment would be expected to be the same under the two alternatives. For those stocks/stock complexes where the composition of stocks under **Alternative 1** differed under **Preferred Alternative 3**, any differences on the expected physical effects would be subtle because of the generalized approach to fishing. Indirect effects of fishing activities on the physical environment would depend on whether and how management (e.g., establishment of ACLs and AMs) affects fishing effort. However, again, to the extent that fishing effort is reduced, there could be benefits to the physical environment by reducing interactions with fishing gear.

Alternative 4 determines whether to assign indicator stock (**Preferred Sub-alternative 4a**) or to not assign an indicator stock (**Preferred Sub-alternative 4b**) to a stock complex. **Preferred Sub-alternative 4a** could have indirect effects on the physical environment. For complexes in which an indicator stock was selected, those effects would be expected to be beneficial if, for example, AMs that reduce the length of the fishing season based on landings of the indicator stock were triggered more frequently than AMs based on landings of the aggregate stock complex. More frequent AMs could reduce fishing effort and potential gear interactions; however on multi-species fisheries, like in Puerto Rico, an AM based fishing season reduction for one species that co-occurs with others in the fishery might not reduce overall pressure. 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 which is the premise of **Sub-alternative 4b** as discussed in Section 2.3.2. All physical 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**.

4.3.2 Direct and Indirect Effects on the Biological/Ecological Environment

Action 3 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 would depend on how the stocks, stock complexes, or indicator stocks are managed, including whether there is sufficient information to inform that management, and how fishing activities change as a result of that management.

For those stocks/stock complexes that are not changed in **Alternative 1** compared to the U.S. Caribbean wide FMPs, the indirect effects to the biological/ecological environment would continue to occur based as previously discussed in the 2010 and 2011 Caribbean ACL Amendments (CFMC 2011a, b), unless management measures controlling harvest are changed (see Action 4). Only a few stock complexes would be unchanged compared to the U.S. Caribbean wide complexes (e.g., Snapper 1, see Table 2.3.1), thus indirect effects to the biological/ecological environment could occur depending on how the changes to the complex composition alter management of these stocks. For stocks new to management that would be managed individually, indirect effects on the biological/ecological environment would be the same as **Alternative 2**, described below.

Alternative 2 would not group stocks into stock complexes and would result in management measures being established for each individual. For stocks that are caught in conjunction with other species or as part of a multi-species fishery, which is characteristic of the Puerto Rico reef fish fishery, if an AM that reduces harvest is applied to a stock but not others, managing at the individual stock level could be less biologically beneficial than stock complex management, in that it could increase the amount of discard mortality of the stock subject to the AM.

For stocks that have insufficient data to establish reliable SDC or evaluate stock status relative to the SDC (e.g., variable landings, infrequently caught, species misidentification), managing at the individual stock level could be less beneficial than stock complex management (as proposed in

Alternative 1 and **Preferred Alternative 3**), as managing these data limited stocks together with stocks with more data could better prevent overfishing of these stocks and ensure OY.

Following Action 2, the composition of some stocks/stock complexes under **Preferred Alternative 3** would be the same as the composition under **Alternative 1**. For those stocks/stock complexes, the indirect effects to the biological/ecological environment would be expected to be the same under the two alternatives. For those stocks/stock complexes where the composition of stocks differs, **Preferred Alternative 3** would be beneficial to the biological/ecological environment. When determining appropriate stock complexes under **Preferred Alternative 3**, the Council and its SSC considered the availability of information about each stock to establish SDC and monitor stock status as well as other factors, such as how the stock is targeted and where stocks co-occurred. **Preferred Alternative 3** represents the best balance of individual versus stock complex management. 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, when compared to **Alternative 2** and **Alternative 1**. For example, the Council can tailor management in a way that might avoid AM-based fishing season reductions, which reduces the potential for regulatory discards and discard mortality. In addition, the Council would be better positioned to set ACLs that would provide better protection of the stocks and stock complexes.

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. **Preferred Sub-alternative 4a** increases the potential indirect 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, or be more vulnerable, with special regard to interactions with the fishery. In data-limited situations, indicator species minimize the risk 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. Where an appropriate indicator cannot be selected, 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. Indirect effects to ESA-listed species may occur if individual stock versus stock complex management affects harvest and resource use and the potential for fishing-related interactions. It is not possible to know how individual stock or stock complex management would affect those interactions, as the factors that influence ESA-listed species are numerous and complex (e.g., co-location of the fisheries with the ESA species, seasonal migrations), or how the overall amount of pressure related to those factors would be affected.

4.3.3 Direct and Indirect Effects on the Economic Environment

The arrangement (or change in arrangement) of stocks 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 harvest or use of the resource. Indirect effects are manifested via management actions that follow from the complex organization and influence harvest and resource use.

Alternative 2 does not organize stocks into stock complexes. As noted in section 2.3, however, all stocks may not necessarily benefit from being managed as individual stocks due to issues associated with the mis-identification of some individual species and unreliability of landings associated with the less frequently caught species. Given these factors, it could be difficult to establish reference points that are protective of stock status while allowing access to the resource. Annual catch limits associated with each individual species within the Puerto Rico FMP would most likely result in a significant increase in administrative burden as AMs would need to be imposed when the ACLs are reached. These frequent AMs can be disruptive to the fishing communities, and may not be necessary to protect the stock if based on insufficient information. Reference points that do not protect a stock from overfishing could have long-term negative economic consequences. Individual management of the less frequently landed stocks is not likely to be effective, and could impose economic costs. These stocks are not targeted by 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 these infrequently caught species via individual stock management, such as stock specific ACLs and AMs, 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 stocks are also simultaneously curtailed. However, given the low landings of these infrequently caught stocks, short-term producer surplus would likely not be reduced significantly even with numerous AMs specific to the infrequently caught stocks. Thus, where insufficient information exists to manage a stock individually, or where stocks are caught together, managing the stocks in a complex, with a single ACL and AM for the complex, could avoid regulatory discards and protect economically important species. **Alternative 2** would prevent these benefits.

Like **Alternative 2**, **Alternative 1** is not expected to influence 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 stock complexes as in **Alternative 1**, could 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**. **Alternative 1** does rely on individual stock management for species that are new to management, however, it also relies on stock complex management. Hence, benefits associated with **Alternative 2** are less than those of **Alternative 1**.[55]

Preferred Alternative 3, like **Alternative 1**, would use the concept of stocks and stock complexes to manage species that were selected for management in Action 2. However, the organization of stocks and stock complexes would differ from those designated in **Alternative 1** (see Table 2.3.3). A comparison of **Alternative 1** with **Preferred Alternative 3** indicates some of the differences in the arrangement of stocks (stock complexes) represent inclusion of species new to management into stock complexes in **Preferred Alternative 3**. For example, yellowmouth grouper would be managed under the Grouper 4 stock complex and gray triggerfish would be part of the Triggerfish complex under **Preferred Alternative 3**. These stocks would not be grouped in a complex under **Alternative 1** and instead would be managed individually. Annual landings of these stocks are relatively limited, and therefore these stocks are not of significant economic importance. Other changes in stock complex organization reflect additional information about how the stocks are caught and additional consideration of life history information. For example, some complexes were further divided to reflect differences in the stocks (e.g., lane snapper was removed from Snapper Unit 3).

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 harvest or use of the resource. Subsequent regulations, such as implementation of AMs, could trigger a change in the economic environment. While differences between **Alternative 1** and **Preferred Alternative 3** are relatively minor (in terms of changes in the economic environment that may be forthcoming with regulation), **Preferred Alternative 3** relied on additional and more recent information to organize stock complexes than is the case with **Alternative 1**. 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 1** which, through time, 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 harvest or use of the resource. Assuming subsequent regulation, 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)

[55] See Section 2.3 for detail regarding types of scientific analysis which would be considered in development of the stocks and stock complexes.

the indicator stock selected and (b) the 'jointness in catch' among the individual stock in the complex.[56] Presumably, the indicator stocks selected would reflect those species which provide the most informative catch data.[57] If this is the situation and if catch in the multispecies fishery is highly joint in nature, use of an 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 better ensure that less frequently caught stocks (which have less informative data) would be better protected and not 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.[58]

4.3.4 Direct and Indirect Effects on the Social Environment

The organization of stocks and stock complexes, as proposed under Action 3, would not result in direct effects to the social environment because it would not influence fishing activities or use of the resource. The social effects from establishing stock complexes would be indirect as many of the impacts would come from ACLs, other reference points, and AMs that govern harvest of each stock or stock complex. Managing with stock complexes helps resolve the difficulty in establishing reference points for each individual stock, especially those that do not have reliable landings histories which can place unnecessary burdens on different fishing sectors according to their fishing practices for a particular species.

For the most part, **Alternative 1** (No Action) would organize stocks and stock complexes as they were organized under the U.S. Caribbean-wide FMPs. However, stocks that are newly added to management would not be included in complexes and would need to have reference points, such as ACLs, established individually, which may prove difficult if data are not available. Without reliable and consistent data, the reference points that would be established and AMs that could follow may result in fishing season reductions that disrupt fishing patterns. Managing species individually, for stocks new to management under **Alternative 1** and for all stocks under **Alternative 2**, has the potential to trigger unnecessary and onerous management actions that could have complex negative social effects. For example, if, as might be the case for some species, there is insufficient information to develop robust reference points based on available data, ACLs might be set at a precautionary level that could result in frequent closures.

[56] 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.
[57] See Section 2.3.2 for the set of criteria that may be used to select one or more indicator species.
[58] 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.

The selection of stock complexes or single stocks under **Preferred Alternative 3** relied on analysis and extensive review by expert and experience-based panels. This process, involving experts and user groups from the island, garners both scientific and public support and is consistent with the purpose of creating an FMP tailored to Puerto Rico. **Alternative 1** also relies on stock complexes and individual stock management. The complex organization under **Alternative 1** is largely the same as under **Preferred Alternative 3**, however, that organization was not re-reviewed with scientific and experience-based experts, and thus does not reflect a refined approach to management. For this reason, it is not likely to provide the same benefits to the social environment as **Preferred Alternative 3**.

Alternative 4 would allow the Council to choose indicator stocks that would be used to set SDC for a particular stock complex. Under **Alternative 4, Sub-alternative 4a,** the SSC evaluated various criteria to select indicator stocks and discussed those selections at a public meeting where members of the Puerto Rico DAP were able to offer input. This process lends confidence regarding the suitability of the indicator stock to manage the stock complex. **Alternative 4, Preferred Sub-alternative 4b** would be applied to those stocks complexes for which there is no appropriate indicator. In this instance, reference points would be established for the stock complex based upon the aggregate stock information and AMs would be applied based on those reference points. It is anticipated that the preferred alternatives would have positive social benefits through practical selection or non-selection of indicator stocks, that reflect available information. However, the formation of reference points for grouped stocks and the use of indicator stocks may induce some changes in fishing behavior if unanticipated closures occur as a result of thresholds for the stock complex being exceeded. 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

Action 3 would directly and indirectly affect the administrative environment. Direct effects result as management resources are expended to update the stock/stock complex organization (e.g., update regulations, revise management plans) and indirect effects depend on the resources needed to manage the resultant stock/stock complexes going forward (e.g., monitor ACLs and apply AMs). Generally, individual stock management would require more administrative resources than stock complex management.

Alternative 1 retains the prior stock/stock complex organization, as applicable, for stocks that were managed under the Reef Fish, Spiny Lobster, Queen Conch and Coral FMPs. Stock complexes were updated to reflect that certain species are no longer being managed as a result of Action 2. Species new to management are not organized into stock complexes and would be managed individually. Updating the management plans and regulations to revise these stock complexes directly impacts the administrative environment. Indirect administrative effects would depend on the amount and frequency of future administrative actions needed to manage these stocks/stock complexes. Management measures would need to be established for the species new to management, which would include 18 fish stocks and many individual stocks of corals, sea cucumbers, and sea urchins.

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 decrease the number of stock/stock complexes compared to both **Alternative 1** and **Alternative 2**, potentially increasing the positive indirect effects to the administrative environment. **Preferred Alternative 3** would be expected to result in better management of the stocks in the Puerto Rico FMP, as the stocks and stock complexes were organized using the best information available. Thus, it would be expected that the number of future administrative actions related to these stocks/stock complexes would be fewer and less frequent than under other the alternatives. As with **Alternatives 1** and **2**, indirect effects would result from establishing management measures for the species new to management.

Preferred Sub-alternative 4a (selecting an indicator stock) would have minimal direct effect on the administrative environment and **Preferred Sub-alternative 4b** (not selecting an indicator stock) would have no direct effect on the administrative environment. The direct effect of **Preferred Sub-alternative 4a** follows from expending management resources to update the management plan and regulations to reflect the selection of an indicator stock. The indirect effects depend on updating the management measures applicable to the stock/stock complex and managing those stock/stock complexes. 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 scientific information available 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

Summary of Management Alternatives

Alternative 1. No action. Retain the management reference point values and SDC specified in the 2010 and 2011 Caribbean ACL Amendments; and the Caribbean SFA Amendment definitions for MSST.

Alternative 2 (**Preferred**). Where data are available, use sector (i.e., commercial, recreational) information to derive and establish reference points and SDC for the stock or stock complex, and set ACLs by sector.

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

Step 1. Adopt and apply the ABC Control Rule described in Table 2.4.1.

Step 2. 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 $F_{MSY} = F_{40\%SPR}$;
- **Sub-alternative 3c** (**Preferred**). The proxy for $F_{MSY} = F_{30\%SPR}$

Step 3. Determine the OY and the ACL based on the sub-alternatives below and the ABC from **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 and/or 2011 Caribbean ACL Amendments, as applicable, to set management reference points and/or SDC.

Step 1. Time Series:

- **Sub-alternative 4a.** Use the longest year sequence of reliable landings data available;
- **Sub-alternative 4b.** Use the longest time series of pre-Caribbean SFA Amendment landings data considered to be consistently reliable;
- **Sub-alternative 4c.** Use 2012-2016 as the most recent five years of available landings data;
- **Sub-alternative 4d.** Use another year sequence, as recommended by the Council's SSC

Step 2. Determine the MSY proxy (the MSY proxy = OFL):

- **Sub-alternative 4e.** Median annual landings from the year sequence selected in Step 1;
- **Sub-alternative 4f.** Mean annual landings from the year sequence selected in Step 1;
- **Sub-alternative 4g.** Maximum of a single year of recreational landings x 3 during the year sequence selected in Step 1 (for recreational only).

Step 3. Determine the ABC:

- **Sub-alternative 4h.** Do not specify an ABC Control Rule. Adopt the ABC recommended by the Council's SSC;
- **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.

Step 4. Determine ACL and OY (OY = ACL):

- **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

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, as applicable to stock/stock complex composition (resulting from Action 2) and organization (resulting from Action 3). **Alternative 1** simply carries over the existing management reference points and SDC as discussed in Section 2.4.2. This alternative would largely maintain the status quo, which would not have effects to the physical environment beyond those existing effects from fishing for managed stocks and stock complexes. However, **Alternative 1** does not respond to and incorporate additional data, and does not adapt to a changing suite of managed stocks. Failing to revise management would preclude realization of any benefits or negative consequences of updated reference points, discussed in **Alternative 3** and **Alternative 4**. Stocks newly added to the Puerto Rico FMP would not be accounted for in **Alternative 1**, a result that does not meet the requirements of the Magnuson-Stevens Act. Not specifying and monitoring harvest levels for newly added stocks, however, is not expected to change fishing behavior relative to the status quo, and thus is not expected to alter effects to the physical environment. These stocks were not managed and the continued absence of harvest levels is not expected to change behavior, though selecting this alternative would prevent realizing any benefits to the physical environment from management.

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 is not expected to 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, whether or not the sectors are managed separately should not alter overall effects to the physical environment. Effects to the physical environment occur as a result of gear interactions (traps, hook and line) and interactions with vessels, including anchors. The potential for these interactions varies depending on the fishing effort. **Alternative 3** and **Alternative 4** could change allowable catch levels compared to the status quo. Whether the sectors are managed separately or not should not affect overall catch levels and overall fishing effort, and thus should not alter effects to the physical environment. However, to the extent that failing to manage by sector concentrates fishing effort at a particular time—for example, if, without sector separation, both sectors concentrate their efforts at the beginning of the fishing season to ensure access to the resource—and this concentrated efforts increases the potential for interactions with the physical environment, then there could be effects to the physical environment.

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**, could result in short- and long-term effects to the physical environment depending on how fishing effort is adjusted. Reducing catch limits would generally reduce fishing effort and the potential for negative effects to the physical environment from gear and vessel interactions. Increasing catch limits would be expected to have the opposite result. However, in a multispecies fishery, where many fish are caught together, reducing harvest of one stock or stock complex but allowing harvest of others may not reduce overall effort and associated effects to the physical environment.

Step 1 applies a tiered control rule to develop reference points and SDC, depending on available information. Step 2 provides that when information is not available to determine the fishing mortality rate when fishing at maximum sustainable yield quantitatively, the Council can select a qualitative proxy. When applied over the long-term, this fishing mortality rate would allow a stock to achieve the maximum sustainable yield. **Sub-alternative 3b** of Step 2 is more conservative and thus, when data exists for this proxy to inform practical management measures, it could provide greater protections to the physical environment from reducing the potential for interactions than **Sub-alternatives 3a** and **3c** (**Preferred**). Step 3 derives OY and ACL from the ABC established via the tiered control rule in Step 1. With the series of sub-alternatives included in **Preferred Alternative 3,** Step 3, progressing from **Sub-alternative 3d** to **Sub-alternative 3i**, each sub-alternative progressively identified a more restrictive OY and ACL, with **Sub-alternative 3i** the most restrictive (no catch). As the sub-alternatives progress to a larger buffer between the ABC and ACL and lower ACL and OY, the effects to the physical environment would become increasingly positive as interactions between gear and habitat are reduced due to catch limits becoming increasingly lower.

Alternative 4 would follow the SDC and reference point setting methodologies developed in the 2010 and 2011 Caribbean ACL Amendments. The effects to the physical environment resulting from **Alternative 4** would depend on the combination of sub-alternatives selected and the catch levels resulting from application of this control rule, with interactions between gear and habitat reduced with lower catch levels. Step 1 **(Sub-alternatives 4a-4d**) would depend on the catch history (i.e., landings) of the stock and would could vary greatly depending on the length and timing of the year sequence selected. For some stocks, historical landings (**Sub-alternatives 4a** and **4b**) were not reported at the stock level, but rather at the family level (e.g. groupers). For those stocks, landings may be more reliable under **Sub-alternative 4c**, which uses a more recent year sequence, and may reflect updated landings reporting to the stock level. Step 2 (**Sub-alternatives 4e-4g**) would depend on the catch data available during the year sequence selected in Step 1. **Sub-alternative 4g** would be expected to return the greatest number for recreational data when compared to either the mean or the median value. For commercial stocks, the result would depend on the variability in the annual catch, which again would vary greatly by stock. With the exception of **Sub-alternative 4h**, in which the SSC would select and apply an altenative control rule, Step 3 (**Sub-alternatives 4i-4l**) would result in an increasingly lower ABC with the progression of each sub-alternative following from **Alternative 4**, Steps 1 and 2. Thus greater benefits to the physical environment would be expected with **Sub-alternative 4l** (ABC = OFL*0.75), as it applies the greatest reduction factor from OFL. Similarly, the final step in **Alternative 4** sets the ACL by applying a reduction buffer to the ABC resulting from Step 3 in order to account for uncertainty in the management process (**Sub-alternatives 4m-4r**). The range of reduction buffers is identical to the range of buffers included in **Preferred Alternative 3**, Step 3 (**Sub-alternatives 3d-3i**). The physical effects of lower catch levels would be expected to be the same as for **Preferred Alternative 3** discussed above.

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, as applicable to the stocks and stock complexes to be managed under the Puerto Rico FMP (See Section 2.4.2). 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, see below), 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 Caribbean 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 ensuring that the Council 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 dolphin and such ecologically important stocks as sea urchins. That outcome could result in direct negative biological effects because, without management reference points, these stocks may not achieve OY and indirect negative ecological effects by failing to ensure the provision of essential ecosystem services such as grazing capacity.

Preferred Alternative 2 would establish management reference points for a stock/stock complex in the Puerto Rico FMP be using sector specific information (e.g., commercial and recreational), when the data allow. Only ACLs would be set by sector. This is an administrative action with minimal direct or indirect biological/ecological impacts. All of the alternatives consider available sector landings and sector-specific ACLs are included in the presently existing management reference points applicable to the Puerto Rico EEZ, thus, there would be no difference in outcome between **Alternative 1** and **Preferred Alternative 2**. The biological/ecological environment would not be affected 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. **Preferred Alternative 3** sets forth a three step process to derive MSY or its proxy, SDC, ABC, ACLs, and OY. In step 1, the Council applies a tiered ABC CR to determine MSY and SDC, or their proxies. Higher tiers in the ABC CR reflect more information about the stock. With less information, more conservative approaches are warranted. The Council and their SSC applied considerable expertise and effort to the process of developing the ABC control rule (CR) in Step 1 of **Preferred Alternative 3**, establishing the process and protocols for implementing that ABC CR. Relying on a tiered control rule provides positive short- and long-term benefits to the biological/ecological environment by ensuring the best information is used throughout time to develop reference points indicative of potential negative trends in reproductive capacity and ecological function. Under National Standard 2 of the Magnuson-Stevens Act, the Council must always use the best scientific information available. The tiered ABC CR sets up a system that anticipates evolving and better information. If the Council selects another ABC CR that does not contemplate better information, for example information from stock assessments that would be used in Tier 1, it would have to develop and apply another ABC CR that is able incorporate that information when it becomes available. Under **Preferred Alternative 3**, the Council would be able to update management measures, SDC, reference points, and catch limits by simply re-applying the tiered ABC CR. Reflecting potential data limitations, Step 2 of the control rule provides that the Council can select a proxy for the fishing mortality rate when fishing at the maximum sustainable yield when that fishing mortality rate cannot be derived from the ABC CR. When data allow, 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**).

For each of **Preferred Alternative 3** and **Alternative 4**, the final step in the process of establishing reference points is to set the ACL/OY. The Council selected **Preferred Alternative 3** as preferred based on the benefits of the tiered approach, discussed above, and directed the SSC to apply the control rule to develop reference points and SDC from the ABC CR. The SSC accounted to some degree for uncertainty when establishing SYL (Tier 4) 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 (**Sub-alternatives 3e-3h**). Those reductions are slightly less than the reductions in the reference points that would be carried over from the U.S. Caribbean-wide FMPs 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 uncertainty reduction inherent in **Alternative 1**.

The series of sub-alternatives included in **Preferred Alternative 3** Step 3, progressively identifies a more restrictive OY and ACL, from no buffer in **Sub-alternative 3d** (no buffer)**,** 5% buffer in **3e** (preferred for all stocks but parrotfish, angelfish, and surgeonfish), 10% buffer in **3f,** 15% buffer in **3g** (preferred for parrotfish, angelfish, and surgeonfish to account for the ecological services these stocks provide to the coral reef ecosystem), 25% buffer in **3h** to no catch in **3i** (most restrictive). As the sub-alternatives progress to a larger buffer between the ABC and ACL and lower ACL and OY, the biological/ecological effects would become increasingly positive due to catch limits becoming increasingly lower.

Effects to the biological/ecological environment resulting from **Alternative 4,** Step 1 **(Sub-alternatives 4a-4d),** Step 2 **(Sub-alternatives 4e-4g)**, and Step 3 **(Sub-alternatives 4h-4l)** 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 biological/ecological effects, but the extent of those positive effects would be limited over time as this control rule does not provide a mechanism to consider and apply the best scientific information available and to update management as those data expand and improve. The range of reduction buffers to set the ACL in Step 4 of **Alternative 4** is identical to the range of buffers included in **Preferred Alternative 3**, Step 3 (**Sub-alternatives 3d-3i**). The biological/ecological effects would be expected to be the same as for **Preferred Alternative 3** discussed above.

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. However, it is uncertain how fishing under the new ACLs established under **Preferred Alternative 3** would impact ESA-listed species compared to the status quo, since some stock/stock complex-specific ACLs increased while others decreased. Overall, we expect decreases in ACLs to reduce the amount of fishing and the potential for fishing related interactions (interactions with gear, vessels, anchors). However, in a multispecies fishery, where many fish are caught together, reducing harvest of one stock or stock complex but allowing harvest of others may not reduce overall effort and associated effects to the biological environment.

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, in order to protect stocks (or complexes) from being overfished, while achieving, on a continual basis, OY. Ideally, these alternatives would be analyzed by examining the changes in producer and consumer surplus under each of the alternatives. The lack of information on costs in the commercial sector, from which information regarding consumer surplus is derived, the lack of information on the benefits derived from recreational fishing activities, and the lack of 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, where applicable (see Section 2.4.2). 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, do not reflect more recent analyses (e.g., changes in stock complex composition or organization).[59] If the status quo ACLs are specified in such a manner that they do not adequately protect stocks/stock complexes, 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 when landings exceed the ACL, action is taken to reduce

[59] 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.

harvest to 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. Without sector management, if the total ACL was met or exceeded and an AM triggered that resulted in catch restrictions applicable to both sectors, 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, exceeding a sector ACL would only reduce surplus on that sector subject to an overage. For example, under the current management scheme, which has separate sector management and triggers a sector AM when both the sector and total ACLs are exceeded, if the recreational sector of those fishing for yellowtail snapper meets or exceeds its ACL, and the total ACL is also met or exceeded, 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.[60] 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 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 fishing community asked the Council to consider the use of sector ACLs and therefore managing in this manner may yield greater compliance in the respective sectors.

Preferred Alternative 3 would use a three step process to specify the MSY or proxy, OFL or proxy, 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 effects on the economic environment.

Upon adoption of this control rule, an optional second step allows the Council to determine the proxy for the fishing mortality rate associated with fishing at MSY, when data is not available to derive this information from the ABC CR. This will inform qualitative approximations of MSY

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[60]This, of course, presumes adequate enforcement of the recreational sector (including the sale of recreationally harvested yellowtail snapper in commercial-based establishments).

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).

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[61]) 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.[62]

Given the lack of information, discussion of each of the sub-alternatives is also limited. Certainly as one moves 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 but this protection may be unwarranted (such as under **Sub-Alternative 3i** which sets OY and ACL equal to zero). The reduction in catches as one moves from **Sub-alternative 3d** to **Sub-alternative 3i** would, at least 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 will provide the necessary biological protection to the stock/stock complex. If reduction 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.[63]

Alternative 4 is comparable 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

[61] 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 scientifically '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.
[62] The assumption is being made that dockside price does not change in response to changes in binding ACLs.
[63] 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.

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.

4.4.4 Direct and Indirect Effects on the Social Environment

Setting management reference points can impose indirect social effects. Impacts are recognized after the catch limits are implemented and subsequent actions, such as AMs, follow to ensure compliance with those limits. The social effects of retaining reference points for stocks or stock complexes under **Alternative 1** may be negative because those reference points may not mirror the Puerto Rico fishery as it is being managed through this FMP. In applying **Preferred Alternative 2**, the Council would use available sector-specific information to establish management reference points and SDC for the stock or stock complex as a whole, and set sector-specific catch levels. This alternative would likely have positive social benefits as the ensuing catch levels ensure that each sector has access to the resource commensurate with 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 establishing reference points and SDC 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 scientific experts for specifying SDC for those species that do not have assessments (Tiers 4a and 4b). **Preferred Alternative 3** has an optional second step for establishing the proxy for the fishing mortality rate associated with fishing at MSY, when data is not available to derive this information from the step 1. The three sub-alternatives depend 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, to the extent it is able to inform catch levels, would provide greater assurance overfishing would not occur than the F_{MSY} proxies specified under **Sub-alternatives 3a** and **3c** (**Preferred**). Therefore, the social benefits of **Sub-alternative 3b** would be greater than **Sub-alternatives 3a** and **3c** (**Preferred**). With the series of sub-alternatives included in **Preferred Alternative 3** Step 3, 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 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 **Preferred Alternative 3**, **Alternative 4** would also use a series of steps to choose various reference points. For many sub-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.

Alternative 4 (Step 3) would identify 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 measures that are based on the ABC, 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, which is equal to the ACL, through the choice of a series of sub-alternatives. Under Step 4, OY is either equal to or reduced from ABC (**Sub-alternative 4m** to **Sub-alternative 4q**), or set at zero (**Sub-alternative 4r)**. Optimum yield is a reference point that takes into consideration social, economic and ecosystem factors to provide net benefits to the nation, and ACLs represent allowable catch levels. Setting a buffer from the ABC to establish OY and ACLs provides insurance that the stock would be healthier and thus positive social benefits should accrue as there should be continuous fish to harvest. However, buffers may not be necessary to protect the stock. Optimum yield is a management target and setting it too low may have negative short term social impacts, although, lower levels of OY and ACLs 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. The Council would select the sub-alternative that reflects its risk tolerance in view of available information.

Establishing reference points would not be expected to have direct social effects and any effects could be difficult to determine until reference point have been implemented and other processes such as stock assessments have been completed. Because the references points here are being selected with St. Croix and its stocks and stock complexes that are important for island fishermen in mind, then it is assumed that the social effects would be beneficial. Therefore, **Preferred Alternative 2** should have the most social benefits because it is more responsive to the actual fishery in St. Croix and uses more timely information. **Alternative 3** is somewhat outdated because of the timeframes that were used in previous amendments and was based on species that were more U.S. Caribbean-wide and not specific to the St. Croix fishery. However, it is difficult to determine precise social effects and the scope of their nature as mentioned because they are indirect effects that depend on many other factors. If the fishery remains healthy as a result and fishermen are not unnecessarily constrained in their ability to make a living or recreate, there should be positive benefits.

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.

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, enhanced long-term positive effects on the administrative environment could be expected from **Preferred Sub-alternative 3c** of Step 2 because, when data are available to rely on this proxy to derive reference points, 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. **Sub-alternatives 3d** to **3i** of Step 3 provide options for determining OY and ACLs from the ABC derived from Step 1. These alternatives result in progressively greater reductions from the ABC, and progressively lower catch levels. The lower the catch levels, the more likely administrative action will be taken to ensure accountability with those levels.

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 depend on the resulting catch levels and the administrative effort necessary to monitor and ensure compliance with those levels. Those effects will be essentially the same as those identified for **Preferred Alternative 3** above.

4.5 Action 5: Accountability Measures for Stocks and Stock Complexes

Summary of Management Alternatives

Alternative 1. No action. Retain the methods for triggering and applying AMs included in the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs and brought into the Puerto Rico FMP under Action 1. Do not establish AMs for new stocks.

Alternative 2 (**Preferred for reef fish and spiny lobster***). Trigger an AM if total landings (commercial + recreational, as applicable) exceed the total ACL, based on one of the sub-alternatives. The AM would be triggered only for the sector that exceeded its ACL.** The AM would reduce the length of the fishing season in the year following the overage determination and be applied from September 30 backward. If additional reductions are needed, they would be applied from October 1, forward.

> **Sub-alternative 2a.** Beginning with the most recent year available, use a single year of landings data;
> **Sub-alternative 2b.** Beginning with the most recent year available, use a single year of landings data, then a progressive running 2-year average of landings data;
> **Sub-alternative 2c.** Beginning with the most recent year available, use a single year of landings data, followed by a 2-year average of landings data, then a progressive running 3-year average of landings data;
> **Sub-alternative 2d** (**Preferred).** Use a single year of landings data from 2018, followed by a second single year of landings data from 2019, followed by a 2-year average of 2019-2020 landings data, then a progressive running 3-year average of landings data beginning with 2019-2021. The Regional Administrator in consultation with the Council may deviate from the specific time sequences based on data availability.

* Spiny lobster is not managed by sector

** if landings for one sector are not available for the averaging period, the ACL for the sector with available data would be the ACL for the stock/stock complex, and the AM would be triggered when available landings exceed that ACL.

Alternative 3 (**Preferred for pelagics**). Establish an ACT (**<u>Step 1</u>**) for the pelagic stocks/complexes only, and use the ACT as the AM. Upon exceeding the ACT (**<u>Step 2</u>**), the Council with the SEFSC would assess whether corrective action is needed.

<u>Step 1</u>: Specify the ACT for each stock:

> **Sub-alternative 3a** (**Preferred**)**:** ACT = ACL x 0.90; **Sub-alternative 3b:** ACT = ACL x 0.80**;**
> **Sub-alternative 3c:** ACT = ACL x 0.70; For each Sub-alt, 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.

<u>Step 2</u>: Determine the sequence of years to be used to determine if an overage has occurred.

> **Sub-alternative 3d.** Beginning with the most recent year available, use a single year of landings data;
> **Sub-alternative 3e.** Beginning with the most recent year available, use a single year of landings data, then a progressive running 2-year average of landings data;
> **Sub-alternative 3f.** Beginning with the most recent year available, use a single year of landings data, followed by a 2-year average of landings data, then a progressive running 3-year average of landings data;
> **Sub-alternative 3g** (**Preferred**). Use a single year of landings data from 2018, followed by a second single year of landings data from 2019, followed by a 2-year average of 2019-2020 landings data, then a progressive running 3-year average of landings data beginning with 2019-2021. The Regional Administrator in consultation with the Council may deviate from the specific time sequences based on data availability.

Alternative 4. Establish an in-season AM for stocks or stock complexes in the FMP. Harvest would be prohibited for the remainder of the fishing season if the total ACL is reached or projected to be reached.

Alternative 5 (**Preferred for corals, sea cucumbers, sea urchins, Nassau and goliath grouper, giant manta ray, spotted eagle ray, southern stingray, queen conch, and midnight, blue, and rainbow parrotfish**). For a stock with a harvest prohibition, the prohibition would serve as the AM.

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. Physical effects to the environment from fishing activities primarily result from gear interactions with physical structures such as seagrass beds or 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 fishing gear with the sea bottom, including structural habitat such as coral. Overall physical effects would also 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 if gear-bottom interactions increased. 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 may be neutral.

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** (see below). Positive indirect physical effects from the application of AMs reflect the reduction in fishing effort for the stock affected by the AM and/or a reduction in the number of anchoring events when fishing for the stock affected by the AM when the length of the fishing season is reduced (**Alternatives 1**, **2 (Preferred)**, and **4**) or harvest is prohibited (**Preferred Alternative 5**). However, these benefits would only be realized if fishing effort is not shifted to species not subject to the AM that are caught in the same areas with the same gear and methods. Within **Preferred Alternative 2**, the choice of **Sub-alternatives 2a-2d** could influence the frequency with which an AM-based fishing season reduction is implemented and the length of that fishing season reduction, however, 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 physical effects of each sub-alternative.

Indirect positive effects from the application of AMs would not be expected in the short-term from **Preferred Alternative 3** because triggering an AM under this alternative does not necessarily result in a fishery closure as in the other alternatives. The Council can, however, take corrective action if needed that could reduce fishing activities and the potential for gear and vessel interactions, which could benefit the physical environment. **Sub-alternatives 3a** (**Preferred**), **3b**, and **3c** simply set reduction factors from ACL to ACT and would likely have similar, if any, indirect effects to the physical environment. **Sub-alternatives 3d – 3g**

(**Preferred**) use the same year sequences as **Sub-alternatives 2a** – **2d** (**Preferred**). Again, it would be difficult to assess the relative physical effect of each sub-alternative.

An AM could result in an increase in fishing effort within the shortened season for stocks affected by an AM, though this would only be the case with a post-season AM (**Alternative 1; Preferred Alternative 2** -regardless of the sub-alternative chosen; **Preferred Alternative 3** -if the Council choses to reduce the fishing season for pelagic stocks, and regardless of the sub-alternative chosen), 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. 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 physical effect.

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 and these are expected from all alternatives proposed.

Under **Preferred Alternative 2** (post season AMs), positive benefits to the biological/ecological environment would be expected 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. As discussed in Section 2.5.2, **Sub-alternatives 2a-2d (Preferred)** under **Preferred Alternative 2** propose a different choice of years in a stepwise temporal approach to calculate average landings for comparison against the applicable ACL. Although 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, the specific effects associated with each of **Sub-alternatives 2a-d** (**Preferred**) 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. However, in general, the fewer years of landings used for comparison against the ACL (i.e., **Sub-alternative 2a** [single year of landings] or **Sub-alternative 2b** [one single year, then average of two-years]), the more variable the resultant year-to-year comparison will be against 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. 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 like that proposed in **Preferred Sub-alternative 2d**, the more closely management will achieve OY.

Alternative 4 (in season AMs) achieves the same goals as **Preferred Alternative 2** (post-season AMs) 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, and 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 occur from re-establishing AMs for previously managed stocks and by establishing AMs for newly managed stocks, as proposed in **Preferred Alternative 2 and Alternative 4**. Again, **Alternative 4** is advantageous relative to **Preferred Alternative 2** because **Alternative 4** provides an anticipatory rather than a reactive response as would be the case with **Preferred Alternative 2**.

For those stocks 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 during the fishing season. The post-season AMs contemplated in **Alternatives 1** and **Preferred Alternative 2** result in a lag in application of the AM to constrain harvest. 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. **Preferred Alternative 2** 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 (CFMC 2011a, b) and summarized as follows. 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 socio-economic) environments may result from the potential increase in regulatory discards of species caught during an AM fishing season reduction 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 re-submergence is unknown.

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 because it would not establish AMs for those stocks. This would likely negatively affect the biological/ecological environment by potentially failing to achieve OY or to minimize the risk of stock depletion due to a failure to properly manage harvest.

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 a future fishing season in response to an ACL overage (**Preferred Alternative 2**) may provide little positive biological/ecological benefit. The approach proposed in **Preferred Alternative 3** (establishing an ACT as a percentage of the ACL that would serve as the AM trigger) would require convening the Council to determine, based on advice from the SEFSC, whether corrective action is needed following an ACT exceedance. From the three sub-alternatives proposed under **Preferred Alternative 3** for setting the ACT relative to the applicable ACL (i.e., commercial or recreational ACL, where landings data are available to manage by sector, or where landings data are available for one sector only, the ACL for the sector with available landings), **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 and potentially take corrective action. That likelihood decreases with **Sub-alternative 3b** and is lowest with **Preferred Sub-alternative 3a**. The choice of years to calculate average landings for comparison against the applicable ACT as the determinant to trigger an AM proposed in **Sub-alternatives 3d-3g (Preferred)** could influence the frequency with which an AM is triggered, but the specific effects associated with each of **Sub-alternatives 3d-g** (**Preferred**) depend on the pelagic stock in question and the variability in landings associated with that stock. Without that information, it is difficult to assess the relative biological/ecological effects of each sub-alternative. In general, the biological/ecological effects from **Preferred Alternative 3** would likely be less beneficial relative to the other alternatives proposed because the AM would not require action in season or post season to limit harvest for the stock when triggered, risking potential depletion of the resource. However, long-term beneficial biological/ecological effects would be anticipated. Consulting with the SEFSC to take appropriate action 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. Any management revisions resulting from this would benefit stock productivity in the long-term with resultant benefits to the biological/ecological (and socio-economic environments discussed in Sections 4.5.3 and 4.5.4 below).

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 which the Council assigned an ACL of zero based on the Council's preferred alternative in Action 4). It is possible that beneficial long-term biological/ecological (and socio-economic effects discussed in Sections 4.5.3 and 4.5.4) 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 socio-economic 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.

No direct effects to ESA-listed species are expected from this action, as an administrative action that establishes how and when an AM would be applied. With the exception of **Preferred Alternative 3**, AMs under this Action would generally reduce the length of the fishing season for a stock or stock complex, potentially resulting in a decrease of interactions with ESA-listed turtle and fish (interactions with hook-and-line gear) or corals (interactions with trap gear or anchors). **Preferred Alternative 3** allows the Council to consider whether additional corrective action, which could include fishing season reductions or could result in changes to the ACLs, is needed. Although indirect effects to ESA-listed species may occur if and when those AMs are applied, 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, and thus how ESA-listed species could be impacted. 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, it is difficult to predict which fisheries would experience fishing season reductions.

4.5.3 Direct and Indirect Effects on the Economic Environment

If stocks/stock complexes newly added to the Puerto Rico FMP can potentially be overfished, or be subjected to overfishing in the future, **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. In addition, as noted in Section 2.5.2, **Alternative 1** would fail to comply with the requirements of the Magnuson-Stevens Act, which requires that mechanisms to ensure accountability with measures designed to prevent overfishing (namely, ACLs) 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 composed 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** (a single year of landings) would likely lead to the triggering of an AM in many instances where such a triggering 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 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 represent 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.

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**, which would rely on three years of landings, would appear to adequately protect the stocks/stock complexes while imposing the least economic costs on the fishing communities 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 **Sub-alternative 2c** with the difference being those which are entailed during the first few years of FMP operation. **Preferred Sub-alternative 2d** also allows the Regional Administrator to deviate from the specific years based on data quality and availability. Deviation from the specified years based on data quality and availability is beneficial from an economic perspective since use of years with 'better' quality data will provide more accurate estimates while the availability of data necessitates deviation from the specified years. However, **Sub-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 Sub-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. Based on the largely migratory nature of these pelagic stocks/stock complexes and the relatively wide geographical area over which these stocks/stock complexes are harvested, limited economic effects would be expected to result from **Preferred Alternative 3** in the long run. Among the proposed sub-alternatives, **Preferred Sub-alternative 3a** (i.e., ACT would be 90% of ACL) in conjunction with **Preferred Sub-alternative 3g** (which grants additional flexibility by allowing the Regional Administrator, in consultation with the Council, to modify the specific time sequences based on data availability) would impose the least costs on fishing communities and would also entail the least amount of administrative burden.[64] The rationale for **Preferred Sub-alternative 3a** is that it gives the highest ACT relative to ACL. When this ACT is met, the Council convenes to determine, in consultation with the SEFSC, whether corrective action is needed. The rationale for **Sub-alternative 3g**, which provides the years for which landings will be compared to the ACT, follows the line of reasoning used in the selection of **Sub-alternative 2d** in the economic analysis of **Preferred Alternative 2**. Conversely, the greatest costs to fishing communities (and high administrative burden) would be the combination of **Sub-alternative 3c** (ACT is 70% of the ACL) in conjunction with **Sub-alternative 3d** (single year of landings). Costs associated with all other combinations would fall somewhere in between these two extremes.[65]

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[64] It is worth noting that triggering of the AM would not automatically necessitate any mitigation of 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, or a post-season fishing reduction). 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 costs of not taking action to curtail future harvests are the costs of convening with the SEFSC.
[65] Benefits in all cases would likely be very low for reasons already cited.

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. Therefore, the benefits and costs expected from **Alternative 4** could only be thoroughly evaluated once the contours of in-season management are detailed and the data to support such a management approach are available. In general, in-season management provides a more timely response to ACL exceedances, and thus could more quickly impose economic costs than post-season management.

Potential benefits relative to costs associated with **Preferred Alternative 5** are expected to be relatively large. This is based on the consideration that ACL 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, midnight, and rainbow parrotfish, giant manta ray, spotted eagle ray, southern stingray, sea cucumbers, sea urchins, and corals). Hence, enhanced protection of these stocks is warranted.

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 stocks/stock complexes managed under the U.S. Caribbean region wide FMPs would continue to apply to the stock/stock complexes previously managed, 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 (commercial + recreational) 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 two-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. **Sub-alternative 2c** is similar to **2b** but, in the third year, uses a progressive three-year average. **Preferred Sub-alternative 2d** uses a similar stepwise approach as in **Sub-alternative 2c**, but it includes an additional single year of landings at the onset (single year, subsequent single year, two year average, three year average). It also prescribes the landings years to use, but allows the Regional Administrator to deviate from the specific years based on data availability. Which of these sub-alternatives would have the least negative social effects is difficult to determine. The alternative that best reflects fishing trends and prevents overages from occurring is the more desirable. Those that incorporate running averages, and allow flexibility based on data availability, 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 as an AM trigger and then apply the AM (assess any necessary corrective action) 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, because the more conservative approach resulting from **Sub-alternative 3c** likely would result in the ACT being met more frequently. This may have positive social effects in the long term, however, if catches stabilize, although it may require more frequent reevaluation of how stock/stock complex are managed to best reflect fishing practices, prevent overfishing, and ensure OY. **Sub-alternatives 3d-3g (Preferred)** would evaluate whether the AM trigger had been met (the ACT had been exceeded) based on landings from the same potential year sequences as the 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 applicable ACL is reached or projected to be 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 ACL of zero, **Preferred Alternative 5** would establish the harvest prohibition as the required AM. There would be few if any immediate social effects from choosing this alternative, however, over time as these stocks recover and harvest is again allowed there could be positive social effects in the long term.

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 a legal response. **Preferred Alternatives 2** and **3** (all sub-alternatives), **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 would increase the administrative burden. That result would be expected from those sub-alternatives that use a few years of landings (i.e., **Sub-alternative 2a, 2b**) instead of longer time series of landings (i.e., **Sub-alternative 2c, Preferred Sub-alternative 2d**). The fewer years of landings used, the more variable the resultant year-to-year comparison will be against the established ACL with more frequent exceedances of the ACL. This outcome would not be expected from **Sub-alternatives 3d -3g** (Preferred) of **Preferred Alternative 3** (*i.e.*, choice of years for comparison against ACT) because exceeding the ACT does not trigger a fishing season reduction, unless a closure is selected by the Council in consultation with the SEFSC as a corrective measure. However, exceeding the ACT requires the Council to take action to determine whether corrective action is needed, which imposes administrative costs. The additional condition included in **Preferred Sub-alternative 2d** and **Preferred Sub-alternative 3g** that allows the Regional Administrator in consultation with the Council to deviate from specific time sequences would add an inconsequential administrative burden. Lastly, **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 Species not Previously Managed in the Puerto Rico EEZ

Summary of Management Alternatives

Alternative 1. No action. EFH designations would not be described and identified for species new to management under the Puerto Rico FMP. EFH designations for species previously managed under the U.S. Caribbean-wide FMPs (i.e., Reef Fish, Spiny Lobster, Queen Conch, and Coral) would be retained.

Alternative 2 (**Preferred**). EFH designations would be described and identified for species new to management according to functional relationships between life history stages and marine and estuarine habitats, based on best scientific information available from the literature, landings data, fishery-independent surveys, and expert opinion.

Alternative 3. Use the highest level of detailed information below to describe and identify EFH for species new to management.

1) Designate EFH based on distribution data (distribution of habitat types, fish species and fishing effort) (Level 1 data – surveys of presence/absence);
2) Designate EFH based on habitat-related densities of the species (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) Designate EFH based on data on growth, reproduction, or survival rates within habitats (Level 3 – obtained from tagging data (growth), fecundity data by area);
4) Designate EFH based on production rates by habitat (Level 4); and
5) Designate EFH based on habitat suitability models (uses models prepared by National Ocean Service to infer information about species distribution, and possibly relative density).

4.6.1 Direct and Indirect Effects on the Physical Environment

Action 6 would identify and describe EFH for species new to management under Action 2. Designation of EFH has no direct effects on the physical environment, but may have indirect effects 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 (MSA Section 303(a)(7)). Second, federal agency actions that may adversely affect EFH trigger consultation and/or recommendations (MSA Section 305(b)(2)-(4)). As an example, positive indirect effects could occur if EFH designation leads to future regulatory action that increase area protections or lead to EFH consultations, and negative indirect effects could occur if EFH is not designated and if fishing activities (i.e., gear/anchor interactions with bottom) adversely impact bottom structure or function.

Fishing gear could have impacts on the biogenic structure and biota living on the bottom. However, the fishing gears used in harvesting the 18 new finfish species for which EFH must be designated are similar to fishing gears used for species already managed. The Council previously considered the effect these gears have on the physical environment in the Final Environmental Impact Statement (FEIS) for the Generic EFH Amendment (2004 FEIS) (CFMC 2004) and the Reef Fish FMP, and took action to protect areas that it had identified as EFH. If the Council identifies additional habitat areas as EFH for the species new to management, it would similarly need to take action to minimize the adverse effects to these areas of EFH from fishing, which could benefit the physical environment (assuming fishing practices harm these areas and the effects can be addressed). If no new habitat areas are identified as EFH, no further action may be needed, and no additional benefits would be achieved.

Alternative 1 would not comply with the Magnuson-Stevens Act, which requires that EFH be identified for all managed species, and therefore would not be viable. The indirect effects stemming from the decision not to identify EFH for the proposed species is that the Council would not identify new habitat areas as EFH, and thus would not be required to take action to protect these areas from fishing or to consult on effects to these areas. Thus, if EFH is not identified, potential benefits from consultation and actions to protect EFH might not be realized, but of course those potential benefits depend on new areas of EFH being identified and there being effects to these areas that can be offset, or there being something different about how the species use the EFH that results in additional protections from any EFH consultations.

Under **Preferred Alternative 2,** the Council would describe and identify EFH for species new to management following the same approach used in the 2004 FEIS (CFMC 2004) for those species already under management. **Preferred Alternative 2** identified 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 information available through literature review, fishery-dependent and independent data, and expert opinion (Section 2.6, Appendix I). **Preferred Alternative 2** identified new habitat areas as EFH for corals, sea urchins, and sea cucumbers, namely substrates in waters from mean low water to the outer boundary of the EEZ. This designation includes substrates in waters of all depths, not just subtrates in waters from mean low water to 100 fathoms as was previously identified as EFH for managed corals, sea urchins, and sea cucumbers. The substrates identified as EFH for tripletail, dolphin, pompano dolphin, little tunny, blackfin tuna, king mackerel, cero mackerel, and wahoo also included substrates from mean high water out to the outer boundary of the EEZ. Substrates in these deeper waters were not identified as EFH for species previously under management. Thus, there could be indirect effects from EFH identification (e.g., triggering future regulatory actions or consultations) on the physical environment for those newly added species. However, for the newly added species, **Preferred Alternative 2** would not be expected to lead to additional protective measures as interactions resulting from the use of hook-and-line gear to pursue deep-water species, such as queen and silk snapper, would have minimal impact on the underlying substrates. In addition, the Council prohibited harvest of managed coral reef resources and ray species through Action 4, positively benefitting EFH. Finally, projects affecting substrates located beyond 100 fathoms are generally infrequent (e.g., submarine cables and transmission lines) and the landward extent of those project from 100 fathoms already trigger EFH consultations.

Alternative 3 proposes other approaches to describe and identify EFH for species new to federal management that were explored in the 2004 FEIS (CFMC 2004) that could be used depending on data availability. The limiting factors for these approaches 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. At this time, indirect effects of **Alternative 3** would be the same as **Alternative 1** for the species new to management. When the data required for any of the approaches listed under **Alternative 3** become available, then the effects of this alternative would be expected to be similar to the effects of **Preferred Alternative 2,** as EFH would be designated for the new species. If the information allowed for additional or more precise descriptions of EFH, the effects might be more beneficial.

4.6.2 Direct and Indirect Effects on the Biological/Ecological Environment

Identifying EFH would not have direct effects on the biological/ecological environment, but indirect effects could occur depending on future regulatory actions taken to minimize effects to EFH (MSA Section 303(a)(7)) and EFH consultations on the effects to EFH (MSA Section 305(b)(2)-(4))).

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. 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.

Preferred Alternative 2 identifies EFH for newly proposed species for federal management and includes substrates in deeper waters than was identified as EFH for the previously managed species. **Alternative 3** would allow the Council to more finely identify EFH, if information was available to use **Alternative 3**. As a result, **Alternative 3** could inform more specific protections for the more finely identified EFH. However, at this time, we do not know what designations would result from **Alternative 3**, and thus do not know which additional protections might be needed or available.

Alternative 1 would not comply with the requirements of the Magnuson-Stevens Act, as it would not identify EFH for new species included in the Puerto Rico FMP. Negative indirect effects could occur under this alternative if habitats important to particular life stages for the species new to management were impacted from fishing or non-fishing activities. Not identifying EFH for the newly proposed species (**Alternative 1**), 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.

The indirect effects of **Preferred Alternative 2** and **Alternative 3** would depend on the EFH areas identified and future management actions associated to protect those areas. The Council may not need to take future action if the areas identified as EFH for the species new to management are the same as the areas previously identified as EFH in the U.S. Caribbean-wide FMPs. Likewise, 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 identifies and describes EFH for the species new to management, including substrates in deeper waters than was previously identified as EFH. Thus, **Preferred Alternative 2** could lead to additional protective measures from fishing gear regulations or additional protections resulting from consultations on federal actions that may adversely affect EFH. Although the EFH descriptions for the Sea urchins, Sea cucumbers, and Corals stock complexes included in the Puerto Rico FMP were updated to account for species new to management in the Puerto Rico EEZ, the Council prohibited harvest for each of these stock complexes and for all ray species under Action 4; thus, no additional measures to manage fishing for these species are necessary and no associated biological/ecological effects would be expected. Biological/ecological effects from identifying EFH for pelagic species, which also include deeper substrates, are not expected. Due to the pelagic nature of this fishery, which takes place in the upper water column only, and other deepwater fisheries (e.g., the silk and queen snapper fisheries), no measures to protect deeper substrates are expected. Finally, projects affecting substrates located beyond 100 fathoms are generally infrequent (e.g., submarine cables and transmission lines) and the landward extent of those project from 100 fathoms already trigger EFH consultations.

Alternative 3 would not describe or identify EFH at the present time, but in the future it might provide better information to inform management or consultations.

No direct effects to ESA-listed species would be expected from this action, as it just describes and identifies EFH for species new to management. Indirect effects could occur if, through future action, the Council puts protective measures in place to protect EFH (e.g., limiting fishing within an area) that also benefits ESA-listed species occurring within those areas.

4.6.3 Direct and Indirect Effects on the Economic Environment

Although identifying or not identifying EFH is merely an administrative action that would have no direct economic effects, not identifying EFH for species new to management as would result from **Alternative 1** 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 needed and 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.[66]

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 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. Likewise, if the same areas that are currently designated as EFH, and currently subject to protections and consultations, are designated as EFH for additional species, there would be no indirect benefits of stating that these areas also are EFH for additional 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 information, based on availability, for doing so. As with **Alternative 1**, these alternatives 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

[66] 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

gear and/or activities and regulations are implemented to protect EFH, there would be beneficial impacts to the habitat and species, thereby resulting in associated economic benefits (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. The net economic effects expected to result from **Preferred Alternative 2** cannot be determined at this time. The relative magnitude of any potential economic costs and benefits that could be expected to result from **Preferred Alternative 2** may only be estimated if (and once) specific regulations to protect EFH are outlined and enacted. However, as noted above, the Council is not expected to take additional action to manage fishing activities to protect these deeper EFH substrates, given the current harvest prohibitions and the pelagic nature of the deep-water fisheries. In addition, projects affecting substrates located beyond 100 fathoms are generally infrequent (e.g., submarine cables and transmission lines) and the landward extent of those project from 100 fathoms already trigger EFH consultations. **Alternative 3** would not yet result in EFH designations. and any potential economic benefits would only materialize once they serve as a basis for improving management in the future.

4.6.4 Direct and Indirect Effects on the Social Environment

Identifying EFH has limited direct social impacts, although by identifying and possibly protecting habitat by implementing 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 would not be identified 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 information to identify EFH. **Preferred Alternative 2** would use available information to describe and identify EFH, whereas **Alternative 3** would allow the Council to select among different approaches to determine EFH. The social effects of either alternative would be hard to determine, if they were both currently applicable, given the indirect links to other management alternatives that may or may not have some impacts. However, **Preferred Alternative 2** is more beneficial since **Alternative 3** is dependent upon information that is not available, although in the future if more information is available, **Alternative 3** may be a better choice. 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 OY. As mentioned in the economic effects section, positive social effects could be expected for those species for which **Preferred Alternative 2** described new areas as EFH (e.g., deeper waters for coral reef resources) within the U.S. Caribbean EEZ, as the coral reef ecosystem is vital to the well-being of the fishermen and fishing communities of Puerto Rico. However, the Council is not expected to take additional action to manage fishing activities to protect these deeper EFH substrates, given the current harvest prohibitions and the pelagic nature of the deep-water fisheries, and additional social effects are not expected. In addition, for the reasons noted above, additional EFH consultations are unlikely to yield additional social benefits.

4.6.5 Direct and Indirect Effects on the Administrative Environment

Alternative 1 (no action) would have a negative impact on the administrative environment since the description and identification of EFH is a required provision for FMPs, as stated in the Magnuson-Stevens Act. This could potentially result in lawsuits for non-compliance, which would require resources to address.

Preferred Alternative 2 uses the same approach that the Council previously used to identify EFH for the species under management in the U.S. Caribbean-wide FMPs. **Preferred Alternative 2** complies with the requirements under the Magnuson-Stevens Act as it identifies and describes EFH for newly proposed species for federal management, including newly defined substrates located beyond 100 fathoms for some managed species. Indirect effects from EFH identification on the administrative environment (e.g., triggering future regulatory actions or consultations) could be expected but projects affecting substrates located beyond 100 fathoms are generally infrequent (e.g., submarine cables and transmission lines) and the landward extent of those project from 100 fathoms already trigger EFH consultations. In addition, the Council is not expected to take additional action to manage fishing activities to protect these deeper EFH substrates, given the current harvest prohibitions and the pelagic nature of the deep-water fisheries.

Alternative 3 would allow the Council to select among a variety of methods to determine EFH. Although **Alternative 3** includes options that would provide the most refined description of EFH for all species under management, these data are not currently available to describe EFH for any of the species new to management, and therefore, this is not a viable alternative. Selecting **Alternative 3** would not result in EFH being identified, and would have the same effects as **Alternative 1**. If the information were to become available, the costs (in terms of administrative resources expended) of using one or more of the approaches under **Alternative 3** could be greater than the costs under **Preferred Alternative 2**. If more information were to become available, **Alternative 3** could result in EFH designations that could potentially result in additional or new management measures. Those new designations would have an indirect impact on the administrative environment depending on the effort required to update maps and information on EFH, as well as to promulgate any additional/new management measures necessary to protect the areas.

4.7 Action 7: Framework Procedures for the Puerto Rico FMP - Environmental Consequences

Summary of Management Alternatives

Alternative 1. No action. Retain the framework procedures included in the Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs listed in Table 2.7.1. No new or modified framework procedures would be added to the Puerto Rico FMP.

Alternative 2 (**Preferred**). Adopt the framework procedures listed in Table 2.7.2 that include both closed and open framework procedures and, within the open framework, the additional option of using an abbreviated framework.

Alternative 3. Adopt the broader framework procedures listed in Table 2.7.3 that include both closed and open framework procedures.

Alternative 4. Adopt the narrower framework procedures listed in Table 2.7.4 that include both closed and open framework procedures.

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 gear types 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 brought into the Puerto Rico FMP under Action 1. Thus, **Alternative 1** would have no additional effects to the physical environment from the baseline. Indirect positive 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 protected species, such as listed habitat-forming corals (e.g., the ESA threatened species *Orbicella annularis*, *Orbicella franski*) and those actions that close/open areas to fishing, and regulate fishing effort (e.g., adjustment of trip limits, bag limits, size limits, ACLs), among others.

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** may result in indirect physical impacts because of the timeliness of implementing the change to the management measures. Similar to **Alternatives 1** and **2 (Preferred)**, this could indirectly benefit the physical environment, for example if a speedier application of measures protecting the biological integrity of managed resources result in quicker protection to the physical environment. With respect to measures to protect the physical environment, **Alternative 3** is more beneficial than **Preferred Alternative 2** although similar to **Alternative 1**. **Alternative 3** allows for the modification of gear restrictions, including modifications to respond to interactions with protected species, like in both **Alternatives 1** and **2** (**Preferred**), but the changes allowed are broader than those in **Preferred Alternative 2** (i.e., change could include a complete prohibition on a specific gear). **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. For example, it does not provide for any framework measures to address gear interactions.

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 allow for the addition through framework of measures that may be more tailored to the specific fisheries within the Puerto Rico FMP. If a measure needed to be expeditiously taken to protect the biological integrity of a resource was not included in the framework (e.g., respecification of SYL), it could have negative indirect effects on the biology of the affected resource.

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. Effects on ESA-listed species and other species and the comparison with the other alternatives are similar to those discussed above under the physical environment. Changes to gear modifications could be expected to indirectly benefit the biological integrity of species, although these benefits would be minor and more insignificant than those expected from **Alternative 1. Preferred Alternative 2** only allows for minor changes to gear modifications to address to address conservation issues, including to respond to interactions with listed species, whereas **Alternative 1** allows for adjustment of gear restrictions or prohibitions.

Alternative 3 and **Alternative 4** may result in indirect biological/ecological impacts as a result of the timeliness of implementing the measure. Although all of alternatives proposed 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. With respect to measures to protect species, **Alternative 3** is more beneficial than **Preferred Alternative 2** but similar to **Alternative 1.** Although it also allows for the modification of gear restrictions to respond to interactions with species, including protected species, like in both **Alternatives 1** and **2**, the changes allowed are broader than those in **Preferred Alternative 2** (i.e., change could include a complete prohibition on a specific gear). These changes could have positive indirect effects on the biological environment.

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, including having no specific measures to address interactions with ESA-listed species, 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.

4.7.3 Direct and Indirect Effects on the Economic Environment

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** includes additional options and therefore should allow for a wider suite of measures that can be more rapidly implemented, which would be beneficial to the stocks and thereby yield 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 2.7.3) 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 U.S. Caribbean-wide FMPs and does not include framework procedures that may be more tailored to specific fisheries within the Puerto Rico FMP. If, for example, the SYL needed to be expeditiously modified to protect the social contributions of a resource and it was not included in the framework, it could have negative indirect effects on the social contributions of the affected resource. The actions under **Alternative 1** are also outdated and do not reflect current management. **Preferred Alternative 2** incorporates an abbreviated and standard frame work 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 SSC, but the Council may do so if deemed appropriate. **Alternative 3** provides options for implementing a framework procedure through open or closed frameworks. 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 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. Frameworks often change after implementation due to the changing nature of the fisheries and other factors, the Council's **Preferred Alternative 2** is likely to have the most positive social effects as it reflects the flexible suite of options and what the Council views are the appropriate procedures given the current status and condition of the fisheries being managed.

4.7.5 Direct and Indirect Effects on the Administrative Environment

Alternative 1 retains framework procedures from the U.S. Caribbean-wide FMPs, and thus is not expected to add to the administrative burden relative to the current situation. However, because it does not allow for the addition of measures more tailored to Puerto Rico (see new measures described in Table 2.7.2 for **Preferred Alternative 2**) it may have negative administrative effects (e.g., time and cost) if a measure that could be taken more expeditiously through framework, needs to be done through a regular amendment.

Different than the rest of the alternatives proposed, **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 input (also similar to **Alternative 1**) and AP input (different from **Alternative 1**), 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 EA to consider not only the direct and indirect effects associated with regulatory actions, but also the cumulative effects resulting from those actions. The NEPA regulations established by the Council on Environmental Quality, which is tasked with ensuring NEPA compliance, define 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 U.S. 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 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 (also see Figure 1.5.1 in Section 1.5), and represents the entire area in which fishing activities for Council-managed stocks 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 U.S. Caribbean-wide 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 would include altering the composition of the stocks (Action 2) and their organization within complexes (Action 3), and would for the first time identify indicator stocks for some of those stock complexes (Action 3). As a result of modifying the list of managed stocks and the composition of stock complexes, harvest reference points (Action 4) and associated AMs (Action 5) would be revised (for stocks or stock complexes previously managed by the Council) or established (for stocks newly added to management). The impacts of these changes would be minimal as discussed in Chapter 4. Based on application of guidance regarding the requirement in the Magnuson-Stevens Act that the Council prepare an FMP for fisheries under its authority that are in need of conservation and management, 38 reef fish, and a host of smaller fish and invertebrates harvested for the aquarium trade, were removed from federal management based on the Council determination that they no longer were in need of conservation and management. In most cases, the decision to remove was based on their infrequent occurrence in federal waters. Applying the same guidance, other reef fish species were identified as being in need of 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. The giant manta ray, spotted eagle ray, and southern stingray, 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 (dolphin, pompano dolphin, wahoo, tripletail, great barracuda, 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 to be managed, 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, assuming landings of these stocks remain at around the same level as they had been without management. 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. Newly managed species occur in the same habitats as those already managed, but in addition, some of these newly added species have a much more extensive offshore distribution. Although new EFH within the U.S. Caribbean EEZ would be specifically described for these newly managed species (e.g., deeper waters for coral reef resources, some rays, and some pelagic species) in all cases safeguards to EFH from fishing activities are already in place either in the form of managed areas (e.g. Bajo de Sico) or simply because of the nature of those fishing activities that do occur in these deeper offshore areas. 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 included in the Puerto Rico FMP/EA is found in Chapter 5.

Other Fishery-related actions

Past Actions

The reader is referred to Appendix C (History of Federal Fisheries 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 ACL Amendments (CFMC 2011a, b) and associated Environmental Impact Statements (EIS)

The CEAs included in each of the 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 on the environment. The 2010 Caribbean ACL Amendment CEA analyzed cumulative effects from certain measures related to managing reef fish and queen conch, whereas the CEA included in the 2011 Caribbean ACL Amendment (CFMC 2011b) analyzed cumulative effects of additional measures related to managing 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. 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. The CEAs for both EISs listed the stresses affecting fishing communities, such as additional regulatory restrictions, competition from foreign seafood imports, coastal development, loss of infrastructure, and rising fuel prices, and discussed how all of these stresses have placed a greater burden on fishermen and fishing communities that threaten their short- and long-term sustainability. The CEAs discussed that although the intent of the actions on those amendments was to improve the targets and thresholds of reef fish, spiny lobster, queen conch, and coral resources, they may cause additional stresses (e.g., lower landings). The process of protecting Council-managed species through the specification of management targets, thresholds, and AMs, and regulations that implement those AMs was expected to have a short-term adverse impact on the social and economic environment, and to create a burden on the administrative environment. However, the process was also expected to provide larger benefits to those environments in the long-run than would be expected with the no action alternative. The effects on the human environments were discussed in detail in those EISs.

In summary, the CEA of both of these documents revealed that in combination with past and present actions, the actions in both amendments could impose more restrictive catch levels on additional fisheries resulting in negative social and economic impacts over the short-term. However, to the extent that catch limits and AMs can prevent overfishing and assist in rebuilding overfished stocks, they should have positive long-term benefits to both the biological and socio-economic environments. No alternatives were considered that would completely avoid those negative effects because they were considered a necessary cost associated with establishing ACLs and AMs in the U.S. Caribbean. The CEAs concluded that for that reason, it was difficult to mitigate these measures and managers must balance the costs and benefits when choosing management alternatives for these fisheries. These CEAs are still considered accurate and useful at the present time and are incorporated herein by reference.

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 of managing the spiny lobster, queen conch, reef fish, and coral resources in the U.S. Caribbean EEZ on the wider environment in light of other past, present, and reasonably future actions, 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 of taking action in light of the effects explained 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 of taking action in light of the effects explained 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, namely, the reef fish managed in the Puerto Rico management area under the Reef Fish FMP. The action triggered an AM for a stock/complex when both the total ACL and the sector ACL, rather than the sector-specific ACL alone, 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. (EBFM U.S. Caribbean Roadmap Implementation Map).

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, described below.

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. 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 socio-economic effects may result from increased compliance and cooperation from affected constituents, which are in favor of an island-based approach and may, as a result, be more willing to comply.

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 socio-economic environment are expected to result from the cumulative past, present, or reasonably foreseeable future impacts of other actions in the area and this action to develop fishery management in federal waters off Puerto Rico. 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 significant cumulative effects would be expected to result from reasonably foreseeable future actions that may be taken, by other federal or non-federal agencies in combination with this action.

5. Summary:

The transition to a Puerto Rico FMP from the U.S. Caribbean-wide FMPs is not expected to have individually significant effects to the biological/ecological, physical, or socio-economic environments 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

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 Standards (NS) of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act).

Chapter 5 describes the Council's conservation and management measures included in the Puerto Rico Fishery Management (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 U.S. Caribbean-wide Approach to an Island-based Approach), although the Puerto Rico FMP would replace the Council's Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs[67], the new FMP carries forward most of the management measures from those four extant FMPs as they apply to the Puerto Rico FMP. 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 environmental assessment included in this document. For additional information on the management measures migrated from the Council's Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs, 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 guidance, National Environmental Policy Act, and other applicable law. The Council continues to believe that the measures that the Council is retaining from the U.S. Caribbean-wide FMPs are necessary and appropriate to manage the fishery under the Puerto

[67] Action 1 established a new-island-based FMP for Puerto Rico EEZ waters, repealed the existing U.S. Caribbean-wide FMPs as they applied to the Puerto Rico management area and replaced them with the island-based FMP for Puerto Rico EEZ waters. Similar actions to repeal and replace the U.S. Caribbean-wide FMPs were taken in the St. Croix FMP and the St. Thomas/St. John FMP.

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 on a continuing basis, 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 applicable to the fishery resources managed in the Puerto Rico EEZ by fishery group: fish (reef fish, pelagic fish, rays), spiny lobster, queen conch, and coral reef resources. If this FMP is approved by the Secretary of Commerce, regulations will be promulgated or updated to implement the management measures described. If there are any differences between the text of this document and the codified regulatory text implementing this FMP, the codified regulatory text controls.

5.1 Definitions

1. Puerto Rico EEZ - Those waters that 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 U.S. Virgin Islands [USVI]) with an abutting EEZ, or to an otherwise negotiated boundary between conjoining international EEZs. Fishery resources within the Puerto Rico EEZ included in this FMP are managed by the Council.

2. Fish - In the Puerto Rico FMP, fish stocks are divided in three categories based on functional groups: Reef Fish (1); Pelagics (2); and Rays (3), as defined below.

1) **Puerto Rico Reef Fish –** One or more of the species, or a part thereof, listed in Table 5.1.1 below.

Table 5.1.1. Species in the Puerto Rico Reef Fish group and their stock/stock complex organization. Indicator stocks are marked with an asterisk. New species (6) included in the reef fish group are in bold.

Family or Class	Stock/Stock Complex	#	Species Name	Common Name
Lutjanidae -- Snappers	Snapper 1	1	*Apsilus dentatus*	Black snapper
		2	*Lutjanus buccanella*	Blackfin snapper
		3	*Lutjanus vivanus**	Silk snapper*
		4	*Rhomboplites aurorubens*	Vermilion snapper

Family or Class	Stock/Stock Complex	#	Species Name	Common Name
		5	*Pristipomoides aquilonaris*	Wenchman
	Snapper 2	6	*Pristipomoides macrophthalmus*	Cardinal snapper
		7	*Etelis oculatus**	Queen snapper*
	Snapper 3	8	*Lutjanus synagris*	Lane snapper
	Snapper 4	9	*Lutjanus analis**	Mutton snapper*
		10	*Lutjanus jocu*	Dog snapper
		11	*Lutjanus apodus*	Schoolmaster
	Snapper 5	12	*Ocyurus chrysurus*	Yellowtail snapper
	Snapper 6	**13**	***Lutjanus cyanopterus***	**Cubera snapper**
Serranidae -- Groupers	Grouper 1	14	*Epinephelus striatus*	Nassau Grouper
	Grouper 2	15	*Epinephelus itajara*	Goliath grouper
	Grouper 3	16	*Cephalopholis fulva**	Coney*
		17	*Cephalopholis cruentata*	Graysby
	Grouper 4	18	*Mycteroperca bonaci*	Black grouper
		19	*Epinephelus morio*	Red grouper
		20	*Mycteroperca tigris*	Tiger grouper
		21	*Mycteroperca venenosa*	Yellowfin grouper
		22	***Mycteroperca interstitialis***	**Yellowmouth grouper**
	Grouper 5	23	*Hyporthodus flavolimbatus*	Yellowedge grouper
		24	*Hyporthodus mystacinus*	Misty grouper
	Grouper 6	25	*Epinephelus guttatus**	Red hind*
		26	*Epinephelus adscensionis*	Rock hind
Scaridae -- Parrotfishes	Parrotfish 1	27	*Scarus coeruleus*	Blue parrotfish
		28	*Scarus coelestinus*	Midnight parrotfish

Family or Class	Stock/Stock Complex	#	Species Name	Common Name
		29	*Scarus guacamaia*	Rainbow parrotfish
	Parrofish 2	30	*Scarus vetula*	Queen parrotfish
		31	*Scarus taeniopterus*	Princess parrotfish
		32	*Sparisoma chrysopterum*	Redtail parrotfish
		33	*Sparisoma viride*	Stoplight parrotfish
		34	*Sparisoma aurofrenatum*	Redband parrotfish
		35	*Scarus iseri*	Striped parrotfish
Acanthuridae -- Surgeonfishes	Surgeonfish	36	*Acanthurus coeruleus*	Blue tang
		37	*Acanthurus bahianus*	Ocean surgeonfish
		38	*Acanthurus chirurgus*	Doctorfish
Balistidae -- Triggerfishes	Triggerfish	39	*Canthidermis sufflamen*	Ocean triggerfish
		40	*Balistes vetula**	Queen triggerfish*
		41	***Balistes capriscus***	**Gray triggerfish**
Labridae -- Wrasses	Wrasses 1	42	*Lachnolaimus maximus*	Hogfish
	Wrasses 2	43	*Halichoeres radiatus*	Puddingwife
		44	*Bodianus rufus*	Spanish hogfish
Pomacanthidae -- Angelfishes	Angelfish	45	*Holacanthus ciliaris*	Queen angelfish
		46	*Pomacanthus arcuatus*	Gray angelfish
		47	*Pomacanthus paru*	French angelfish
Haemulidae -- Grunts	Grunt	48	*Haemulon plumierii*	White grunt
Carangidae -- Jacks	Jacks 1	**49**	***Caranx hippos***	**Crevalle jack**
	Jacks 2	**50**	***Alectis ciliaris***	**African pompano**
	Jacks 3	**51**	***Elagatis bipinnulata***	**Rainbow runner**

2) Puerto Rico Pelagics – One or more of the species, or a part thereof, listed in Table 5.1.2 below.

Table 5.1.2. Species in the Puerto Rico Pelagics group and their stock/stock complex organization. Indicator stocks for the stock complex are marked with an asterisk. All of the pelagic stocks are new to management under the Puerto Rico FMP.

Family or Class	Stock/Stock Complex	#	Species Name	Common Name
Lobotidae -- Tripletail	Tripletail	1	*Lobotes surinamensis*	Tripletail
Coryphaenidae -- Dolphinfish	Dolphinfish	2	*Coryphaena hippurus**	Dolphin*
		3	*Coryphaena equiselis*	Pompano dolphin
Scombridae – Mackerels and tunas	Tuna	4	*Euthynnus alletteratus*	Little tunny
		5	*Thunnus atlanticus*	Blackfin tuna
	Mackerel	6	*Scomberomorus cavalla*	King mackerel
		7	*Scomberomorus regalis*	Cero mackerel
	Wahoo	8	*Acanthocybium solandri*	Wahoo
Sphyraenidae -- Barracudas	Barracuda	9	*Sphyraena barracuda*	Great barracuda

3) Puerto Rico Rays - One or more of the species, or a part thereof, listed in Table 5.1.3 below.

Table 5.1.3. Species in the Puerto Rico Rays group and their stock/stock complex organization. All of the ray species are new to management under the Puerto Rico FMP.

Family or Class	Stock/Stock Complex	#	Species Name	Common Name
Myliobatidae – Eagle and Manta Rays	Rays 1	1	*Manta birostris*	Giant manta ray
	Rays 2	2	*Aetobatus narinari*	Spotted eagle ray
Dasyatidae - Stingrays	Rays 3	3	*Hypanus americanus*	Southern stingray

3. Caribbean Spiny Lobster - the species, *Panulirus argus*, or a part thereof. This species is managed as a single stock (i.e., Spiny lobster).

4. Queen Conch - the species, *Lobatus gigas* (formerly *Strombus gigas*), or a part thereof. This species is managed as a single stock (i.e., Queen conch).

5. Puerto Rico Coral Reef Resources - The Coral Reef Resources would be divided into three groups: (1) Sea cucumbers; (2) Sea urchins; and (3) Corals. There are species within each of the groups that would be new to management under the Puerto Rico FMP (See Appendix E).

6. Fish trap - In the Puerto Rico EEZ, a trap and its component parts (including the lines and buoys), regardless of the construction material, used for or capable of taking finfish, except a trap used in the directed fishery for Caribbean spiny lobster.

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 (Reef Fish, Pelagics, Rays)

This provision applies to the following stocks/stock complexes:
<u>Groupers:</u> Grouper 1 complex (Nassau grouper [*Epinephelus striatus*] and Grouper 2 complex (goliath grouper [*E. itajara*])
<u>Rays 1</u>: giant manta ray (*Manta birostris*)
<u>Rays 2</u>: spotted eagle ray (*Aetobatus narinari*)
<u>Rays 3</u>: Southern stingray (*Hypanus americanus*)
<u>Parrotfish 1 Complex</u>: blue parrotfish (*Scarus coeruleus*); midnight parrotfish (*Scarus coelestinus*); rainbow parrotfish (*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 southern stingray in or from the Puerto Rico EEZ. Such fish caught in the Puerto Rico EEZ must be released immediately with a minimum of harm.

<u>This provision applies to all finfish, whether managed under the Puerto Rico FMP or not.</u>
<u>Landing fish intact.</u>

- 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 (e.g., stony corals, octocorals, black corals) in or from the Puerto Rico EEZ. The taking of a managed coral 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. The taking of managed sea urchins and sea cucumbers in the Puerto Rico EEZ is not considered unlawful possession provided it is returned immediately to the sea in the general area of fishing.

5.3 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 Fish (Reef Fish, Pelagics, Rays)

5.3.2.1 Prohibited Gear and Methods for the Harvest of Puerto Reef Fish

A. Applicable to both the Commercial and Recreational Sectors of those Fishing for Puerto Rico Reef Fish

Poisons
A poison, drug, or other chemical may not be used to fish for Puerto Rico reef fish in the Puerto Rico EEZ.

Powerheads
A powerhead may not be used in the Puerto Rico EEZ to harvest Puerto Rico reef fish. The possession of a mutilated Puerto Rico 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 Puerto Rico reef fish. Possession of a gillnet or trammel net and any Puerto Rico 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 Puerto Rico Reef Fish

A. Applicable to the Commercial Sector (See Table 5.3.1 below)

Table 5.3.1. Gear type allowed in the commercial sector of the Puerto Rico Reef Fish fishery.

Puerto Rico Reef Fish Fishery	Gear Type
Commercial Longline/hook and line fishery	Longline, hook and line
Commercial Trap/pot fishery	Trap, pot
Other commercial fishery	Spear

B. Applicable to the Recreational Sector (See Table 5.3.2 below)

Table 5.3.2. Gear Type Allowed in the recreational sector of the Puerto Rico Reef Fish Fishery.

Puerto Rico Reef Fish Fishery	Gear Type
Recreational fishery	Dip net, handline, rod and reel, slurp gun, spear, trap, pot

C. Applicable to the Commercial and Recreational Sectors

Specifications are provided only for the trap/pot gear, as allowed in both the commercial and recreational sectors (see Tables 5.3.1 and 5.3.2, above), 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 USVI so as to be easily identified. Fish 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. 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.

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

<u>Spears and hooks</u>
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 (see Table 5.3.3 below)

Table 5.3.3. Gear Type Allowed in the commercial sector of the Puerto Rico spiny lobster fishery.

Caribbean Spiny Lobster Fishery	Gear Type
Trap/pot fishery	Trap/pot
Dip net fishery	Dip net
Hand harvest fishery	Hand harvest, snare

B. Applicable to the Recreational Sector (see Table 5.3.4 below)

Table 5.3.4. Gear Type Allowed in the recreational sector of the Puerto Rico Spiny Lobster Fishery.

Caribbean Spiny Lobster Fishery	Gear Type
Recreational fishery	Dip net, hand harvest, snare, trap, pots

C. Applicable to the Commercial and Recreational Sectors

Specifications are provided only for the trap/pot gear, as allowed in both the commercial and recreational sectors (see Tables 5.3.3 and 5.3.4, above), as follows:

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 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 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.

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.

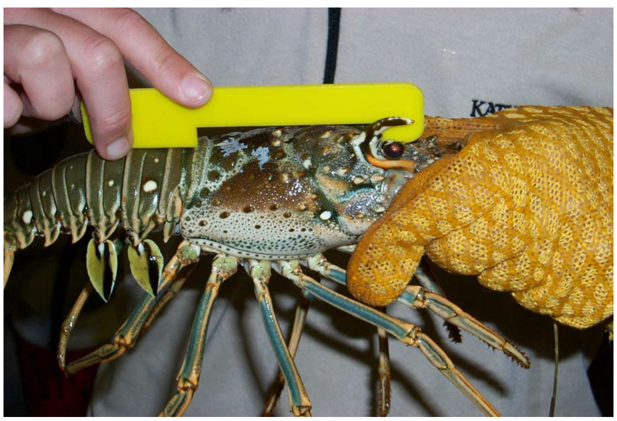

Figure 5.4.1. Measurement of a spiny lobster carapace.

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[68]

Bag and possession limits apply to the harvest of the Puerto Rico reef fish stocks listed in Table 5.6.1 below.

Table 5.6.1. Bag and possession limits for the recreational harvest of Puerto Rico Reef Fish.

Aggregate bag limit for:	Allowed quantity:
Snapper grouper parrotfish, combined	5 fish per person/day, of which no more than 2 may be parrotfish, or if 3 or more persons are aboard, 15 fish total per vessel/day, of which no more than 6 may be parrotfish.
angelfish, grunts, wrasses, jacks, triggerfish, surgeonfish, combined	5 fish per person/day, of which no more than 1 may be surgeonfish, or, if 3 or more persons are aboard, 15 fish total per vessel/day, of which no more than 4 may be surgeonfish.

5.6.3 Bag and Possession Limits for Caribbean Spiny Lobster

Bag and possession limits applicable to the harvest of the Puerto Rico spiny lobster (Table 5.6.2).

Table 5.6.2. Bag and possession limits for the recreational harvest of Puerto Rico 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.

[68] The recreational bag limit only applies to Puerto Rico 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, tripletail, and the great barracuda, or to rays.

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 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.

5.8 Anchoring Restrictions

5.8.1 General

Specific areas in the Puerto Rico EEZ with anchoring restrictions

Anchoring by fishing vessels is prohibited year-round in the portions of the Bajo de Sico Spawning Aggregation Area, west of Puerto Rico, that are in the Puerto Rico EEZ (See Section 5.10 and Figure 5.10.1 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 Puerto Rico 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 Reef Fish Species

The seasonal closures applicable to fishing for the species listed below (Table 5.9.1) apply to all fishing activities. 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.

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.

Species	Open	Closed
Silk snapper	January 1 – September 30	October 1 – December 31
Black snapper		
Blackfin snapper		
Vermillion snapper		
Mutton snapper	July 1 – March 31	April 1 – June 30
Lane snapper		
Red hind grouper (applies only west of 67º10' W longitude)	March 1 – November 30	December 1 – Last day of February
Yellowfin grouper	May 1 – January 31	February 1 - April 30
Red grouper		
Tiger grouper		
Black grouper		
Yellowedge grouper		

5.10 Seasonal Area Closures Applicable to Specific Fishing Activities and to Certain Species

The seasonal area closures in the Puerto Rico EEZ are all located off the west coast of Puerto Rico (Table 5.10.1; Figure 5.10.1).

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 Puerto Rico reef fish[2] during closure. The prohibition is limited to managed Puerto Rico 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., high migratory species [HMS][3]). The prohibition on possession does not apply to such Puerto Rico 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 Prohibition	
- Anchoring, by fishing vessels, is prohibited year-round.	Year-round Prohibition	

Area	Open	Closed
Tourmaline Bank[1] and Abrir La Sierra Spawning Areas		
- 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 Prohibition	

[1] Closures applies only to the portion of those areas in the Puerto Rico EEZ.
[2] Closures cover any newly managed reef fish in the Puerto Rico FMP.
[3] Highly migratory species means bluefin, bigeye, yellowfin, albacore, and skipjack tunas; swordfish; sharks (listed in Appendix A to part 635 of this title); and white marlin, blue marlin, sailfish, and longbill spearfish.

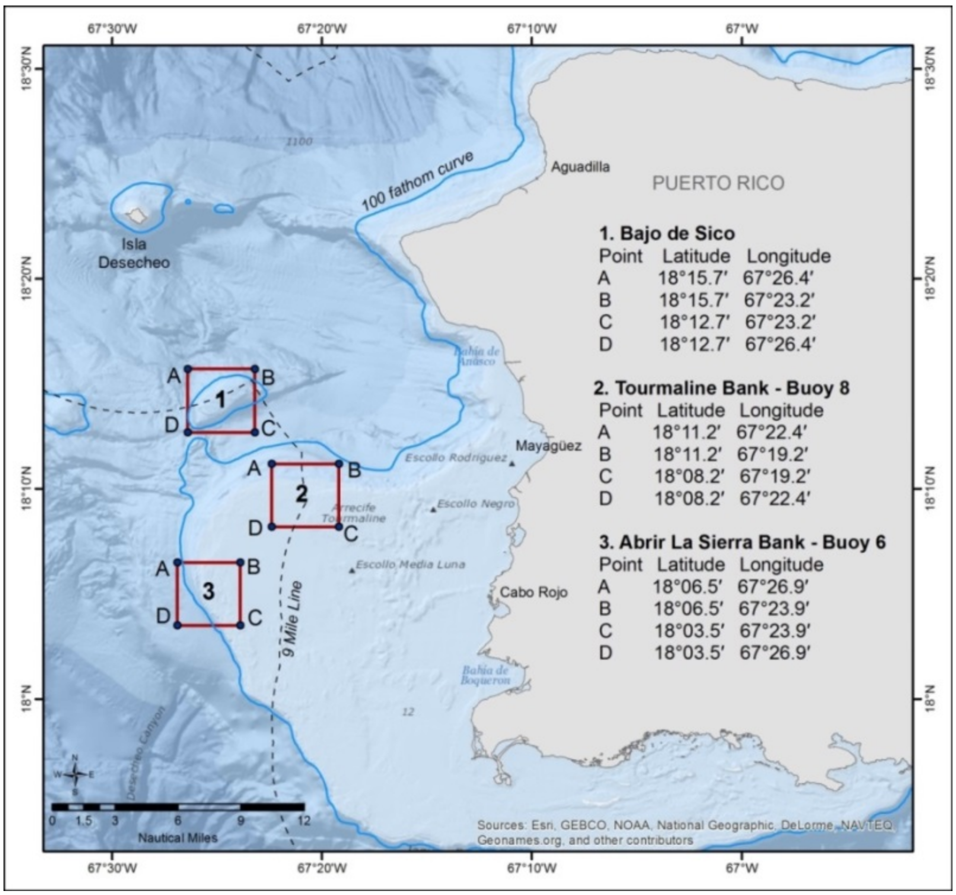

Figure 5.10.1. Map of the Bajo de Sico (#1), Tourmaline Bank (#2), and Abrir La Sierra (#3) closed areas off the west coast of Puerto Rico.

5.11 Permitting and Reporting

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: 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. • 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. • 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:** A. Standard Framework • Changes that do not qualify as routine or insignificant. • Requires a completed framework document with supporting analyses. B. Abbreviated Framework • Can be used for routine or insignificant changes • Request is made with letter or memo from the Council to the RA with supporting analyses (biological, social, economic). • If RA concurs and approves action, it will be implemented through publication of FR Notice. **3. Actions available under different open frameworks:** A. Abbreviated Framework i. Gear marking requirements ii. Vessel marking requirements iii. Restrictions related to maintaining fish in a specific condition (whole condition, filleting, use as bait, etc.) iv. Recreational bag and possession limit changes of not more than 1 fish per boat v. Size limit changes of not more than 1-inch of the prior size limit for reef fish. vi. Commercial vessel trip limit changes of not more than 10% of the prior trip limit vii. Changes to the length of an established closed season by no more than 1 day of the existing season.

OPEN FRAMEWORK
viii. Minor changes to gear modifications to address conservation issues including to respond to interactions with listed species. B. Standard Framework In addition to making changes specified under Abbreviated Framework (above) that exceed the established thresholds, the following actions can be completed via a standard framework: i. Re-specify ABC ii. Re-specify MSY and OY, and SDC iii. Re-specify SYL iv. Re-specify ACLs v. Re-specify ACTs vi. Rebuilding plans and revisions to approved rebuilding plans vii. Revise accountability measures (e.g., change AM triggers and AM timing) viii. Modify reporting and monitoring requirements ix. Modify seasonal or year-round closures and closure procedures x. Modify area closures and closure procedures **4. Open Framework Steps:** • 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. • 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. • 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. • 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: • Reopen any sector of the fishery that had been prematurely closed. • 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 Status Determination Criteria and Management Reference Points

National Standard 1 of the Magnuson-Stevens Act mandates that conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery (16 U.S.C. 1851(a)(1)). The optimum yield from the fishery is based on the maximum sustainable yield. NMFS's guidelines on National Standard 1 provide additional information on establishing MSY and ensuring compliance with the fundamental goal of fisheries management expressed in NS1. Per the National Standard 1 guidelines, 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 (50 CFR § 600.310(e)(1)(v)). In the U.S. Caribbean region, scientific assessments from which MSY and 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) chose to adopt the sustainable yield level (SYL) as their alternative measure of reproductive potential for stocks and stock complexes identified in Chapter 2 of this document, in addition to proxies for MSY based on qualitative estimates of fishing mortality rates and biomass expected when achieving MSY noted in Section 5.13.1 below. The SYL is based on an equilibrium (long-term) concept. It is set based on long-term landings, but is adjusted to account for variability in landings. MSY is an equilibrium concept and OFL 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 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 measure that is based on long-term landings, but accounts for variability, is similar to an OFL. In addition, in the absence of better information, it can be considered to be a minimum estimate of MSY. 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 will be used to understand the sustainability of the fishery. While landings in excess 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. See below for a summary of each of these SDCs and management reference points or their proxies, selected by the Council in Action 4, as they are applied to stock and stock complexes in the Puerto Rico FMP.

5.13.1 Maximum Sustainable Yield (MSY)

The MSY for stocks and stock complexes in the Puerto Rico FMP is a proxy that is equal to the long-term yield at F_{MSY}. The F_{MSY} cannot be estimated from available data at this time and thus a proxy is specified (see discussion in Section 2.4, under Preferred Alternative 3). In the Puerto Rico FMP, the F_{MSY} proxy equals $F_{30\%SPR}$. In addition, as discussed in Section 5.13.4, MSY is greater than or equal to the SYL, and is considered a proxy for MSY.

5.13.2 Maximum Fishing Mortality Yield (MFMT)

The MFMT is a determined level used by fishery managers to assess whether a fish stock is undergoing overfishing. If fishing mortality rates exceed MFMT, a stock is determined to be undergoing overfishing[69]. The MFMT for stocks and stock complexes in the Puerto Rico FMP is equal to the F_{MSY} proxy as defined in Section 5.13.1 above.

5.13.3 Minimum Stock Status Threshold (MSST)

The MSST is a biomass level used by fishery managers to assess whether a fish stock is overfished. If the biomass of a fish stock falls below MSST, a stock is determined to be overfished. For stocks and stock complexes in the Puerto Rico FMP, the MSST = 0.75*long-term Spawning Stock Biomass at MFMT (SSB_{MFMT}).

5.13.4 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, and above, the SYL is considered to be a proxy for OFL and a minimum estimate of MSY (where MSY $\geq$ SYL) and thus another MSY proxy. The SYL is not intended as a metric for reporting stock status in terms of overfishing or overfished, meaning that an SYL exceedance does not automatically trigger a determination that the stock is undergoing overfishing or overfished. Instead, the SYL is intended to ensure a stock or stock complex is maintained at a sustainable level. While landings in excess of SYL would not establish that overfishing is occurring, they would indicate that harvest could be above a sustainable level. Therefore, when landings exceed the SYL, those landings 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.

To evaluate the status of a stock or stock complex relative to the SYL, the 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 compared to stepped series of fishing years, similar to the process used to determine whether an AM is triggered following ACL exceedances in Section 2.5.1 of this FMP (Preferred Alternative 2). 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

69 https://sero.nmfs.noaa.gov/sustainable_fisheries/more_info/documents/pdfs/glossary_of_fishery_terms.pdf

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. Table 5.13.2 below shows the SYL values for each of the stock/stock complexes managed under the Puerto Rico FMP.

5.13.5 Overfishing Limit (OFL)

The OFL 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. Because OFL cannot be quantified for stocks in Tier 4, which includes all stocks/complexes managed in the Puerto Rico FMP, the SYL would be used as a proxy for OFL.

5.13.6 Acceptable Biological Catch (ABC)

The ABC is the catch level recommended by the Council's SSC that accounts for scientific uncertainty in the estimate of OFL, as well as any other sources of scientific uncertainty[70]. The ABC is a product of the ABC Control Rule (ABC CR), as developed and applied by the Council's SSC.

<u>ABC Control Rule</u>

The Council's ABC CR contains four tiers to be used by the Council's SSC in specifying recommendations and other management reference points for stocks managed under the Puerto Rico FMP (Table 5.13.1) (See Section 2.4.2). The Council's ABC CR responds to different levels of data availability, and results in reference point estimates culminating in an ABC for each managed stock (Table 5.13.2). As set forth in NMFS's guidelines on National Standard 1, the Council's SSC may recommend an ABC that differs from the result of the ABC control rule calculation, based on factors such as data uncertainty, recruitment variability, declining trends in population variables, and other factors, but must provide an explanation for the deviation. 50 CFR 600.310(f)(3).

[70] https://www.fisheries.noaa.gov/insight/frequent-questions-national-standard-1-final-rule

Table 5.13.1. Caribbean Fishery Management Council Acceptable Biological Catch Control Rule for stocks/stock complexes managed under the Puerto Rico FMP.

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 MSST = 0.75*long-term Spawning Stock Biomass at MFMT (SSB_{MFMT}) 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 (σ), where the PDF is determined from the assessment (where $\sigma > \sigma_{min}$)[3]. ABC= d * OFL where $d = \begin{cases} \text{Scalar} & \text{if } B \geq B_{MSY} \\ \text{Scalar} * (B-B_{critical}) / (B_{MSY}-B_{critical}) & \text{if } B < B_{MSY} \end{cases}$ Scalar = 1 if acceptable probability of overfishing is specified (<0.5), < 1 if not specified (=0.5). $B_{critical}$ is defined as the minimum level of depletion at which fishing would be allowed.
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 (σ) must be greater than 1.5 σ_{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 MSST = 0.75* SSB_{MFMT} or proxy OFL = Catch at MFMT
ABC	ABC determined from OFL as reduced (buffered) by scientific uncertainty[4] and reflecting the acceptable probability of overfishing[2] a. Where the buffer is applied to the PDF of OFL when the PDF is determined from the assessment (with $\sigma \geq 2\sigma_{min}$) **OR** b. Where ABC = buffer * OFL, where buffer must be $\leq$ 0.9
Tier 4: Data Limited: No Accepted Assessment Available	
MSY	MSY proxy = long-term yield at proxy for F_{MSY}.

SDC	MFMT = F_{MSY} proxy MSST = 0.75* SSB_{MFMT} SYL[5] = a level of landings that can be sustained over the long-term. OFL proxy = SYL
Tier 4a	
Conditions for Use	No accepted[6] 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[7] cannot be reached on the use of Tier 4a, Tier 4b should be used.
SYL	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. Scalar $\leq$ 3 depending on perceived degree of exploitation, life history and ecological function.
ABC	ABC = buffer * SYL, where buffer must be $\leq$ 0.9 (e.g., 0.9, 0.8, 0.75, 0.70…) based on the SSC's determination of scientific uncertainty[8].
Tier 4b	
Conditions for Use	No accepted[6] 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.
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. Scalar < 2 depending on perceived degree of exploitation, life history, and ecological function.
ABC	ABC[9] = buffer * SYL, where buffer must be $\leq$ 0.9 (e.g., 0.9, 0.8, 0.75, 0.70…) based on the SSC's determination of scientific uncertainty[8].
Footnotes	[1]Scientific uncertainty would take into account, but not be limited to, the species life history and ecological function. [2]Acceptable probability of overfishing determined by Council. [3]σ_{min} could be equal to coefficient of variation; σ_{min} is in a log scale. [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. [5]MSY $\geq$ SYL. See Appendix G for a detailed explanation of SYL. [6]Accepted means that the assessment was approved by the SSC as being appropriate for management purposes. [7]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. [8]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. [9]The ABC for a Tier 4b stock should not exceed mean landings during the reference period.

Table 5.13.2. SYLs and ABCs calculated following the ABC CR for each stock/stock complex selected for management in the Puerto Rico FMP. Indicator stocks are marked in bold.

Stock/Stock Complex	SYL (lbs)	ABC (lbs)
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

Stock/Stock Complex	SYL (lbs)	ABC (lbs)
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 tunny, blackfin tuna)	254,937	123,435
Mackerel (cero mackerel, king mackerel)	761,268	380,634
Wahoo	498,207	249,104
Rays 1 (giant manta ray)	1,657	0
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

** Where SYL is a non-zero number, but the ABC is zero, the SSC recommended that the ABC be set at zero by deviating from the control rule for the reasons discussed at the SSC meetings in which the ABC was developed.

5.13.7 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 5.13.3 lists the ACLs (and OY = total ACL) established for stocks and stock complexes in the Puerto Rico commercial and recreational sectors.

5.13.7.1 Annual Catch Limits and Optimum Yield for Fish (Reef Fish, Pelagics, Rays)

In the EEZ management area surrounding Puerto Rico, both recreational and commercial harvest data are collected for Council-managed fish (reef fish, pelagics, and rays). This allows for the establishment of separate ACLs and AMs for each federally managed fish 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 stingray, ACLs are based on the combined Puerto Rico EEZ and territorial landings reported for Puerto Rico. Annual catch limits are discussed in Section 2.4. This section lists the outcomes from the preferred alternatives, which establish ACLs for stocks/stocks complexes managed under the Puerto Rico FMP.

For fish stocks (reef fish, pelagics, rays), OY would equate to the total (recreational + commercial) ACL 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 ACLs for all Council-managed stocks and stock complexes are listed in Table 5.13.3.

5.13.7.2 Annual Catch Limits and Optimum Yield 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 the AM (discussed in Section 5.13.8 below) for spiny lobster governs all harvest of spiny lobster, whether commercial or recreational. The ACL is based on available commercial landings information, whether reported as landed from federal or territorial waters (Table 5.13.3). For Caribbean spiny lobster, the OY would equate to the ACL.

5.13.7.3 Annual Catch Limits and Optimum Yield 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 5.13.3). See Appendix G.3 for each sector's contribution to the SYL and ABC, which were then used to determine the sector ACLs for each stock/stock complex. The total ACL is the commercial ACL plus the recreational ACL.

Table 5.13.3. Annual catch limits 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. Indicator stocks are marked in bold text. Note that the total ACL = optimum yield (OY).

Stock/Stock Complex	Commercial ACL (lbs)	Recreational ACL (lbs)	Total ACL (lbs) (=OY)
Spiny Lobster	NA	NA	527,232
Queen conch	NA	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 tunny, blackfin tuna)	82,779	34,485	117,263
Mackerel (cero mackerel, 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) (=OY)
Sea Cucumbers	0	0	0
Sea Urchins	0	0	0
Corals	0	0	0

5.13.8 Accountability Measures (AM) 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 with the AMs.

5.13.8.1 Accountability Measures for Reef Fish and Spiny Lobster

For all Puerto Rico reef fish for which harvest is allowed and for spiny lobster, landings would be evaluated relative to the applicable ACL (commercial or recreational ACL, depending on data availability) 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, as applicable, see note below) exceed the sector ACL and the total landings (commercial plus 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 ACL.

Landings from the following years, in order, would be used to evaluate an exceedance of the ACL, as described above:

(1) Landings from 2018
(2) 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.

Process for Applying an AM for Reef Fish and Spiny Lobster

If an AM is triggered, NMFS will reduce the length of the fishing season for the 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 will revisit the use of September 30 as the end date for AM-based closures every two years.

Note on sector ACLs and sector AMs for Reef Fish only: If 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 ACL for the stock/stock complex. When landings exceed the 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.

Note on ACLs and AMs for Spiny Lobster only: In Puerto Rico, only commercial harvest data are collected for spiny lobster (recreational landings are not available). However, the ACL and the AM for spiny lobster governs all harvest of spiny lobster, whether commercial or recreational.

5.13.8.2 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 in the Federal Register, 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 EEZ may not be purchased or sold. Harvest or possession of such stocks or stock complexes in or from the Puerto Rico EEZ 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 in paragraph (2) below 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 in the Federal Register, 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 EEZ 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., 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 any such stock or stock complex in or from the Puerto Rico EEZ is zero.

5.13.8.3 Closure Provisions for Caribbean Spiny Lobster

During the closure period announced in the notification in the Federal Register, 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.

5.13.8.4 Accountability Measures for Pelagic Stocks

For the following pelagic stocks/stock complexes: dolphin, pompano dolphin (Dolphinfish stock complex), little tunny, blackfin tuna (Tuna stock complex), king mackerel, cero mackerel (Mackerel stock complex), tripletail, great barracuda, 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 annual catch target (ACT) as a percentage of the ACL that would serve as the AM trigger (See Section 2.5) as discussed below. If an AM is triggered, the Council in consultation with the SEFSC would assess whether corrective action is needed.

<u>Annual Catch Target</u>

The ACT is a level of catch set to account for management uncertainty in controlling catch at or below the ACL. The following ACTs apply to the pelagic stocks/stock complexes listed in Table 5.13.4. The ACTs were set at 90% 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 operates as the stock/stock complex ACL when landings for the other sector are not available.

Table 5.13.4. Annual catch targets for pelagic stocks/stock complexes in the Puerto Rico FMP by sector (commercial and recreational). Values are in pounds (lbs) of whole weight. Indicator stocks are marked in bold text. Where an indicator stock is used, the indicator information applies to the complex as a whole.

Stock/Stock Complex	Commercial ACT (lbs)	Recreational ACT (lbs)
Dolphinfish complex (**dolphin**, pompano dolphin)	208,956	1,362,486
Wahoo	23,320	189,663
Mackerel complex (cero mackerel, king mackerel)	209,180	116,262
Tunas complex (little tunny, blackfin tuna)	74,501	31,037
Tripletail	243	35,105
Great barracuda	445	150,924

<u>Process for Triggering an AM for the listed Pelagic Stocks/Stock Complexes</u>

An AM would be triggered if the applicable landings (e.g., sector landings, as available) exceed the applicable ACT (e.g., sector ACT) for that stock/stock complex.

Regarding the applicable ACT, where landings data are available to manage by sector, the ACT is the sector ACT, and sector landings are compared to the sector ACT. The AM would be triggered only for the sector(s) that exceeded the ACT. If landings data are not available to manage by sector, the ACT for the sector with available landings is the ACT for the stock/stock complex as a whole, and available sector landings are compared to the ACT for the stock/stock complex as a whole. The AM would apply to all those fishing for the stock/stock complex.

Landings from the following years, in order, would be used to evaluate an exceedance of the ACT:

(1) Landings from 2018
(2) 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 Pelagic Stocks/Stock Complexes</u>

If an AM is triggered, the Council in consultation with the SEFSC would assess whether corrective action is needed.

5.13.8.5 Accountability Measures for Stocks with Prohibited Harvest

The harvest prohibition (ACL = 0) would serve as the AM for queen conch, Nassau grouper, goliath grouper, midnight parrotfish, rainbow parrotfish, blue parrotfish, sea cucumbers, sea urchins, all managed corals,southern stingray, giant manta ray, and spotted eagle ray.

5.13.9 Stocks Under Rebuilding Plans

Three stocks and one stock complex were identified in the Caribbean 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). These stocks were classified as overfished in the 2003 Report to Congress. 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 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.

The rebuilding plan for the Grouper Unit 4 stock complex, which at the time of the Caribbean Sustainable Fisheries Amendment included misty, yellowedge, yellowfin, red, tiger, and black grouper, lasted ten years and ended in 2015. Under the Puerto Rico FMP, the Grouper 4 complex composition has changed.

Rebuilding plan for Nassau grouper: Rebuild Nassau grouper to B_{MSY} in 25 years, using the formula T_{MIN} (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 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.

5.14 Essential Fish Habitat

A general description of EFH for species managed under the Puerto Rico FMP is described in Chapter 3, Section 3.2.3.1. EFH identified for each life stage for each species managed under the Puerto Rico FMP is listed below. EFH for species in the Puerto Rico FMP was identified and described according to functional relationships between life stages of the species and marine and estuarine habitats, as based on best scientific information available from the literature, landings data, fishery-independent surveys, and expert opinion. For the species that were previously managed under the Council's U.S. Caribbean-wide FMP that were retained in the Puerto Rico FMP under Action 2 (spiny lobster, queen conch, and 45 reef fish), EFH was described and identified in the Final Environmental Impact Statement (FEIS) for the Generic EFH Amendment (CFMC 2004) and the Caribbean Sustainable Fisheries Act (SFA) Amendment (CFMC 2005). Those descriptions are incorporated herein by reference. Those existing designations are being evaluated during the ongoing EFH Five-Year Review and the Council's ongoing data analysis efforts. EFH for newly managed species (18 species of fish) in the Puerto Rico FMP was identified and described in Action 6 of this FMP (see Section 2.6 and Tables 2.6.1 and 2.6.2). Appendix I summarizes the available information (e.g., literature, landings data, fishery-independent surveys, expert opinion) on the functional relationships between life history stages of federally-managed species and Puerto Rico marine and estuarine habitats that were used to designate EFH for species new to management.

<u>Reef Fish EFH in the Puerto Rico FMP</u>:
EFH for the Reef Fish consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs[71] and larvae) and all substrates from mean high water to 100 fathoms depth (habitats used by other life stages).[72] In addition, for the juvenile and adult life stages of African pompano, rainbow runner, and crevalle jack, EFH includes all waters from mean high water to 100 fathoms.

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[71] For gray triggerfish, the eggs are not associated with the water column, and this area is not EFH for the eggs.
[72] The Reef Fish EFH description includes the newly added species: yellowmouth grouper, cubera snapper, gray triggerfish, crevalle jack, African pompano, and rainbow runner. For specific details about particular habitats used per life stage of these newly added species, see Section 2.6.2. For specific information about EFH descriptions for previously managed reef fish retained in the Puerto Rico FMP see the 2004 EFH-FEIS (CFMC 2004) and the Caribbean SFA Amendment (CFMC 2005).

Pelagic Fish EFH in the Puerto Rico FMP:
EFH for little tunny (*Euthynnus alleteratus*) and blackfin tuna (*Thunnus atlanticus*) (Tuna stock complex); king mackerel (*Scomberomus cavalla*) and cero mackerel (*Scomberomus regalis*) (Mackerel stock complex) consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs, larvae, juveniles and adults) and sargassum substrate from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae). All life stages of these species are pelagic.

EFH for wahoo (*Acanthocybium solandri*) (Wahoo stock) consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs, larvae, juveniles, and adults) and sargassum, coral reef, and hard bottom substrates from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by juveniles, adults, and larvae [for larvae, sargassum substrates only]).

EFH for dolphin (*Coryphaena hippurus*) and pompano dolphin (*Coryphaena equiselis*) (Dolphinfish stock complex) consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs, larvae, juveniles, and adults) and coral reefs, hard bottom, and sargassum substrates from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by juveniles, adults, and larvae [for larvae, sargassum substrates only]).

EFH for great barracuda (*Sphyraena barracuda*) (Barracuda stock) consists of all waters and sargassum substrates from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae), and all waters and mangroves, seagrass, coral reefs, and hard bottom substrates from mean high water to 100 fathoms (habitats used by juveniles [water column, mangrove, seagrass], and adults [water column, coral, hard bottom]).

EFH for tripletail (*Lobotes surinamensis*) (Tripletail stock) consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs, larvae, juveniles, and adults) and sargassum substrates from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae).

Rays EFH in the Puerto Rico FMP:
EFH for the giant manta ray (*Manta birostris*) (Rays 1 stock) consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by juveniles and adults).

EFH for the spotted eagle ray (*Aetobatus narinari*) (Rays 2 stock) consists of all waters and coral reefs, hard bottom, and sand substrates from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by juveniles and adults).

EFH for the southern stingray (*Hypanus americanus*) (Rays 3 stock) consists of all waters and mangroves, seagrass, coral reefs, and sand substrates from mean high water to 100 fathoms (habitats used by juveniles and adults).

<u>Spiny Lobster EFH in the Puerto Rico FMP:</u>
EFH for the spiny lobster consists of all waters from mean high water to the outer boundary of the U.S. Caribbean EEZ (habitats used by phyllosome larvae) and seagrass, benthic algae, mangrove, coral, and live/hard bottom substrates from mean high water to 100 fathoms depth (habitats used by other life stages)[73].

<u>Queen Conch EFH in the Puerto Rico FMP</u>:
EFH for the queen conch consists of all waters from mean high water to the outer boundary of the EEZ (habitats used by eggs and larvae) and seagrass, benthic algae, coral, live/hard bottom and sand/shell substrates from mean high water to 100 fathoms depth (habitats used by other life stages)[74].

<u>Coral Reef Resources EFH</u>:
EFH for sea urchins (Sea urchins stock complex) consists of all waters from mean low water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae) and mangrove, seagrass, coral reef, hard bottom, sand, mud, and algal plain substrates from mean low water to the outer boundary of the U.S. Caribbean EEZ (habitats used by juveniles and adults).

EFH for sea cucumbers (Sea cucumbers stock complex) consists of all waters from mean low water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae) and mangrove, seagrass, coral reef, hard bottom, sand, and algal plain substrates from mean low water to the outer boundary of the U.S. Caribbean EEZ (habitats used by juveniles and adults).

EFH for corals (Coral stock complex) consists of all waters from mean low water to the outer boundary of the U.S. Caribbean EEZ (habitats used by eggs and larvae) and coral reef and hard bottom substrates from mean low water to the outer boundary of the U.S. Caribbean EEZ (habitats used by juveniles and adults).

[73] For specific information about the EFH description for spiny lobster in the Puerto Rico FMP see the 2004 EFH-FEIS (CFMC 2004) and the Caribbean SFA Amendment (CFMC 2005).
[74] For specific information about the EFH description for queen conch in the Puerto Rico FMP see the 2004 EFH-FEIS (CFMC 2004) and the Caribbean SFA Amendment (CFMC 2005).

Chapter 6. Fishery Impact Statement

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) requires a Fishery Impact Statement (FIS) be prepared for all Fishery Management Plans (FMPs) and amendments. The FIS contains an assessment of the likely biological, social, and economic effects of the conservation and management measures on: (1) fishery participants and their communities; (2) participants in the fisheries conducted in adjacent areas under the authority of another Council; and (3) the safety of human life at sea. Detailed discussion of the expected effects for all alternatives considered is provided in Chapter 4. The FIS provides a summary of these effects.

Actions contained in the Puerto Rico FMP

The affected area of this proposed action encompasses federal waters off Puerto Rico as well as their fishing communities dependent on fishing for fish (including reef fish, pelagics, rays), spiny lobster, queen conch, and coral reef resources and the ecosystem services they provide. Additionally, because implementation of the Puerto Rico FMP requires transitioning U.S. Caribbean-wide management included in each of the Spiny Lobster, Queen Conch, Reef Fish, and Corals FMPs to island-based management, the geographic scope of the action includes those EEZ waters surrounding the islands of the U.S. Virgin Islands. The Puerto Rico FMP has seven actions: <u>Action 1</u> reorganizes existing management measures such that they apply only in the Puerto Rico EEZ, rather than throughout the U.S. Caribbean EEZ. It has two alternatives. Under **Alternative 1,** no action, the transition from a U.S. Caribbean-wide approach to an island-based approach to management in Puerto Rico would not be implemented. Instead, the four U.S. Caribbean-wide FMPs (Reef Fish, Spiny Lobster, Queen Conch, and Coral) would remain in place. **Preferred Alternative 2** would establish a new Puerto Rico FMP and would repeal the U.S. Caribbean-wide FMPs, as they apply to the Puerto Rico management area. The new Puerto Rico FMP would include all fishery management measures presently included in the four Council FMPs that are applicable to the Puerto Rico EEZ.

Actions 2-7 tier from Action 1.

<u>Action 2</u> revises the list of species (i.e., stocks) included for management, focusing on those applicable to the Puerto Rico EEZ and provides two alternative approaches. Under **Alternative 1,** no action, the Puerto Rico FMP would continue to manage all stocks that are managed within the U.S. Caribbean-wide FMPs. **Preferred Alternative 2** has five criteria to be applied in a stepwise fashion to identify stocks in need of conservation and management. The criteria are applied to stocks for which landings data are available.

<u>Action 3</u> considers alternative methods for grouping stocks into stocks complexes (**Alternatives 1-3**), then determines if one or more indicator stocks (and which stock, if using) should be

assigned to the stock complex (**Alternative 4**). Under **Alternative 1**, no action, the Puerto Rico FMP would not revise these stock complex groupings; and species newly added to management based on Action 2 would not be assigned to complexes, but would be managed individually. **Alternative 2** would result in stocks not being assigned to stock complexes; all stocks would be managed individually. **Preferred Alternative 3** would organize stock complexes based on scientific analysis, applying outcomes from one or more methods such as statistical analyses, information from past data evaluations, biological and life history similarities, or expert opinion. **Preferred Alternative 4** concerns indicator stocks and has two sub-alternatives. **Preferred Sub-alternative 4a** determines if indicator stocks would be used, and then describes the process to be used to identify one or more appropriate indicator stocks. No indicator stocks would be assigned under **Preferred Sub-alternative 4b.**

Action 4 describes alternative approaches for establishing status determination criteria (SDC) and management reference points. Four alternatives are included. Under **Alternative 1** (No Action), the previously established SDC and management reference points for those stocks currently under federal management in the four U.S. Caribbean wide FMPs, would still apply. This alternative would not establish SDC or reference points for those stocks new to management resulting from Preferred Alternative 2 of Action 2, and thus would not comply with the Magnuson-Stevens Act. **Preferred Alternative 2** would allow for a determination as to whether reference points are established for the entire stock/complex/indicator or separately for each of the commercial and recreational sectors comprising that stock/complex/indicator.

Preferred Alternative 3 defines a three-step process for determining SDC and management reference points. Step 1 would require application of the Council's four-tier Acceptable Biological Catch (ABC) Control Rule (CR). At this time, all stocks/complexes in the Puerto Rico FMP would fall under Tier 4 (applied when inadequate data are available with which to conduct a formal stock assessment). Step 2 provides three sub-alternatives for setting an estimate of fishing mortality rate when harvest is at the maximum sustainable yield (MSY) (the "F_{MSY} proxy") based on various fishing mortality rates. This step is applied only when this fishing mortality rate cannot be defined from the tiered control rule. **Sub-alternative 3a** establishes a fishing mortality rate equivalent to maximum fishing mortality rate (F_{MAX}), whereas **Sub-alternative 3b** equates F_{MSY} to the fishing mortality rate at a 40% spawning potential ratio (SPR) and **Preferred Sub-alternative 3c** sets that rate at a 30% SPR. Step 3 provides six sub-alternatives for establishing the ACL from the ABC derived from applying the control rule in Step 1. The OY would be set equal to the ACL. **Sub-alternative 3d** would set OY = ACL = ABC; **Sub-alternative 3e** (**preferred for all stocks except angelfish, parrotfish, and surgeonfish**) would set OY = ACL = ABC x 0.95; **Sub-alternative 3f** sets the OY = ACL = ABC x 0.90; **Sub-alternative 3g** (**preferred for angelfish, parrotfish, and surgeonfish**) sets the OY = ACL = ABC x 0.85; **Sub-alternative 3h** sets the OY = ACL = ABC x 0.75; and **Sub-alternative 3i** would set OY = ACL = 0.

Alternative 4 follows previously established procedures for determining stock/stock complex SDC and reference points (2010 and 2011 Caribbean ACL Amendments). This alternative has four steps, each containing various sub-alternatives. Step 1 has four sub-alternatives for defining the year sequence to calculate average landings to set reference points: **Sub-alternative 4a** uses the longest year sequence of reliable landings data available, as applicable; **Sub-alternative 4b** uses the longest time series of pre-Caribbean Sustainable Fisheries Act (SFA) Amendment landings data that is considered to be consistently reliable; **Sub-alternative 4c** uses 2012-2016 as the most recent five years of available landings data; and **Sub-alternative 4d** uses another year sequence, as recommended by the Council's SSC. Step 2 determines how the year sequence chosen in Step 1 would be used to establish the proxy for MSY and, from that, the OFL, and has three sub-alternatives: **Sub-alternative 4e** uses the median annual landings from the year sequence selected in Alternative 4, Step 1; **Sub-alternative 4f** uses the mean annual landings from the year sequence selected in Alternative 4, Step 1; and **Sub-alternative 4g** (for the recreational sector) uses the maximum of a single year of recreational landings x 3 during the year sequence selected in Alternative 4, Step 1. Step 3 has five sub-alternatives for establishing the ABC for each stock/stock complex based on the OFL for that stock/stock complex: **Sub-alternative 4h** does not specify an ABC CR and adopts the ABC recommended by the Council's SSC; **Sub-alternative 4i** adopts an ABC CR where ABC= OFL; **Sub-alternative 4j** adopts an ABC CR where ABC = OFL x 0.90; **Sub-alternative 4k** adopts an ABC Control Rule where ABC =OFL x 0.85; and **Sub-alternative 4l** adopts an ABC CR where ABC = OFL x 0.75. Step 4 provides six sub-alternatives for establishing the ACL for each stock/complex based on the ABC. The OY is then set equal to the ACL. **Sub-alternative 4m** sets OY = ACL = ABC; **Sub-alternative 4n** sets OY = ACL =ABC x 0.95; **Sub-alternative 4o** sets OY = ACL= ABC x 0.90; **Sub-alternative 4p** sets OY = ACL =ABC x 0.85; **Sub-alternative 4q** sets OY = ACL =ABC x 0.75; and **Sub-alternative 4r** sets OY = ACL = 0.

<u>Action 5</u> establishes accountability measures (AM) to be implemented when landings exceed the ACL and includes five alternatives. **Alternative 1,** no action, would retain the methods for triggering and applying an AM included in the U.S. Caribbean-wide FMPs for previously managed stocks but would not establish AMs for stocks added to management in Action 2. **Preferred Alternative 2** (**preferred for reef fish and spiny lobster**) applies the same post-season approach to applying AMs as was prescribed in the four U.S. Caribbean wide FMPs, but allows the Council to expand that AM approach to newly managed stocks/stock complexes. This alternative includes sub-alternatives to select the determinant for triggering an AM. **Sub-alternative 2a** uses a single year of applicable landings, beginning with the most recent available complete year of landings; **Sub-alternative 2b** uses a single year of applicable landings, beginning with the most recent available complete year of landings, then a 2-year average of total landings from that single year and the subsequent year, and thereafter a progressive running two-year average; **Sub-alternative 2c** uses 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** uses 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 would establish an annual catch target (ACT) for the pelagic stocks/stock complexes (dolphinfish, tripletail, tunas, mackerel, barracuda, and wahoo) only, and rely on the ACT as an AM; upon exceeding the ACT, the Council in consultation with the Southeast Fisheries Science Center (SEFSC) would assess whether corrective action is needed. **Preferred Alternative 3** has two steps. Step 1 has three options to specify the ACT for each pelagic stock/stock complex: **Preferred Sub-alternative 3a** sets the ACT as 90% of the ACL; **Sub-alternative 3b** sets the ACT as 80% of the ACL; and **Sub-alternative 3C** sets the ACT as 70% of the ACL. In Step 2, the Council would choose one of four options to determine the sequence of years to be used to determine if an ACL overage has occurred, thereby triggering an AM. **Sub-alternatives 3d, 3e, 3f,** and **3g (Preferred)** propose the use of the same years as in **Preferred Alternative 2, Sub-alternatives 2a-2d**. **Alternative 4** would establish an in-season AM for stocks or stock complexes in the FMP. **Preferred Alternative 5** (**preferred for corals, sea cucumbers, sea urchins, Nassau grouper, goliath grouper, giant manta ray, spotted eagle ray, southern stingray, queen conch, midnight, blue, rainbow parrotfish**) proposes that for a stock with a harvest prohibition, the prohibition would serve as the AM.

<u>Action 6</u> identifies and describes essential fish habitat (EFH) only for species included in the FMP that have not been previously managed by the Council and has three alternatives. Under **Alternative 1**, no action, EFH would not be described and identified for species included in the Puerto Rico FMP that were not previously managed. Under **Preferred Alternative 2**, functional relationships between life history stages and the marine and estuarine habitats of Puerto Rico would be use to describe and identify EFH, which is the same process previously used to describe EFH for managed species in the U.S. Caribbean-wide FMPs. **Alternative 3** would allow the use of one or more sources of information for describing and identifying EFH, including distribution data, species density within specific habitats, spatial relationships between habitat and species, habitat suitability models, life history traits, or habitat-specific production estimates.

Action 7 establishes framework procedures that would allow the Council to adjust reference points and management measures more quickly. It has four alternatives. Under **Alternative 1,** no action, framework measures in the four U.S. Caribbean wide FMPs, and included in the Puerto Rico FMP under Action 1, would be retained, and no additional framework measures added. **Preferred Alternative 2** would utilize a base framework procedure for determining items to be included as framework measures, and includes an abbreviated framework procedure within the open framework. **Alternative 3** would utilize a broad framework procedure for determining items to be included as framework measures. **Alternative 4** would utilize a narrow framework procedure for determining items to be included as framework measures.

Assessment of Biological Effects

Preferred Alternative 2 of Action 1 would not have short-term biological effects because the applied regulatory environment would not change. In the long term, impacts to the biological environment from fishing activities could potentially be minimized by enhancing fisheries management.

Preferred Alternative 3 of Action 2 would be biologically beneficial because it would re-specify the species to be managed, focusing management on species in need of conservation and management. Managing additional species would increase the likelihood of sustainable harvest, as the Council must establish ACLs and could establish other measures that would provide a more comprehensive management of the coral reef ecosystem. The effects of removing species from management depends on how harvest changes without federal oversight. For stocks predominantly caught in territorial waters, the absence of federal oversight might not change how they are harvested and might not be expected to have indirect biological effects.

Preferred Alternative 3 of Action 3, revising stock complex organization and composition, and also **Preferred Sub-alternative 4b** (i.e., not selecting an indicator stock), would be expected to result in more careful and responsive management of the fisheries, and provide increased indirect benefits to the biological environment. Where data is not available to manage stocks individually, selecting an indicator species that is targeted by the fishery in **Preferred Sub-alternative 4a** 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.

Establishing sector-specific reference points in **Preferred Alternative 2** of Action 4 would have no biological effects because it does not change the total ACL. **Preferred Alternative 3** would have positive short- and long-term biological effects because applying the best scientific information available to ensure federally managed stocks are harvested sustainably over the long-term ensures those fish and invertebrate populations supporting harvest are exploited to the greatest practicable extent while protecting reproductive capacity and maintaining effective ecological contributions. **Preferred Sub-alternative 3c** would control fishing effort thus benefitting the biological environment. **Preferred Sub-alternative 3e** (**preferred for all stocks except angelfish, parrotfish, surgeonfish**) would account for management uncertainty with a relatively minimal reduction that is more conservative than status quo. The buffer applied in **Preferred Sub-alternative 3g** (**preferred for angelfish, parrotfish, surgeonfish**) would be beneficial to the biological environment as it accounts for the ecological services to the coral reef ecosystem that these species provide.

Preferred Alternative 2 of Action 5 would have positive biological benefits to reef fish and spiny lobster by ensuring fishing effort is managed as necessary to prevent a subsequent exceedance of the ACL. Specific effects from **Preferred Sub-alternative 2d** (landings years to evaluate ACL exceedance) depend on the stock and the variability in landings associated with that stock, but using a longer time series as in this alternative, would allow to more closely achieve OY.

Preferred Alternative 3 in general could risk potential depletion of a pelagic resource as harvest is not closed if an AM is triggered; however, the Council could revise its management approach or determine a closure is necessary in response to recommendations from the Southeast Fisheries Science Center. Those management revisions would benefit stock productivity in the long-term. **Preferred Sub-alternative 3a** (establishing an ACT based on 90% of the ACL) is the least conservative sub-alternative as it provides the least likelihood for convening the Council's response, however it does not prevent a response. Specific effects from **Preferred Sub-alternative 3g** (landings years to evaluate ACT exceedance) depend on the pelagic stock and the variability in landings associated with that stock, but using a longer time series, would allow to more closely achieve OY.

By equating the AM with a complete prohibition on harvest, **Preferred Alternative 5** provides the greatest overall biological benefit but only for those stocks for which the Council assigned an ABC of zero based on the SSC recommendations.

Preferred Alternative 2 of Action 6 would have no direct biological effects, and no indirect biological effects unless actions were to be taken to regulate or mitigate impacts to the EFH designations. Although the EFH descriptions for species new to management include substrates beyond the 100 fathom contour line, additional protections via management measures or from consultations on actions that could adversely affect EFH would not be expected due to the limited interactions that may occur between fishing gear and the bottom at these deeper water depths (i.e., greater than 100 fathoms). In addition, projects affecting substrates located beyond 100 fathoms are generally infrequent (e.g., submarine cables and transmission lines) and the landward extent of those project from 100 fathoms that may adversely affect substrates already trigger EFH consultations.

Under **Preferred Alternative 2** of Action 7, more expeditious regulation changes in response to changes in resource abundance and new scientific information would indirectly protect the biological integrity of managed resources and decrease the risk of overfishing those resources.

Assessment of Economic Effects

No direct economic effects are expected from **Preferred Alternative 2** of Action 1 but would result in indirect economic benefits due to an expected increase in compliance with fishery regulations and potential improvements in fishery-dependent data collected, as the fishing community requested and is supportive of the transition to island-specific management measures. Benefits also are expected from the development of effective island-specific management measures.

Preferred Alternative 2 of Action 2 would not be expected to result in direct economic effects but positive indirect economic effects would be expected from allowing management and enforcement activities to focus on more important species, from the additional protection to vulnerable species included in the FMP; from the fishing opportunities to recreational and commercial fishermen by including economically important species; and potential increased fishing opportunities that could result from future management measures for species in need of conservation and management included in the FMP.

Preferred Alternative 3 and **Preferred Sub-alternatives 4a** and **4b** of Action 3, would not be expected to result in direct economic effects, but indirect effects are expected by relying on better and more recent scientific information to create stock complexes. **Preferred Alternative 3** may increase the likelihood of setting ACLs that would provide adequate protection to the stocks, thereby resulting in positive indirect economic benefits. The selection of one or more indicator species (**Preferred Sub-alternative 4a**) and the non-assignment of indicator species (**Preferred Sub-alternative 4b**) may result in positive or negative indirect economic effects depending on the indicator species selected and on the jointness-in-catch among the species included in a given stock complex.

Preferred Alternative 2 of Action 4 is an administrative action with no indirect economic impact until such time that subsequent regulations are imposed.

Adoption of the ABC CR in **Preferred Alternative 3** of Action 4 is an administrative action and would not be expected to result in direct effects on the economic environment. 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) 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) (See Section 4.4.3 for additional information).

However, setting reference points and ACLs that protect the stock or stock complexes while optimizing yield are expected to result in positive indirect economic benefits.

Preferred Sub-alternative 2d of Action 5 would be expected to result in net economic benefits because it would be expected to smooth out landings data fluctuations and mitigate potential adverse economic effects by relying on a stepwise temporal approach to trigger an AM. Effects from **Preferred Sub-alternatives 3a** and **3g** would be determined by the nature of the corrective actions, if any, taken by the Council once an AM is triggered. **Preferred Alternative 5** is expected to result in substantial economic benefits for those species with harvest prohibitions due to the enhanced protection conferred to these stocks.

Preferred Alternative 2 of Action 6 would not be expected to result in economic effects. Direct economic effects would be expected if there are impacts to EFH from fishing activities and regulations are implemented to protect EFH, or if impacts to EFH are mitigated in EFH consultations. **Preferred Alternative 2** identified additional EFH beyond 100 fathoms for some newly managed species. However, projects affecting substrates located beyond 100 fathoms are generally infrequent and the landward extent of those project from 100 fathoms already trigger EFH consultations. Additional management measures to protect EFH from fishing impacts would not be expected due to the limited interactions that may occur between fishing gear and the bottom at these deeper water depths (i.e., greater than 100 fathoms). Any potential economic costs and benefits (and their relative magnitude) that could be expected from **Preferred Alternative 2** may only be estimated if (and once) specific regulations to protect EFH are outlined and enacted.

Preferred Alternative 2 of Action 7 would be expected to allow for a timelier implementation of a wider suite of measures that would be beneficial to the stocks, thereby resulting in future biological benefits and associated indirect positive economic effects.

Assessment of Social Effects

By creating an individual FMP for Puerto Rico, **Preferred Alternative 2** of Action 1 addresses the concerns expressed by the public regarding island management. 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, and the increased cooperation may lead to more compliance which should benefit the social environment.

The criteria included in **Preferred Alternative 2** of Action 2 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 indirect positive social effects. By including economically and socially important species, the Council can tailor management to ensure their continued positive social effects. Furthermore, with the addition of all sea cucumbers and sea urchins, there would likely be positive social effects from management and conservation of these species.

The organization of stock complexes or individual stocks under **Preferred Alternative 3** of Action 3 relied on analysis and extensive review by expert and experience-based panels in a process that garnered both scientific and public support and is consistent with the purpose of creating an FMP tailored to Puerto Rico, thus providing benefits to the social environment. **Preferred Alternative 4** would have positive social benefits through practical selection (**Sub-alternative 4a**) or non-selection (**Preferred Sub-alternative 4b**) of indicator stocks, which reflect available information. However, the formation of reference points for grouped stocks and the use of indicator stocks may induce some changes in fishing behavior if unanticipated closures occur as a result of thresholds for the stock complex being exceeded. In the long term, if these measures provide sufficient protection for stocks there should be positive social effects.

Preferred Alternative 2 of Action 4 would likely have positive social benefits as the ensuing catch levels ensure that each sector has access to the resource commensurate with 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 establishing reference points and status determination criteria for those stocks or complexes that have assessments or those with more data, and helps assess the risk of overfishing. The long-term social effects would likely be positive if the OY and ACLs established in this action provide protection for the stocks and ensure the sustainability of stocks and stock complexes.

In **Preferred Alternative 2** of Action 5, an AM would be triggered if sector landings exceed the sector ACL and total landings exceed the total ACL for a stock/stock complex in the Puerto Rico FMP, and may be more aligned with stakeholder desires, benefitting the social environment. It is difficult to determine social effects from **Preferred Sub-alternative 2d**, but by incorporating running averages and allowing flexibility based on data availability, it may be more in tune with fishing practices at the time considered and what may occur in the future. Effects from **Preferred Sub-alternatives 3a** and **3g** would be determined by the nature of the corrective actions, if any, taken by the Council once an AM is triggered. There would be few if any immediate social effects from **Preferred Alternative 5** (harvest prohibition as the AM), however, over time as these stocks recover there could be positive social effects in the long term.

The social effects of **Preferred Alternative 2** in Action 6 would be hard to determine, given the indirect links to other management alternatives that may or may not have some impacts. 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 OY.

Preferred Alternative 2 of Action 7 is likely to have the most positive social effects of all alternatives proposed as it reflects the flexible suite of options and what the Council views are the appropriate procedures given the current status and condition of the fisheries being managed.

Assessment of Effects on Safety at Sea

The actions in the Puerto Rico FMP are not expected to have a direct impact on safety at sea, as none of them have safety implications or would significantly change the way in which the Puerto Rico EEZ fisheries operate.

Chapter 7. Regulatory Impact Review

7.1 Introduction

The National Marine Fisheries Service (NMFS) requires a Regulatory Impact Review (RIR) for all regulatory actions that are of public interest. The RIR does three things: (1) it provides a comprehensive review of the level and incidence of impacts associated with a proposed or final regulatory action; (2) it provides a review of the problems and policy objectives prompting the regulatory proposals and an evaluation of the major alternatives that could be used to solve the problem; and, (3) it ensures that the regulatory agency systematically and comprehensively considers all available alternatives so that the public welfare can be enhanced in the most efficient and cost-effective way. The RIR also serves as the basis for determining whether the regulations are a "significant regulatory action" under the criteria provided in Executive Order (E.O.) 12866. This RIR analyzes the impacts this action would be expected to have on the fisheries of the Puerto Rico exclusive economic zone (EEZ).

7.2 Problems and Objectives

The problems and objectives addressed by this action are discussed in Section 1.2.

7.3 Description of Fisheries

A description of the fisheries of the Puerto Rico EEZ is provided in Section 3.5.

7.4 Impacts of Management Measures

7.4.1 Action 1: Transition Fisheries Management in the Puerto Rico EEZ from an U.S. Caribbean-wide Approach to an Island-based Approach

A detailed analysis of the economic effects expected to result from this action is provided in Section 4.1.3. The following discussion summarizes the expected economic effects of the preferred alternative.

Preferred Alternative 2 would repeal the current U.S. Caribbean-wide fishery management plans (FMP) as they apply to the Puerto Rico management area and replace them with the island-based FMP for Puerto Rico EEZ waters. **Preferred Alternative 2** would not be expected to result in direct economic effects because it would not affect the harvest or other customary uses of fishery resources. However, **Preferred Alternative 2** would be expected to result in indirect economic benefits due to an expected increase in compliance with fishery regulations, potential improvements in fishery-dependent data collected, and the development of effective island-specific management measures. The magnitude of these expected economic benefits is unknown because it would be determined by a range of factors including, the extent to which compliance would improve, costs associated with the commercial harvest of seafood, changes in producer and consumer surplus, and the management measures that would be implemented following the transition to an island-specific FMP.

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

A detailed analysis of the economic effects expected to result from this action is provided in Section 4.2.3. The following discussion summarizes the expected economic effects of the preferred alternative.

Preferred Alternative 2 uses a stepwise process based on five specified criteria to determine the species to include in (or exclude from) the island-specific Puerto Rico FMP. **Preferred Alternative 2** would not be expected to affect the harvest or other customary uses of fishery resources and would therefore not be expected to result in direct economic effects. However, **Preferred Alternative 2** would be expected to result in an array of indirect economic effects. As with the U.S. Caribbean-wide FMPs, the inclusion of overfished stocks in the island-specific FMP would be expected to increase the likelihood of successfully rebuilding these stocks, thereby resulting in positive economic effects due to increased fishing opportunities in the long run. The exclusion of species that are infrequently occurring in the Puerto Rico EEZ would be expected to result in economic benefits by allowing management and enforcement activities to focus on more important species. The inclusion of vulnerable species in this island-specific FMP could also be expected to result in positive economic effects if the Council enacts management measures affording additional protection to these species. The inclusion of species of economic importance to the regional or national economy could be expected to result in economic benefits derived from the fishing opportunities that could be provided to recreational and commercial fishermen in the Puerto Rico EEZ. Finally, the inclusion in this island-specific FMP of species in need of conservation and management, as determined by the Council, could be expected to result in positive economic effects due to potential increased fishing opportunities that could result from future management measures. Overall, the net economic effects expected to result from **Preferred Alternative 2** would be determined by the management measures implemented by the Council after it determines the list of species included in this island-specific FMP.

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

A detailed analysis of the economic effects expected to result from this action is provided in Section 4.3.3. The following discussion summarizes the expected economic effects of the preferred alternatives.

Preferred Alternative 3 would, based on scientific analysis, manage stocks included in the Puerto Rico FMP as individual stocks or stock complexes. For stock complexes identified under **Preferred Alternative 3**, indicator stocks may be used (**Preferred Sub-alternative 4a)** or not (**Preferred Sub-alternative 4b**). The management of species as individual stocks or stock complexes and the assignment of indicator species are administrative measures that would not be expected to alter the harvest or other customary uses of these stocks. Therefore, **Preferred Alternative 3** and **Preferred Sub-alternatives 4a** and **4b** would not be expected to result in direct economic effects. The set of preferred alternatives selected in this action (Action 3) would however be expected to result in indirect economic effects. By relying on better and more recent scientific information to create stock complexes, **Preferred Alternative 3** may increase the likelihood of setting ACLs that would provide adequate protection to the stocks, thereby resulting in positive indirect economic benefits. The selection of one or more indicator species (**Preferred Sub-alternative 4a**) and the non-assignment of indicator species (**Preferred Sub-alternative 4b**) may result in positive or negative indirect economic effects depending on the indicator species selected and on the jointness-in-catch among the species included in a given stock complex. If harvests of species belonging to a given stock complex are highly joint in nature, the use of indicator species would be expected to assist in the management and evaluation of other stocks within the stock complex, particularly those stocks for which landings and other relevant data are limited, thereby resulting in indirect economic benefits. Conversely, the non-assignment of indicator species when jointness in catch exists within a stock complex could be expected to result in adverse indirect economic effects because data that could assist in improving the management process would be forgone. Alternatively, if jointness in the harvesting process is weak or non-existent, potential indirect economic effects that would be expected to be derived from the use of indicator species would be reduced.

7.4.4 Action 4: Establish Status Determination Criteria (SDC) and Management Reference Points

A detailed analysis of the economic effects expected to result from this action is provided in Section 4.4.3. The following discussion summarizes the expected economic effects of the preferred alternatives.

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 not dependent on decisions to manage stocks and stock complexes by sector or in total (i.e., combined commercial and recreational). **Preferred Alternative 3** would use a three-step process to specify the MSY or proxy, ABC, OY, and ACL for each stock/stock complex. The first step would be the adoption of an ABC control rule. Adoption of the ABC CR is entirely administrative in nature and would not be expected to result in direct or indirect effects on the economic environment. Upon adoption of this control rule, the second step is to determine fishing mortality rate associated with fishing at MSY, which will inform approximations of MSY and MFMT when F_{MSY} cannot otherwise be determined from application of the ABC CR in step 1, based on three sub-alternatives. The third step is to determine OY and ACL based on several sub-alternatives. In these sub-alternatives, OY is set equal to ACL with ACL being some fraction of ABC (ranging from 0 to 1).

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[75]) 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.[76] In general, setting reference points and ACLs that protect the stocks or stock complexes while optimizing yield are expected to result in positive indirect economic benefits.

7.4.5 Action 5: Accountability Measures for Stocks and Stock Complexes

A detailed analysis of the economic effects expected to result from this action is provided in Section 4.5.3. The following discussion summarizes the expected economic effects of the preferred alternatives.

Preferred Sub-alternative 2d uses a stepwise temporal approach to calculating average landings for comparison against the applicable ACL to determine if an AM would be triggered. For a given stock or stock complex, if an AM is triggered, **Preferred Sub-alternative 2d** would be expected to result in positive economic effects derived from the added protection to the stock or stock complex. However, **Preferred Sub-alternative 2d** would also be expected to result in adverse economic effects due to disruptions to fishing communities and losses in economic benefits derived from fishing activities, regulatory discards from bycatch of species caught during an AM closure, and an increased administrative burden. Landings data may be relatively imprecise and subject to sizeable annual fluctuations. Overall, **Preferred Sub-alternative 2d** would be expected to result in net economic benefits because it would be expected to smooth out

[75] 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.
[76] The assumption is being made that dockside price does not change in response to changes in binding ACLs.

these fluctuations and mitigate potential adverse economic effects by relying on a stepwise temporal approach to trigger an AM.

For pelagic stocks only, **Preferred Alternative 3** uses a two-step process to set an ACT and trigger an AM. **Preferred Sub-alternative 3a** sets an ACT equal to 90% of the ACL. **Preferred Sub-alternative 3g** use a stepwise temporal method to trigger an AM. Based on data availability, the Regional Administrator in consultation with the Council may modify the specific time sequences considered under **Preferred Sub-alternative 3g**. The economic effects expected to result from the set of sub-alternatives selected in **Preferred Alternative 3** would reflect the trade-off between economic benefits resulting from the added protection to the stock expected from the establishment of an AM and the associated economic costs due to losses of fishing opportunities and landings once an AM is triggered. Overall, the net economic effects expected to result from preferred sub-alternatives would be determined by the nature of the corrective actions, if any, taken by the Council once an AM is triggered.

For stocks with harvest prohibitions, **Preferred Alternative 5** uses the prohibitions as the AM. Because the ABC for these species is set to zero due to the overfished condition of some stocks (i.e., queen conch, Nassau grouper, goliath grouper) and the ecological importance of others (blue parrotfish, midnight parrotfish, rainbow parrotfish, sea cucumbers, sea urchins, and corals), the enhanced protection of these stocks is warranted and is expected to result in substantial economic benefits.

7.4.6 Action 6: Describe and Identify EFH for Species not Previously Managed in the Puerto Rico EEZ

A detailed analysis of the economic effects expected to result from this action is provided in Section 4.6.3. The following discussion summarizes the expected economic effects of the preferred alternative.

Preferred Alternative 2 would describe and identify EFH according to functional relationships between life history stages for stocks not previously managed in Puerto Rico EEZ and marine and estuarine habitats. **Preferred Alternative 2** would not be expected to result in economic effects if fishing gear and fishing activities do not impact EFH. However if there are impacts to EFH from fishing gear and/or activities and regulations are implemented to protect EFH, **Preferred Alternative 2** would be expected to result in direct economic effects. **Preferred Alternative 2** would result in economic benefits due to the added protection to EFH and the economic value it would generate, e.g., direct benefits enjoyed by non-consumptive users such as scuba divers. Any regulations implemented to protect EFH would also result in direct economic costs borne by those sectors upon which the regulations are imposed. For example, regulations may include costly gear restrictions or limitations resulting in a reduction in catch. The net economic effects expected to result from **Preferred Alternative 2** cannot be determined at this time. The relative magnitude of any potential economic costs and benefits that could be expected to result from **Preferred Alternative 2** may only be estimated if (and once) specific regulations to protect EFH are outlined and enacted. However, at this time, no economic effects are expected. **Preferred Alternative 2** identified additional EFH beyond 100 fathoms for some newly managed species. Additional EFH consultations are not likely as projects affecting substrates located beyond 100 fathoms are generally infrequent and the landward extent of those project from 100 fathoms already trigger EFH consultations. Additional management measures to protect EFH from fishing impacts would not be expected due to the limited interactions that may occur between fishing gear and the bottom at these deeper water depths (i.e., greater than 100 fathoms). Therefore, this alternative will not impose any additional economic costs or result in additional economic benefits.

7.4.7 Action 7: Framework Procedures for the Puerto Rico FMP

A detailed analysis of the economic effects expected to result from this action is provided in Section 4.7.3. The following discussion summarizes the expected economic effects of the preferred alternatives.

Preferred Alternative 2 would expand the range of management measures that can be implemented by the Council without going through a full plan amendment process. Compared to the time typically required to develop an FMP amendment, **Preferred Alternative 2** would be expected to allow for a timelier implementation of a wider suite of measures that would be beneficial to the stocks, thereby resulting in future biological benefits and associated indirect positive economic effects. The magnitude of the indirect economic benefits expected to result from **Preferred Alternative 2** would depend upon the relative speed at which regulatory changes can be implemented.

7.5 Public and Private Costs of Regulations

The preparation, implementation, and monitoring of this or any federal action involves the expenditure of public and private resources which can be expressed as costs associated with the regulations. Estimated costs associated with this action include:

Council costs of document preparation, meetings, public hearings,
and information dissemination______________________________________$333,650

NMFS administrative costs of document preparation, meetings and review__________$756,650

TOTAL____$1.09 million

7.6 Determination of Significant Regulatory Action

Pursuant to E.O. 12866, a regulation is considered a "significant regulatory action" if it is likely to result in: (1) an annual effect of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local, or tribal governments or communities; (2) create a serious inconsistency or otherwise interfere with an action taken or planned by another agency; (3) materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights or obligations of recipients thereof; or (4) raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in this executive order (E.O). Based on the information provided above, this action has been determined to not be economically significant for the purposes of E.O. 12866.

Chapter 8. List of Preparers

List of personnel that assisted with development of the Puerto Rico Fishery Management Plan and Environmental Assessment.

Table 8.1. List of interdisciplinary plan team (IPT) members and other contributors.

Name	Agency	Title
Bill Arnold	NMFS/SFD	Caribbean Branch Chief / Fishery Biologist
María del Mar López	NMFS/SFD	IPT Co-lead / Fishery Biologist
Sarah Stephenson	NMFS/SFD	Fishery Biologist
Graciela García-Moliner	CFMC	IPT Co-lead / Fishery Biologist
Miguel Lugo	NMFS/SFD[77]	Fishery Biologist (Former IPT Co-lead)
Michael Jepson	NMFS/SFD	Anthropologist
David Dale	NMFS/HCD	EFH Specialist
Kate Quigley	CFMC[78]	Economist
Karla Gore	NMFS/SFD	Fishery Biologist
Denise Johnson	NMFS/SFD	Economist
Jennifer Lee	NMFS/PRD	Fishery Biologist
Patrick O'Pay	NMFS/PRD	Fishery Biologist
Michael Larkin	NMFS/SFD	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/SFD	Technical Writer
Jose Rivera	NMFS/HCD	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
Pace Wilber	NMFS	Habitat Specialist
Walter R. Keithly	CFMC	Economist
Peggy Overbey	Contractor	Social Sciences
Adyan Rios	NMFS/SEFSC	Biologist
Skyler Sagarese	NMFS/SEFSC	Biologist

NMFS = National Marine Fisheries Service, CFMC = Caribbean Fishery Management Council, SFD = Sustainable Fisheries Division, PRD = Protected Resources Division, SERO = Southeast Regional Office, HCD = Habitat Conservation Division, GC = General Counsel, SEFSC = Southeast Fisheries Science Center, OLE= Office of Law Enforcement

[77] Currently at NOAA NMFS Seafood Inspection Program, Southeast Inspection Branch
[78] Currently at NOAA Office for Coastal Management, South Carolina

Chapter 9. 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 for the Puerto Rico Fishery Management Plan

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Appendix A. National Environmental Policy Act Scoping Process and Outcomes from Scoping Hearings

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[79], the Caribbean Fishery Management Council (Council), and National Marine Fisheries Service (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 U.S. Caribbean-wide 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 U.S. Virgin Islands (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. 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

[79] 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.

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 U.S. Caribbean-wide 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 U.S. Caribbean-wide 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 U.S. Caribbean-wide 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 had 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, physical, biological/ecological, 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.

In April 2019, NMFS reassessed the actions in each FMP relative to NEPA and its requirements and preliminarily determined that the proposed actions would not significantly affect the quality of the human environment, and that draft EISs previously developed were not required. As a result of this determination, NMFS, in collaboration with the Council, would develop a draft EA for each new FMP rather than proceeding with the development of draft EISs. This information was provided in a Notice published in the *Federal Register* (84 FR 14096, April 9, 2019), which aslo informed the public of the withdrawl of the previous NOI and supplemental NOIs.

In April 2019, the Council held public hearings on each of Puerto Rico, St. Croix, and St. Thomas/St. John to provide an overview of the most complete draft island-based FMP that pertains to the island at which they presented. The audience was also provided with the time and opportunity to comment on their island's plan. Public hearings were held in the Puerto Rico municipalities of San Juan (April 1), Naguabo (April 2), and Mayaguez (April 3). A total of 31 persons participated in these hearings. In general, persons offering testimony at the hearings emphasized their support for specific actions. For example, support was expressed for Action 2 (Stocks managed under the Puerto Rico FMP) and the Council's use of ecological, economic, and social considerations to decide in a stepwise fashion (Preferred Alternative 2) which species should be managed under the new FMPs, as well as for Action 1 (Transitioning from a Species-based FMPs to an Island-based FMP), Alternative 2 (i.e., transitioning to the island-based FMPs). Additional information about the public hearings can be found at the Council's website. At their April 23-24, 2019 regular meeting, the Council voted to submit each of the island-based FMPs to the Secretary of Commerce for approval.

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 Procedure 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 (FMP) and amendments and the use of best scientific information available is the second national standard under the Magnuson-Stevens Act. 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.

The Puerto Rico FMP will subsume some of the activities currently managed under the Reef Fish FMP of Puerto Rico and the U.S. Virgin Islands (USVI) (Reef Fish FMP) and the Spiny Lobster FMP of Puerto Rico and the USVI (Spiny Lobster FMP). Fishing activities authorized under the Puerto Rico FMP may affect ESA-listed species or designated critical habitat that occur in the Puerto Rico management area. A formal consultation (i.e., biological opinion) is currently in process to comprehensively package all analyses for all actions under the Puerto Rico FMP into one document 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.

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.

NMFS has determined that fishing activities conducted under this FMP will have no adverse impact on marine mammals. In the 2019 List of Fisheries published by NMFS, all gear (dive, hand/mechanical collection fisheries) used in the Puerto Rico fisheries are considered Category III (84 FR 22051). This classification indicates the annual mortality and serious injury of a marine mammal stock resulting from any fishery is less than or equal to one percent of the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock, while allowing that stock to reach or maintain its optimum sustainable population. This FMP does not change the list of authorized gear and will not alter this determination.

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 FMP 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, coral reef resources, and fish. As specified in the Magnuson-Stevens Act, EFH consultation is required for federal actions which may adversely affect EFH. Any required consultation requirements will be completed prior to implementation of any new management measures.

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 Assessment to satisfy the NEPA requirements. The Purpose and Need can be found in Section 1.4, Alternatives are found in Chapter 2, the Environmental Consequences are found in Chapter 4, the List of Preparers is in Chapter 9, and a list of the agencies/people consulted is found in Chapter 10.

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. See the RFA analysis in Chapter 8 for more information.

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. See Chapter 7 (RIR) for more information.

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 3.5.10 for Environmental Justice considerations as they relate to this FMP.

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 will have no direct impacts on coral reefs, and positive indirect impacts can be expected from the prohibition of harvest on all species of corals, sea cucumbers, and sea urchins in the Puerto Rico EEZ. The U.S. Caribbean wide FMPs managed many species of corals, sea cucumbers, and sea urchins, and prohibited harvest of the corals. Puerto Rico FMP manages all species of corals, sea cucumbers, and sea urchins, prohibiting the harvest of all managed species. Thus the harvest prohibition is more extensive than the prohibition under the U.S. Caribbean wide FMPs, and will provide additional benefits. 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 MPAs in federal waters of Puerto Rico.

Appendix C. History of Federal Fisheries Management

Tables C.1-C.4 summarize actions in the Caribbean Fishery Management Council's (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), R 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. The Puerto Rico FMP contained in this document replaces these plans as they applied to the Puerto EEZ.

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; - 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; - Concluded that local fishermen were harvesting 100% of the OY. Therefore, there was no remaining harvest identified for foreign fishing; - Established a minimum mesh size for fish traps of 1 ¼ to allow for the escape of juvenile fish; - Required a self-destruct panel (not smaller than the funnel opening of the trap) and/or self-destruct door fastening in fish traps; - 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
			systems required by the Puerto Rico and USVI management agencies can be used by fishermen of those states to meet the federal marking requirements; - 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; - 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. - 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; - 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; - 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; - 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; - 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; - Described the characteristics of the habitat used by the stocks in the shallow water reef fish FMU. - *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; - Prohibited the harvest and possession of Nassau grouper due to low abundance; - Revised the data collection efforts to include the collection of socio-economic information on the different managed fisheries; - 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[80]. - Defined overfishing (OF) and overfished conditions for shallow water reef fish; - 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:

[80] 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; ▪ 1.5 inches for square mesh through September 13, 1993; and ▪ 2.0 inches (5.1 centimeters) for square mesh, effective September 14, 1993. - Added more specific requirements for degradable panel on fish traps.
Amendment #2 to the Reef Fish FMP (1993)	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; - Extended protection to the aquarium trade finfish species (included them in the FMU); - 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; - Prohibited the harvest and possession of certain aquarium trade species: ▪ Live red hind (*Epinephelus guttatus*) and mutton snapper (*Lutjanus analis*) juveniles to allow for the recovery of these rebuilding species; ▪ Seahorses (*Hippocampu*s spp.) and basslets (*Liopropom*a) due to their scarcity; ▪ 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; ▪ 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
			aculeatus), due to their high mortality in captivity; ▪ 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. - 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)*. - Retitled the FMP from the Shallow Water Reef Fish FMP to the FMP for the Reef Fish Fishery of Puerto Rico and the USVI; - 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; - Required that the fish traps be constructed as follows: ▪ Basic construction material must be 1.5-in hexagonal mesh wire or 2.0-in square mesh wire; ▪ 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); ▪ 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; - Prohibited the harvest of Goliath grouper in the U.S. Caribbean EEZ; - 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; - 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; - Established seasonal closures in two additional areas off the west coast of Puerto Rico (Abrir La Sierra Bank and Bajo de Sico); - Closed the EEZ portions in three areas to all fishing between December 1 and February 28, each year: ▪ 1.5 mile radius centered around a buoy to be deployed in the area known as Bajo de Sico; ▪ 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); ▪ 1.5 mile radius around Buoy 6 at Abrir La Sierra Bank.
Amendment #3 to the Reef Fish FMP (2005) Part of the Caribbean Sustainable Fisheries Act Amendment	11/28/2005	PR:70 FR 53979 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); ▪ The degradable panel must be at least 8 x 8 in and with mesh not smaller than the mesh of the trap; - Individual traps or pots must have at least one buoy attached that floats on the surface; - 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; - 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; - 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. - Required an anchor retrieval system for anyone fishing for or possessing reef fish species; - Prohibited the filleting of fish at sea; - 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
			- Established seasonal closures (no fishing or possession), every year during the specified months, for: ▪ Silk, black, blackfin and vermillion snapper from October 1 through December 31; ▪ Tiger, yellowfin, yellowedge, red and black from February 1 through April 30; ▪ Red hind from December 1 through the last day of February; ▪ Lane and mutton snapper from April 1 through June 30. - 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. - 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 scientific information available, 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 scientific information available, the F_{CURR}/F_{MSY}

Fishery Management Plan (FMP) or Amendment	Final Rule Effective Date	Proposed Rule (PR) Final Rule (FR)	Major Actions
			proxy was estimated as 1.50 and the B_{CURR}/B_{MSY} proxy estimated as 0.75. - Defined OY equal to the average yield associated with fishing on a continuing basis at F_{OY}; where $F_{OY} = 0.75F_{MSY}$. - Defined MSST = $B_{MSY}(1\text{-}c)$; where c = the natural mortality rate (M) or 0.50, whichever is smaller. - 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}. - Specified an OY control rule to define target catch limits such that they equal $F_{OY}(B)$. - 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; - Rebuild Nassau grouper to B_{MSY} in 25 years, using the formula T_{MIN} (10 years) + one generation (15 years) = 25 years. - Rebuild Goliath grouper to B_{MSY} in 30 years, using the formula T_{MIN} (10 years) + one generation (20 years) = 30 years. - Rebuild grouper unit 4 to B_{MSY} in 10 years; - 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)); - 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)); - 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; - 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 (started in 1997, but postponed) To implement escape vents in the trap fishery	POSTPONED	N/A NOI:72 FR 57307	N/A
Regulatory Amendment #3 to the Reef Fish FMP (2010) To address management in Bajo de Sico, Puerto Rico *The Final rule included other management measures not part of the amendment.	12/2/2010	PR: 75 FR 44209 (7/28/2010) 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); - Prohibited fishing for or possession of Council-managed reef fish species in Bajo de Sico; - 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. - *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.
Amendment #5 to the Reef Fish FMP (2011) Part of the 2010 Caribbean Annual Catch Limit (ACL) Amendment	1/30/2012	PR: 76 FR 66675 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
			in comparison with other Caribbean parrotfish species, and lack of abundance compared with most parrotfish occupying U.S. Caribbean waters; - Amended the stock complexes in the Reef Fish FMUs: ▪ Separated grouper unit (GU) 4 into GU4 (yellowfin, red, tiger [black grouper was added to GU4]) and GU5 (yellowedge, misty). ▪ Removed creole fish from GU3 and fisheries management ▪ Modified the snapper FMU by adding cardinal snapper to snapper unit (SU) 2 and moved wenchman to SU1; - 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. - 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. - Modified existing management measures as needed to constrain harvest to specified ACLs. - Specified separate commercial and recreational ACLs in Puerto Rico based on the preferred management reference point time series; - 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; - Modified framework measures for the Reef Fish FMP established in Amendment 1.
Amendment #6 to the Reef Fish FMP (2011) Part of the 2011 Caribbean ACL Amendment	1/30/2012	PR: 76 FR 68711 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. - For those species included in Amendment 6, allocated ACLs among island management areas; - Established aggregate recreational bag limits for angelfish, boxfish, goatfish, grunts, wrasses, jacks, scups and porgies, squirrelfish, triggerfish and filefish, tilefish: ▪ 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. - Redefined management reference points, including MSY, OFL, ABC, ACL, AMs; - Allocated the ACLs for the 2011 species by each island's subzone; - 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 (2013)	8/29/2013	PR:78 FR 15338 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: ▪ Minimum size limit of 8 inches (20.3 cm), fork length, for redband parrotfish (*Sparisoma aurofrenatum*) ▪ Minimum size limit of 9 inches (22.9 cm), fork length, for all other parrotfish: princess, queen, striped, redtail, stoplight, redfin. - The current harvest prohibition for midnight, blue, and rainbow parrotfish remains in effect.
Amendment #7 to the Reef Fish FMP (2016) Revised language to reflect current regulatory language	06/10/2016	NOA: 81 FR 5978 PR: 81 FR 9800 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) Modified date of implementation of AM-based closures	06/08/2017	NOA: 82 FR 1308 PR: 82 FR 10324 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. - 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) 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 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. - 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
Spiny Lobster FMP (1981)	1/1985	FR: 49 FR 50049 (12/26/1984)	- 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. - 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; - 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
			greater, that can be harvested on an annual basis;" - Established a domestic annual harvest under the proposed CL of 3.5 in; - Size and harvest requirements included: ▪ Land lobster whole and with a CL equal or larger than 3.5 in; ▪ 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; - Gear requirements included: ▪ Include a self-destruct panel and/or self-destruct door fastenings on traps and pots to eliminate "ghost traps;" ▪ Identify and mark traps, pots, buoys, and boat; ▪ 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; ▪ Report catch and effort information through improvement of the existing data collection systems. - 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; - 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. - Established management measures to halt overfishing should overfishing occur.
Amendment #2 to the Spiny Lobster FMP (2005) Part of the Caribbean Sustainable Fisheries (SFA) Act	11/28/2005	PR: 70 FR 53979 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 = $B_{MSY}(1\text{-}c)$; where c = the natural mortality rate (M) or 0.50, whichever is smaller. - Minimized bycatch and bycatch mortality to the extent practicable; - Described and identified essential fish habitat (EFH) and habitat areas of particular concern for the spiny lobster; - 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: ▪ 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; ▪ 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. - 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 NOI: 72 FR 57307	N/A
Amendment #4 to the Spiny Lobster FMP (2008)	2/11/2009	NOA: 73 FR 61015 PR: 73 FR 64295 FR: 74 FR 1148	- Restricted spiny lobster imports into the U.S.; - Established conservation standards to achieve an increase in spawning stock biomass and increase the long-term yield of the fishery; - 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) Part of the 2011 Caribbean Annual Catch Limit (ACL) Amendment	1/30/2012	NOA: 76 FR 59377 PR: 76 FR 68711 FR: 76 FR 82414	- Revised the management reference points and status determination criteria established in Amendment 2 (i.e, 2005 SFA Amendment); - Established ACLs and accountability measures (AMs) for spiny lobster; - 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. - 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. - Revised framework procedures for the spiny lobster.
Amendment #6 to the Spiny Lobster FMP (2015) Part of the Comprehensive Amendment to the U.S. Caribbean Fishery Management Plans: Application of Accountability Measures	6/10/2016	NOA: 81 FR 5978 PR: 81 FR 9800 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. - Clarified that any AM-based closure would only apply for the fishing year for which it was implemented, consistent with the Council's intent. - The final rule (not included in the amendment) clarified that: ▪ 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. ▪ 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) Part of the Amendments to the U.S. Caribbean Reef Fish, Spiny Lobster, and	6/08/2017	NOA: 82 FR 1308 PR: 82 FR 10324 FR: 82 FR 21475	- Modified the implementation date for AM-based closures. Specifically: ▪ 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. ▪ 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. - 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
Queen Conch FMP (1996)	1/13/1997	PR: 61 FR 45395 FR: 61 FR 65481 (12/13/1996)	- Defined the maximum sustainable yield (MSY) of queen conch as 738,000 lbs per year; - 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;" - Required that all conch species in the fishery management unit be landed in the shell; - 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
			- Implemented a recreational bag limit of three queen conch per day, not to exceed 12 per boat; - 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; - Implemented a commercial catch limit of 150 queen conch per day: ▪ 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; ▪ The quota reduction is subject to review upon receipt of empirical information on which to base the decisions for new limits; - All conch harvested under these provisions must conform to minimum size specifications and be landed still attached to the shell; - Implemented an annual spawning season closure that extended from July 1 through September 30; - Prohibited the use of hookah gear to harvest queen conch; - Established the following framework measures: ▪ Establish closed areas, and address significant changes in fishing practices or environmental disasters; ▪ 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 PR: 70 FR 53979 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*); - Nine species remained in the FMU; - 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; - 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; - 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); ▪ 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; ▪ 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 FR: 76 FR 23907	Established a quota and seasonal closures compatible with the USVI: ▪ 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). ▪ 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) Part of the 2010 Caribbean Annual Catch Limit Amendment	1/30/2012	NOA: 76 FR 59375 PR: 76 FR 66675 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); - 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. - 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; ▪ 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) Part of the 2011 Caribbean Annual Catch Limit Amendment	1/30/2012	NOA: 76 FR 53977 PR: 76 FR 68711 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 FR: 60 FR 58221 (11/27/1995)	- 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; - Prohibited the sale or possession of any prohibited coral unless fully documented as to point of origin; - Prohibited the use of chemicals, plants, or plant-derived toxins, and explosives to take species in the coral FMU; - Required that dip nets, slurp guns, hands, and other non-habitat destructive gear types be used to harvest allowable corals; - Required that harvesters of allowable corals obtain a permit from the local or federal government; - 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 FR: 64 FR 60132	Established a no-take MCD in the U.S. exclusive economic zone (EEZ) southwest of St. Thomas, USVI, including: - 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 FMP, Queen Conch FMP, and Spiny Lobster FMP).

Fishery Management Plan or Amendment	Final Rule Effective Date	Proposed Rule (PR) Final Rule (FR)	Major Actions
			- 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) (Part of the Caribbean Sustainable Fisheries Act Amendment)	11/28/2005	PR: 70 FR 53979 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. - 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) (Part of the 2011 Caribbean Annual	1/30/2012	PR: 76 FR 68711 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 be undergoing overfishing. The ACL for aquarium trade species is a U.S. Caribbean-wide ACL. The U.S.

Fishery Management Plan or Amendment	Final Rule Effective Date	Proposed Rule (PR) Final Rule (FR)	Major Actions
Catch Limit [ACL] Amendment)			Caribbean-wide ACL for the aquarium trade species was established using landings data from the Puerto Rico commercial and recreational sectors. - 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 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) Part of the Comprehensive Amendment to the U.S. Caribbean Fishery Management Plans: Application of Accountability Measures	6/10/2016	NOA: 81 FR 5978 PR: 81 FR 9800 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. - 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

List of species considered by the Caribbean Fishery Management Council for inclusion in the Puerto Rico Fishery Management Plan (FMP) and the applicable selection criterion under Action 2, Preferred Alternative 2 (Table D.1). Comparison of stock complex organization under the U.S. Caribbean-wide Reef Fish FMP and the Puerto Rico FMP as organized under Action 3, Preferred Alternative 3 is shown in Table D.2. Stock organization under the Spiny Lobster and Queen Conch FMPs would be the same as under the Puerto Rico FMP, as these two stocks would continue to be managed individually. All coral species managed under the Coral FMP (Table D.1) would be managed in a Corals stock complex under the Puerto Rico FMP, although additional coral species (see Appendix E) would be added to that stock complex. Similarly, all sea urchin and sea cucumber species that were previously managed in the Aquarium Trade Invertebrates stock complex under the Coral FMP (Table D.1) would be managed in either the Sea urchins stock complex or the Sea cucumbers stock complex under the Puerto Rico FMP along with additional sea urchin and sea cucumber species that occur within the Puerto Rico management area (see Appendix E).

Table D.1. Species considered for management in the Puerto Rico FMP including species that were previously managed in the U.S. Caribbean Reef Fish, Spiny Lobster, Queen Conch, and Coral FMPs and species that were not previously managed, but that were reported in Puerto Rico landings data.

Group	Scientific name	Common name	Previously Managed	Applicable Criterion
Lobster	*Panulirus argus*	Caribbean spiny lobster	Yes	A
Conch	*Lobatus gigas*	Queen conch	Yes	A
Angelfishes	*Holacanthus ciliaris*	Queen angelfish	Yes	C
Angelfishes	*Pomacanthus arcuatus*	Gray angelfish	Yes	C
Angelfishes	*Pomacanthus paru*	French angelfish	Yes	C
Boxfishes	*Lactophrys polygonia*	Honeycomb cowfish	Yes	B
Boxfishes	*Lactophrys quadricornis*	Scrawled cowfish	Yes	B
Boxfishes	*Lactophrys trigonus*	Trunkfish	Yes	B
Boxfishes	*Lactophrys bicaudalis*	Spotted trunkfish	Yes	B
Boxfishes	*Lactophrys triqueter*	Smooth trunkfish	Yes	B
Filefishes	*Aluterus scriptus*	Scrawled filefish	Yes	B
Filefishes	*Cantherhines macrocerus*	Whitespotted filefish	Yes	B
Goatfishes	*Pseudupeneus maculatus*	Spotted goatfish	Yes	B
Goatfishes	*Mulloidichthys martinicus*	Yellow goatfish	Yes	B
Groupers	*Epinephelus striatus*	Nassau Grouper	Yes	A
Groupers	*Epinephelus itajara*	Goliath grouper	Yes	A
Groupers	*Epinephelus fulvus*	Coney	Yes	C
Groupers	*Epinephelus cruentatus*	Graysby	Yes	C
Groupers	*Epinephelus guttatus*	Red hind	Yes	A
Groupers	*Epinephelus adscensionis*	Rock hind	Yes	C
Groupers	*Mycteroperca bonaci*	Black grouper	Yes	A
Groupers	*Epinephelus morio*	Red grouper	Yes	A
Groupers	*Mycteroperca tigris*	Tiger grouper	Yes	A

Group	Scientific name	Common name	Previously Managed	Applicable Criterion
Groupers	*Mycteroperca venenosa*	Yellowfin grouper	Yes	A
Groupers	*Epinephelus mystacinus*	Misty grouper	Yes	C
Groupers	*Epinephelus flavolimbatus*	Yellowedge grouper	Yes	A
Grunts	*Haemulon plumieri*	White grunt	Yes	D
Grunts	*Haemulon album*	Margate	Yes	B
Grunts	*Haemulon aurolineatum*	Tomtate	Yes	B
Grunts	*Haemulon sciurus*	Bluestriped grunt	Yes	B
Grunts	*Haemulon flavolineatum*	French grunt	Yes	B
Grunts	*Anisotremus virginicus*	Porkfish	Yes	B
Jacks	*Caranx crysos*	Blue runner	Yes	B
Jacks	*Caranx latus*	Horse-eye jack	Yes	B
Jacks	*Caranx lugubris*	Black jack	Yes	B
Jacks	*Seriola rivoliana*	Almaco jack	Yes	B
Jacks	*Caranx ruber*	Bar jack	Yes	B
Jacks	*Seriola dumerili*	Greater amberjack	Yes	B
Jacks	*Caranx bartholomaei*	Yellow jack	Yes	B
Parrotfishes	*Scarus coeruleus*	Blue parrotfish	Yes	A
Parrotfishes	*Scarus coelestinus*	Midnight parrotfish	Yes	A
Parrotfishes	*Scarus guacamaia*	Rainbow parrotfish	Yes	A
Parrotfishes	*Scarus taeniopterus*	Princess parrotfish	Yes	C
Parrotfishes	*Scarus vetula*	Queen parrotfish	Yes	C
Parrotfishes	*Sparisoma rubripinne*	Redfin parrotfish	Yes	B
Parrotfishes	*Sparisoma chrysopterum*	Redtail parrotfish	Yes	C
Parrotfishes	*Sparisoma viride*	Stoplight parrotfish	Yes	C
Parrotfishes	*Sparisoma aurofrenatum*	Redband parrotfish	Yes	C
Parrotfishes	*Scarus croicensis*	Striped parrotfish	Yes	C
Porgies	*Calamus bajonado*	Jolthead porgy	Yes	B
Porgies	*Archosargus rhomboidalis*	Sea bream	Yes	B
Porgies	*Calamus penna*	Sheepshead porgy	Yes	B
Porgies	*Calamus pennatula*	Pluma	Yes	B
Snappers	*Apsilus dentatus*	Black snapper	Yes	A
Snappers	*Lutjanus buccanella*	Blackfin snapper	Yes	A
Snappers	*Lutjanus vivanus*	Silk snapper	Yes	A
Snappers	*Rhomboplites aurorubens*	Vermilion snapper	Yes	A
Snappers	*Pristipomoides aquilonaris*	Wenchman	Yes	D
Snappers	*Pristipomoides macrophthalmus*	Cardinal snapper	Yes	D
Snappers	*Etelis oculatus*	Queen snapper	Yes	D
Snappers	*Lutjanus griseus*	Gray snapper	Yes	B
Snappers	*Lutjanus synagris*	Lane snapper	Yes	A
Snappers	*Lutjanus analis*	Mutton snapper	Yes	A
Snappers	*Lutjanus jocu*	Dog snapper	Yes	C
Snappers	*Lutjanus apodus*	Schoolmaster	Yes	C
Snappers	*Lutjanus mahogani*	Mahogany snapper	Yes	B
Snappers	*Ocyurus chrysurus*	Yellowtail snapper	Yes	A
Squirrelfishes	*Myripristis jacobus*	Blackbar soldierfish	Yes	B
Squirrelfishes	*Priacanthus arenatus*	Bigeye	Yes	B
Squirrelfishes	*Holocentrus rufus*	Longspine squirrelfish	Yes	B
Squirrelfishes	*Holocentrus adscensionis*	Squirrelfish	Yes	B
Surgeonfishes	*Acanthurus coeruleus*	Blue tang	Yes	C
Surgeonfishes	*Acanthurus bahianus*	Ocean surgeonfish	Yes	C
Surgeonfishes	*Acanthurus chirurgus*	Doctorfish	Yes	C

Group	Scientific name	Common name	Previously Managed	Applicable Criterion
Tilefishes	*Caulolatilus cyanops*	Blackline tilefish	Yes	B
Tilefishes	*Malacanthus plumieri*	Sand tilefish	Yes	B
Triggerfishes	*Canthidermis sufflamen*	Ocean triggerfish	Yes	C
Triggerfishes	*Balistes vetula*	Queen triggerfish	Yes	C
Triggerfishes	*Xanthichthys rigens*	Sargassum triggerfish	Yes	B
Triggerfishes	*Melichthys niger*	Black durgon[81]	Yes	B
Wrasses	*Lachnolaimus maximus*	Hogfish	Yes	C
Wrasses	*Halichoeres radiatus*	Puddingwife	Yes	C
Wrasses	*Bodianus rufus*	Spanish hogfish	Yes	C
Aquarium Trade Reef Fish	*Antennarius spp.*	Frogfish	Yes	B
Aquarium Trade Reef Fish	*Apogon maculatus*	Flamefish	Yes	B
Aquarium Trade Reef Fish	*Astrapogen stellatus*	Conchfish	Yes	B
Aquarium Trade Reef Fish	*Ophioblennius atlanticus*	Redlip blenny	Yes	B
Aquarium Trade Reef Fish	*Bothus lunatus*	Peacock flounder	Yes	B
Aquarium Trade Reef Fish	*Chaetodon aculeatus*	Longsnout butterflyfish	Yes	B
Aquarium Trade Reef Fish	*Chaetodon capistratus*	Foureye butterflyfish	Yes	B
Aquarium Trade Reef Fish	*Chaetodon ocellatus*	Spotfin butterflyfish	Yes	B
Aquarium Trade Reef Fish	*Chaetodon striatus*	Banded butterflyfish	Yes	B
Aquarium Trade Reef Fish	*Amblycirrhitus pinos*	Redspotted hawkfish	Yes	B
Aquarium Trade Reef Fish	*Dactylopterus volitans*	Flying gurnard	Yes	B
Aquarium Trade Reef Fish	*Chaetodipterus faber*	Atlantic spadefish	Yes	B
Aquarium Trade Reef Fish	*Gobiosoma oceanops*	Neon goby	Yes	B
Aquarium Trade Reef Fish	*Priolepis hipoliti*	Rusty goby	Yes	B
Aquarium Trade Reef Fish	*Gramma loreto*	Royal gramma	Yes	B
Aquarium Trade Reef Fish	*Clepticus parrae*	Creole wrasse	Yes	B
Aquarium Trade Reef Fish	*Halichoeres cyanocephalus*	Yellowcheek wrasse	Yes	B
Aquarium Trade Reef Fish	*Halichoeres garnoti*	Yellowhead wrasse	Yes	B
Aquarium Trade Reef Fish	*Halichoeres maculipinna*	Clown wrasse	Yes	B
Aquarium Trade Reef Fish	*Hemipteronotus novacula*	Pearly razorfish	Yes	B
Aquarium Trade Reef Fish	*Hemipteronotus splendens*	Green razorfish	Yes	B
Aquarium Trade Reef Fish	*Thalassoma bifasciatum*	Bluehead wrasse	Yes	B
Aquarium Trade Reef Fish	*Echidna catenata*	Chain moray	Yes	B
Aquarium Trade Reef Fish	*Gymnothorax funebris*	Green moray	Yes	B
Aquarium Trade Reef Fish	*Gymnothorax miliaris*	Goldentail moray	Yes	B
Aquarium Trade Reef Fish	*Ogcocepahalus spp.*	Batfish	Yes	B
Aquarium Trade Reef Fish	*Myrichthys ocellatus*	Goldspotted eel	Yes	B
Aquarium Trade Reef Fish	*Opistognathus aurifrons*	Yellowhead jawfish	Yes	B
Aquarium Trade Reef Fish	*Opistognathus whitehursti*	Dusky jawfish	Yes	B
Aquarium Trade Reef Fish	*Centropyge argi*	Cherubfish	Yes	B
Aquarium Trade Reef Fish	*Holacanthus tricolor*	Rock beauty	Yes	B
Aquarium Trade Reef Fish	*Abudefduf saxatilis*	Sergeant major	Yes	B
Aquarium Trade Reef Fish	*Chromis cyanea*	Blue chromis	Yes	B
Aquarium Trade Reef Fish	*Chromis insolata*	Sunshinefish	Yes	B
Aquarium Trade Reef Fish	*Microspathodon chrysurus*	Yellowtail damselfish	Yes	B
Aquarium Trade Reef Fish	*Pomacentrus fuscus*	Dusky damselfish	Yes	B
Aquarium Trade Reef Fish	*Pomacentrus leucostictus*	Beaugregory	Yes	B
Aquarium Trade Reef Fish	*Pomacentrus partitus*	Bicolor damselfish	Yes	B
Aquarium Trade Reef Fish	*Pomacentrus planifrons*	Threespot damselfish	Yes	B

[81] Black durgon was previously listed incorrectly as a filefish in the species table in Appendix A to Part 622 (Caribbean Reef Fish).

Group	Scientific name	Common name	Previously Managed	Applicable Criterion
Aquarium Trade Reef Fish	*Priacanthus cruentatus*	Glasseye snapper	Yes	B
Aquarium Trade Reef Fish	*Equetus acuminatus*	High-hat	Yes	B
Aquarium Trade Reef Fish	*Equetus lanceolatus*	Jackknife-fish	Yes	B
Aquarium Trade Reef Fish	*Equetus punctatus*	Spotted drum	Yes	B
Aquarium Trade Reef Fish	*Scorpaenidae*	Scorpionfishes	Yes	B
Aquarium Trade Reef Fish	*Hypoplectrus unicolor*	Butter hamlet	Yes	B
Aquarium Trade Reef Fish	*Liopropoma rubre*	Swissguard basslet	Yes	B
Aquarium Trade Reef Fish	*Rypticus saponaceus*	Greater soapfish	Yes	B
Aquarium Trade Reef Fish	*Serranus annularis*	Orangeback bass	Yes	B
Aquarium Trade Reef Fish	*Serranus baldwini*	Lantern bass	Yes	B
Aquarium Trade Reef Fish	*Serranus tabacarius*	Tobaccofish	Yes	B
Aquarium Trade Reef Fish	*Serranus tigrinus*	Harlequin bass	Yes	B
Aquarium Trade Reef Fish	*Serranus tortugarum*	Chalk bass	Yes	B
Aquarium Trade Reef Fish	*Symphurus arawak*	Caribbean tonguefish	Yes	B
Aquarium Trade Reef Fish	*Hippocampus spp.*	Seahorses	Yes	B
Aquarium Trade Reef Fish	*Syngnathus spp*.	Pipefishes	Yes	B
Aquarium Trade Reef Fish	*Synodus intermedius*	Sand diver	Yes	B
Aquarium Trade Reef Fish	*Canthigaster rostrata*	Sharpnose puffer	Yes	B
Aquarium Trade Reef Fish	*Diodon hystrix*	Porcupinefish	Yes	B
Hydrocorals	*Millepora* spp.	Fire corals	Yes	A
Hydrocorals	*Stylaster roseus*	Rose lace corals	Yes	A
Soft corals	*Erythropodium caribaeorum*	Encrusting gorgonian	Yes	A
Soft corals	*Iciligorgia schrammi*	Deepwater sea fan	Yes	A
Soft corals	*Briareum asbestinum*	Corky sea finger	Yes	A
Soft corals	*Carijoa riisei*	Snowflake coral	Yes	A
Soft corals	*Telesto* spp.	-	Yes	A
Gorgonian corals	*Ellisella* spp.	Sea whips	Yes	A
Gorgonian corals	*Gorgonia flabellum*	Venus sea fan	Yes	A
Gorgonian corals	*G. mariae*	Venus sea fan	Yes	A
Gorgonian corals	*G. ventalina*	Common sea fan	Yes	A
Gorgonian corals	*Pseudopterogorgia acerosa*	Venus sea fan	Yes	A
Gorgonian corals	*P. albatrossae*	-	Yes	A
Gorgonian corals	*P. americana*	Slimy sea plume	Yes	A
Gorgonian corals	*P. bipinnata*	Bipinnate plume	Yes	A
Gorgonian corals	*P. rigida*	-	Yes	A
Gorgonian corals	*Pterogorgia anceps*	Angular sea whip	Yes	A
Gorgonian corals	*P. citrina*	Yellow sea whip	Yes	A
Gorgonian corals	*Eunicea calyculata*	Warty sea rod	Yes	A
Gorgonian corals	*E. clavigera*	Knobby candelabra	Yes	A
Gorgonian corals	*E. fusca*	Doughnut sea rod	Yes	A
Gorgonian corals	*E. knighti*	Knight's flexible sea rod	Yes	A
Gorgonian corals	*E. laciniata*	Black sausage coral	Yes	A
Gorgonian corals	*E. laxispica*	Tube-knob candelabrum	Yes	A
Gorgonian corals	*E. mammosa*	Swollen-knob	Yes	A
Gorgonian corals	*E. succinea*	Shelf-knob sea rod	Yes	A
Gorgonian corals	*E. touneforti*	-	Yes	A
Gorgonian corals	*Muricea atlantica*	-	Yes	A
Gorgonian corals	*M. elongata*	Orange spiny rod	Yes	A
Gorgonian corals	*M. laxa*	Delicate spiny rod	Yes	A
Gorgonian corals	*M. muricata*	Spiny sea fan	Yes	A
Gorgonian corals	*M. pinnata*	Long spine sea fan	Yes	A

Group	Scientific name	Common name	Previously Managed	Applicable Criterion
Gorgonian corals	*Muriceopsis* spp.	-	Yes	A
Gorgonian corals	*M. flavida*	Rough sea plume	Yes	A
Gorgonian corals	*M. sulphurea*	Spiny Gorgonian, Sulfur soft coral	Yes	A
Gorgonian corals	*Plexaura flexuosa*	Bent sea rod	Yes	A
Gorgonian corals	*P. homomalla*	Black sea rod	Yes	A
Gorgonian corals	*Plexaurella dichotoma*	Slit-pore sea rod	Yes	A
Gorgonian corals	*P. fusifera*	Sea rod	Yes	A
Gorgonian corals	*P. grandiflora*	Slit-pore sea rod	Yes	A
Gorgonian corals	*P. grisea*	Gray sea rod	Yes	A
Gorgonian corals	*P. nutans*	Giant slit-pore	Yes	A
Gorgonian corals	*Pseudoplexaura crucis*	False cross plexaura	Yes	A
Gorgonian corals	*P. flagellosa*	0	Yes	A
Gorgonian corals	*P. porosa*	Porous sea rod	Yes	A
Gorgonian corals	*P. wagenaari*	-	Yes	A
Hard corals	*Acropora cervicornis*	Staghorn coral	Yes	A
Hard corals	*A. palmata*	Elkhorn coral	Yes	A
Hard corals	*A. prolifera*	Fused staghorn	Yes	A
Hard corals	*Agaricia agaricities*	Lettuce leaf coral	Yes	A
Hard corals	*A. fragilis*	Fragile saucer	Yes	A
Hard corals	*A. lamarcki*	Lamarck's sheet	Yes	A
Hard corals	*A. tenuifolia*	Thin leaf lettuce	Yes	A
Hard corals	*Leptoseris cucullata*	Sunray lettuce	Yes	A
Hard corals	*Stephanocoenia michelinii*	Blushing star	Yes	A
Hard corals	*Eusmilia fastigiata*	Flower coral	Yes	A
Hard corals	*Tubastrea aurea*	Cup coral	Yes	A
Hard corals	*Cladocora arbuscula*	Tube coral	Yes	A
Hard corals	*Colpophyllia natans*	Boulder coral	Yes	A
Hard corals	*Diploria clivosa*	Knobby brain coral	Yes	A
Hard corals	*D. labyrinthiformis*	Grooved brain	Yes	A
Hard corals	*D. strigosa*	Symmetrical brain	Yes	A
Hard corals	*Favia fragum*	Golfball coral	Yes	A
Hard corals	*Manicina areolata*	Rose coral	Yes	A
Hard corals	*M. mayori*	Tortugas rose coral	Yes	A
Hard corals	*Montastrea annularis*	Boulder star coral	Yes	A
Hard corals	*M. cavernosa*	Great star coral	Yes	A
Hard corals	*Solenastrea bournoni*	Smooth star coral	Yes	A
Hard corals	*Dendrogyra cylindrus*	Pillar coral	Yes	A
Hard corals	*Dichocoenia stellaris*	Pancake star	Yes	A
Hard corals	*D. stokesi*	Elliptical star	Yes	A
Hard corals	*Meandrina meandrites*	Maze coral	Yes	A
Hard corals	*Isophyllastrea rigida*	Rough star coral	Yes	A
Hard corals	*Isophyllia sinuosa*	Sinuous cactus	Yes	A
Hard corals	*Mussa angulosa*	Large flower coral	Yes	A
Hard corals	*Mycetophyllia aliciae*	Thin fungus coral	Yes	A
Hard corals	*M. danae*	Fat fungus coral	Yes	A
Hard corals	*M. ferox*	Grooved fungus	Yes	A
Hard corals	*M. lamarckiana*	Fungus coral	Yes	A
Hard corals	*Scolymia cubensis*	Artichoke coral	Yes	A
Hard corals	*S. lacera*	Solitary disk	Yes	A
Hard corals	*Oculina diffusa*	Ivory bush coral	Yes	A

Group	Scientific name	Common name	Previously Managed	Applicable Criterion
Hard corals	*Madracis decactis*	Ten-ray star coral	Yes	A
Hard corals	*M. mirabilis*	Yellow pencil	Yes	A
Hard corals	*Porites astreoides*	Mustard hill coral	Yes	A
Hard corals	*P. branneri*	Blue crust coral	Yes	A
Hard corals	*P. divaricata*	Small finger coral	Yes	A
Hard corals	*P. porites*	Finger coral	Yes	A
Hard corals	*Astrangia solitaria*	Dwarf cup coral	Yes	A
Hard corals	*Phyllangia americana*	Hidden cup coral	Yes	A
Hard corals	*Siderastrea radians*	Lesser starlet	Yes	A
Hard corals	*S. siderea*	Massive starlet	Yes	A
Black corals	*Antipathes spp.*	Bushy black coral	Yes	A
Black corals	*Stichopathes spp.*	Wire coral	Yes	A
Aquarium Trade Invertebrates	*Aphimedon compressa*	Erect rope sponge	Yes	B
Aquarium Trade Invertebrates	*Chondrilla nucula*	Chicken liver sponge	Yes	B
Aquarium Trade Invertebrates	*Cynachirella alloclada*	-	Yes	B
Aquarium Trade Invertebrates	*Geodia neptuni*	Potato sponge	Yes	B
Aquarium Trade Invertebrates	*Haliclona* spp.	Finger sponge	Yes	B
Aquarium Trade Invertebrates	*Myriastra* spp.	-	Yes	B
Aquarium Trade Invertebrates	*Niphates digitalis*	Pink vase sponge	Yes	B
Aquarium Trade Invertebrates	*N. erecta*	Lavender rope sponge	Yes	B
Aquarium Trade Invertebrates	*Spinosella policifera*	-	Yes	B
Aquarium Trade Invertebrates	*S. vaginalis*	Branching vase sponge	Yes	B
Aquarium Trade Invertebrates	*Tethya crypta*	-	Yes	B
Aquarium Trade Invertebrates	*Aiptasia tagetes*	Pale anemone	Yes	B
Aquarium Trade Invertebrates	*Bartholomea annulata*	Corkscrew anemone	Yes	B
Aquarium Trade Invertebrates	*Condylactis gigantea*	Giant pink-tipped anemone	Yes	B
Aquarium Trade Invertebrates	*Hereractis lucida*	Knobby anemone	Yes	B
Aquarium Trade Invertebrates	*Lebrunia* spp.	Staghorn anemone	Yes	B
Aquarium Trade Invertebrates	*Stichodactyla helianthus*	Sun anemone	Yes	B
Aquarium Trade Invertebrates	*Zoanthus* spp.	Sea mat	Yes	B
Aquarium Trade Invertebrates	*Discosoma* spp. (formerly Rhodactis)	False coral	Yes	B
Aquarium Trade Invertebrates	*Ricordia florida*	Florida false coral	Yes	B

Group	Scientific name	Common name	Previously Managed	Applicable Criterion
Aquarium Trade Invertebrates	*Sabellastarte* spp.	Tube worms	Yes	B
Aquarium Trade Invertebrates	*S. magnifica*	Magnificent duster	Yes	B
Aquarium Trade Invertebrates	*Spirobranchus giganteus*	Christmas tree worm	Yes	B
Aquarium Trade Invertebrates	*Tridachia crispata*	Lettuce sea slug	Yes	B
Aquarium Trade Invertebrates	*Oliva reticularis*	Netted olive	Yes	B
Aquarium Trade Invertebrates	*Cyphoma gibbosum*	Flamingo tongue	Yes	B
Aquarium Trade Invertebrates	*Lima* spp.	Fileclams	Yes	B
Aquarium Trade Invertebrates	*L. scabra*	Rough fileclam	Yes	B
Aquarium Trade Invertebrates	*Spondylus americanus*	Atlantic thorny oyster	Yes	B
Aquarium Trade Invertebrates	*Octopus* spp. (except the Common octopus, O.vulgaris)	-	Yes	B
Aquarium Trade Invertebrates	*Alpheaus armatus*	Snapping shrimp	Yes	B
Aquarium Trade Invertebrates	*Paguristes* spp.	Hermit crabs	Yes	B
Aquarium Trade Invertebrates	*P. cadenati*	Red reef hermit	Yes	B
Aquarium Trade Invertebrates	*Percnon gibbesi*	Nimble spray crab	Yes	B
Aquarium Trade Invertebrates	*Lysmata* spp.	Peppermint shrimp	Yes	B
Aquarium Trade Invertebrates	*Thor amboinensis*	Anemone shrimp	Yes	B
Aquarium Trade Invertebrates	*Mithrax* spp.	Clinging crabs	Yes	B
Aquarium Trade Invertebrates	*M. cinctimanus*	Banded clinging	Yes	B
Aquarium Trade Invertebrates	*M. sculptus*	Green clinging	Yes	B
Aquarium Trade Invertebrates	*Stenorhynchus seticornis*	Yellowline arrow	Yes	B
Aquarium Trade Invertebrates	*Periclimenes* spp.	Cleaner shrimp	Yes	B
Aquarium Trade Invertebrates	*Gonodactylus* spp.	-	Yes	B
Aquarium Trade Invertebrates	*Lysiosquilla* spp.	-	Yes	B
Aquarium Trade Invertebrates	*Stenopus hispidus*	Banded shrimp	Yes	B
Aquarium Trade Invertebrates	*S. scutellatus*	Golden shrimp	Yes	B

Group	Scientific name	Common name	Previously Managed	Applicable Criterion
Aquarium Trade Invertebrates	*Analcidometra armata*	Swimming crinoid	Yes	B
Aquarium Trade Invertebrates	*Davidaster* spp.	Crinoids	Yes	B
Aquarium Trade Invertebrates	*Nemaster* spp.	Crinoids	Yes	B
Aquarium Trade Invertebrates	*Astropecten* spp.	Sand stars	Yes	B
Aquarium Trade Invertebrates	*Linckia guildingii*	Common comet star	Yes	B
Aquarium Trade Invertebrates	*Ophidiaster guildingii*	Comet star	Yes	B
Aquarium Trade Invertebrates	*Oreaster reticulatus*	Cushion sea star	Yes	B
Aquarium Trade Invertebrates	*Astrophyton muricatum*	Giant basket star	Yes	B
Aquarium Trade Invertebrates	*Ophiocoma* spp.	Brittlestars	Yes	B
Aquarium Trade Invertebrates	*Ophioderma* spp.	Brittlestars	Yes	B
Aquarium Trade Invertebrates	*O. rubicundum*	Ruby brittlestar	Yes	B
Aquarium Trade Invertebrates	*Diadema antillarum*	Long-spined urchin	Yes	E
Aquarium Trade Invertebrates	*Echinometra* spp.	Purple urchin	Yes	E
Aquarium Trade Invertebrates	*Eucidaris tribuloides*	Pencil urchin	Yes	E
Aquarium Trade Invertebrates	*Lytechinus* spp.	Pin cushion urchin	Yes	E
Aquarium Trade Invertebrates	*Tripneustes ventricosus*	Sea egg	Yes	E
Aquarium Trade Invertebrates	*Holothuria* spp.	Sea cucumbers	Yes	E
Aquarium Trade Invertebrates	Subphylum Urochordata	Tunicates	Yes	B
Anchovies	*Anchoa hepsetus*	Stiped anchovy	No	-
Anchovies	*Cetengraulis edentulus*	Whalebone anchovy	No	-
Barracudas	*Sphyraena guachancho*	Guanchanche	No	B
Barracudas	*Sphyraena barracuda*	Great barracuda	No	C
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	-

Group	Scientific name	Common name	Previously Managed	Applicable Criterion
Cusk eels	*Brotula barbata*	Bearded brotula	No	-
Cutlassfish	*Trichiurus lepturus*	Atlantic cutlassfish	No	-
Damselfishes	*Chromis multilineata*	Brown chromis	No	-
Dolphinfish	*Coryphaena hippurus*	Dolphin	No	D
Dolphinfish	*Coryphaena equiselis*	Pompano dolphin	No	D
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	C
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	-
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	D
Jacks	*Caranx hippos*	Crevalle jack	No	D

Group	Scientific name	Common name	Previously Managed	Applicable Criterion
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	D
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	*Hypanus americanus*	Southern stingray	No	C
Rays	*Aetobatus narinari*	Spotted eagle ray	No	C
Rays	*Manta birostris*	Giant manta ray	No	C
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	-
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	-

Group	Scientific name	Common name	Previously Managed	Applicable Criterion
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	C
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	C
Tripletail	*Lobotes surinamensis*	Tripletail	No	C
Trumpetfish	*Aulostomus maculatus*	Trumpetfish	No	-
Tunas and Mackerels	*Katsuwonus pelamis*	Skipjack tuna	No	-
Tunas and Mackerels	*Euthynnus alletteratus*	Little tunny	No	D
Tunas and Mackerels	*Thunnus alalunga*	Albacore tuna	No	-
Tunas and Mackerels	*Thunnus albacares*	Yellowfin tuna	No	-
Tunas and Mackerels	*Thunnus atlanticus*	Blackfin tuna	No	D
Tunas and Mackerels	*Thunnus obesus*	Bigeye tuna	No	-
Tunas and Mackerels	*Scomberomorus cavalla*	King mackerel	No	D
Tunas and Mackerels	*Scomberomorus regalis*	Cero mackerel	No	D
Tunas and Mackerels	*Acanthocybium solandri*	Wahoo	No	D
Tunas and Mackerels	*Auxis rochei*	Bullet mackerel	No	-

Table D.2. Stocks and stock complex organization under the Puerto Rico FMP compared to the stock/stock complex organization under the U.S. Caribbean-wide Reef Fish FMP.

Scientific name	Common name	Reef Fish FMP	Puerto Rico FMP
Apsilus dentatus	Black snapper	Snapper Unit 1	Snapper 1
Lutjanus buccanella	Blackfin snapper	Snapper Unit 1	Snapper 1
Lutjanus vivanus	Silk snapper	Snapper Unit 1	Snapper 1
Rhomboplites aurorubens	Vermilion snapper	Snapper Unit 1	Snapper 1
Pristipomoides aquilonaris	Wenchman	Snapper Unit 1	Snapper 1
Pristipomoides macrophthalmus	Cardinal snapper	Snapper Unit 2	Snapper 2
Etelis oculatus	Queen snapper	Snapper Unit 2	Snapper 2
Lutjanus synagris	Lane snapper	Snapper Unit 3	Snapper 3
Lutjanus analis	Mutton snapper	Snapper Unit 3	Snapper 4
Lutjanus jocu	Dog snapper	Snapper Unit 3	Snapper 4
Lutjanus apodus	Schoolmaster	Snapper Unit 3	Snapper 4
Lutjanus griseus	Gray snapper	Snapper Unit 3	removed
Lutjanus mahogani	Mahogany snapper	Snapper Unit 3	removed
Ocyurus chrysurus	Yellowtail snapper	Snapper Unit 4	Snapper 5
Lutjanus cyanopterus	Cubera snapper	not managed	Snapper 6
Epinephelus striatus	Nassau Grouper	Grouper Unit 1	Grouper 1
Epinephelus itajara	Goliath grouper	Grouper Unit 2	Grouper 2
Epinephelus fulvus	Coney	Grouper Unit 3	Grouper 3
Epinephelus cruentatus	Graysby	Grouper Unit 3	Grouper 3
Epinephelus guttatus	Red hind	Grouper Unit 3	Grouper 6
Epinephelus adscensionis	Rock hind	Grouper Unit 3	Grouper 6
Mycteroperca bonaci	Black grouper	Grouper Unit 4	Grouper 4
Epinephelus morio	Red grouper	Grouper Unit 4	Grouper 4
Mycteroperca tigris	Tiger grouper	Grouper Unit 4	Grouper 4
Mycteroperca venenosa	Yellowfin grouper	Grouper Unit 4	Grouper 4
Epinephelus mystacinus	Misty grouper	Grouper Unit 5	Grouper 5
Epinephelus flavolimbatus	Yellowedge grouper	Grouper Unit 5	Grouper 5
Mycteroperca interstitialis	Yellowmouth grouper	not managed	Grouper 4
Scarus coeruleus	Blue parrotfish	Parrotfish	Parrotfish 1
Scarus coelestinus	Midnight parrotfish	Parrotfish	Parrotfish 1
Scarus guacamaia	Rainbow parrotfish	Parrotfish	Parrotfish 1
Scarus taeniopterus	Princess parrotfish	Parrotfish	Parrotfish 2
Scarus vetula	Queen parrotfish	Parrotfish	Parrotfish 2
Sparisoma rubripinne	Redfin parrotfish	Parrotfish	removed
Sparisoma chrysopterum	Redtail parrotfish	Parrotfish	Parrotfish 2
Sparisoma viride	Stoplight parrotfish	Parrotfish	Parrotfish 2
Sparisoma aurofrenatum	Redband parrotfish	Parrotfish	Parrotfish 2
Scarus croicensis	Striped parrotfish	Parrotfish	Parrotfish 2

Scientific name	Common name	Reef Fish FMP	Puerto Rico FMP
Holacanthus ciliaris	Queen angelfish	Angelfish	Angelfish
Pomacanthus arcuatus	Gray angelfish	Angelfish	Angelfish
Pomacanthus paru	French angelfish	Angelfish	Angelfish
Acanthurus coeruleus	Blue tang	Surgeonfish	Surgeonfish
Acanthurus bahianus	Ocean surgeonfish	Surgeonfish	Surgeonfish
Acanthurus chirurgus	Doctorfish	Surgeonfish	Surgeonfish
Haemulon plumieri	White grunt	Grunts	Grunts
Haemulon sciurus	Bluestriped grunt	Grunts	removed
Haemulon album	Margate	Grunts	removed
Haemulon aurolineatum	Tomtate	Grunts	removed
Haemulon flavolineatum	French grunt	Grunts	removed
Anisotremus virginicus	Porkfish	Grunts	removed
Canthidermis sufflamen	Ocean triggerfish	Triggerfish	Triggerfish
Balistes vetula	Queen triggerfish	Triggerfish	Triggerfish
Xanthichthys rigens	Sargassum triggerfish	Triggerfish	removed
Melichthys niger	Black durgon	Triggerfish*	removed
Balistes capriscus	Gray triggerfish	not managed	Triggerfish
Lachnolaimus maximus	Hogfish	Wrasses	Wrasses 1
Halichoeres radiatus	Puddingwife	Wrasses	Wrasses 2
Bodianus rufus	Spanish hogfish	Wrasses	Wrasses 2
Caranx crysos	Blue runner	Jacks	removed
Caranx latus	Horse-eye jack	Jacks	removed
Caranx lugubris	Black jack	Jacks	removed
Seriola rivoliana	Almaco jack	Jacks	removed
Caranx ruber	Bar jack	Jacks	removed
Seriola dumerili	Greater amberjack	Jacks	removed
Caranx bartholomaei	Yellow jack	Jacks	removed
Caranx hippos	Crevalle jack	not managed	Jack 1
Alectis ciliaris	African pompano	not managed	Jack 2
Elagatis bipinnulata	Rainbow runner	not managed	Jack 3
Calamus bajonado	Jolthead porgy	Porgies	removed
Archosargus rhomboidalis	Sea bream	Porgies	removed
Calamus penna	Sheepshead porgy	Porgies	removed
Calamus pennatula	Pluma	Porgies	removed
Myripristis jacobus	Blackbar soldierfish	Squirrelfish	removed
Priacanthus arenatus	Bigeye	Squirrelfish	removed
Holocentrus rufus	Longspine squirrelfish	Squirrelfish	removed
Holocentrus adscensionis	Squirrelfish	Squirrelfish	removed
Lactophrys polygonia	Honeycomb cowfish	Boxfish	removed

Scientific name	Common name	Reef Fish FMP	Puerto Rico FMP
Lactophrys quadricornis	Scrawled cowfish	Boxfish	removed
Lactophrys trigonus	Trunkfish	Boxfish	removed
Lactophrys bicaudalis	Spotted trunkfish	Boxfish	removed
Lactophrys triqueter	Smooth trunkfish	Boxfish	removed
Aluterus scriptus	Scrawled filefish	Filefish	removed
Cantherhines macrocerus	Whitespotted filefish	Filefish	removed
Pseudupeneus maculatus	Spotted goatfish	Goatfish	removed
Mulloidichthys martinicus	Yellow goatfish	Goatfish	removed
Caulolatilus cyanops	Blackline tilefish	Tilefish	removed
Malacanthus plumieri	Sand tilefish	Tilefish	removed
Sphyraena barracuda	Great barracuda	not managed	Barracuda
Lobotes surinamensis	Tripletail	not managed	Tripletail
Coryphaena hippurus	Dolphin	not managed	Dolphin
Coryphaena equiselis	Pompano dolphin	not managed	Dolphin
Euthynnus alletteratus	Little tunny	not managed	Tuna
Thunnus atlanticus	Blackfin tuna	not managed	Tuna
Scomberomorus cavalla	King mackerel	not managed	Mackerel
Scomberomorus regalis	Cero mackerel	not managed	Mackerel
Acanthocybium solandri	Wahoo	not managed	Wahoo
Manta birostris	Giant manta ray	not managed	Rays 1
Aetobatus narinari	Spotted eagle ray	not managed	Rays 2
Hypanus americanus	Southern stingray	not managed	Rays 3

Appendix E. Partial List of Coral and Echinoderm Species included in the Puerto Rico Fishery Management Plan

The following species are known to occur in the Puerto Rico exclusive economic zone, and thus would be included for management in the Puerto Rico FMP. This list is not exhaustive, as newly discovered species, or species newly documented in Puerto Rico EEZ, may be not included at this time. The Council intends to manage all species of corals, whether identified on this list or not. Corals included in the Puerto Rico FMP include the phylum Cnidaria (formerly Coelenterata) 1) Class Hydrozoa: Subclass Hydroidolina - Order Anthoathecata - Family Milleporidae and Family Stylasteridae; 2) Class Anthozoa: Subclass Octocorallia (soft corals, gorgonians, sea pansies, sea pens) - Order Alcyonacea (soft corals), and Order Pennatulacea (sea pens); Subclass Hexacorallia - Order Scleractinia (stony corals), and Order Anthipatharia (black corals).

I. Phylum Cnidaria

A. Class Hydrozoa (hydrocorals)
1. Order Anthoathecata (hydroids)
a. Family Milleporidae
Millepora alcicornis
Millepora spp., Fire corals
b. . Family Stylasteridae
Stylaster roseus, Rose lace corals

B1. Class Anthozoa (Anthozoans)

Subclass Octocorallia

1. Order Alcyonacea (soft corals)
a. Family Acanthogorgiidae
Acanthogorgia aspera
b. Family Anthothelidae
Erythropodium caribaeorum, Encrusting gorgonian
Iciligorgia schrammi, Deepwater sea fan
c. Family Briareidae
Briareum asbestinum, Corky sea finger
d. Family Chrysogorgiidae
Chalcogorgia spp.
Chrysogorgia desbonni
Chrysogorgia spp.
Iridogorgia spp.
Metalogorgia spp.
Pleurogorgia spp.
Radicipes spp.
Trichogorgia spp.
e. Family Clavulariidae
Carijoa riisei
Stereotelesto corallina
Telesto corallina
T. sanguinea
f. Family Ellisellidae
Ellisella elongata
E. schmitti
Nicella goreaui
g. Family Gorgoniidae
Antillogorgia acerosa, Sea plume
A. albatrossae
A. americana, Slimy sea plume
A. bipinnata, Bipinnate plume
A. hystrix
A. rigida
A. elisanethae

Gorgonia flabellum, Venus sea fan
G. mariae, Wide-mesh sea fan
G. ventalina, Common sea fan
Leptogorgia barbadensis
L. cardinalis
L. medusa
L. punicea
L. stheno
L. virgulata
Olindagorgia gracilis
Pterogorgia anceps, Angular sea whip
P. citrina, Yellow sea whip

h. Family Keroeididae
Lignella richardi

i. Family Nephtheidae
Pseudodrifa nigra
Stereonephthya portoricensis

j. Family Nidaliidae
Nidalia occidentalis

k. Family Plexauridae
Eunicea calyculata, Warty sea rod
E. clavigera
E. flexuosa, Bent sea rod
E. fusca, Doughnut sea rod
E. knighti
E. laciniata
E. laxispica
E. mammosa, Swollen-knob
E. pinta
E. succinea, Shelf-knob sea rod
E. touneforti
Heterogorgia uatumani
Muricea atlantica
M. elongata, Orange spiny rod
M. laxa, Delicate spiny rod
M. muricata, Spiny sea fan
M. pinnata, Long spine sea fan
Muriceopsis flavida, Rough sea plume
M. petila
M. sulphurea
Paramuricea hirsuta
Plexaura. homomalla, Black sea rod
Plexaurella dichotoma, Slit-pore sea rod
P. grandiflora
P. grisea
P. nutans, Giant slit-pore
Pseudoplexaura crucis
P. flagellosa
P. porosa, Porous sea rod
P. wagenaari
Swiftia exserta
Thesea nivea

l. Family Primnoidae
Callogorgia gracilis
C. americana Americana

m. Family Spongiodermidae
Diodogorgia nodulifera
Titanideum frauenfeldii

2. Order Pennatulacea (sea pens)

a. Family Renillidae
Renilla mulleri
R. reniformis

b. Family Virgulariidae
Stylatula antillarum
S. brasiliensis
S. diadema
S. elegans
Virgularia presbytes

B2. Class Anthozoa

Subclass Hexacorallia

1. Order Scleractinia (stony corals)

a. Family Acroporidae
Acropora cervicornis, Staghorn coral
A. palmata, Elkhorn coral
A. prolifera, Fused staghorn

b. Family Agariciidae

Agaricia agaricites, Lettuce leaf coral
A. fragilis, Fragile saucer
A. grahamae
A. lamarcki, Lamarck's sheet
A. tenuifolia, Thin leaf lettuce
Helioseris cucullata, Sunray lettuce
Leptoseris cailleti

c. Family Astrocoeniidae
Stephanocoenia intersepta, Blushing star

d. Family Caryophylliidae
Phyllangia americana, Hidden cup coral

e. Family Dendrophylliidae
Tubastreacoccinea, Cup coral

f. Family Faviidae
Cladocora arbuscula, Tube coral
Colpophyllia natans, Boulder coral
Diploria clivosa, Knobby brain coral
D. labyrinthiformis, Grooved brain
Favia fragum, Golfball coral
Isophyllia rigida, Rough star coral
I. sinuosa, Sinuous cactus
Manicina areolata, Rose coral
Mussa angulosa, Large flower coral
Pseudodiploria strigosa, Symmetrical brain
Solenastrea bournoni, Smooth star coral
Mycetophyllia aliciae, Thin fungus coral
M.danaana, Fat fungus coral
M. ferox, Grooved fungus
M. lamarckiana, Fungus coral
Scolymia cubensis, Artichoke coral
S. lacera, Solitary disk

g. Family Meandrinidae
Dendrogyra cylindrus, Pillar coral
Dichocoenia stokesii, Elliptical star
Eusmilia fastigiata, Flower coral
Meandrina brasiliensis
M. meandrites, Maze coral

h. Family Merulinidae
Orbicella annularis, Lobed star coral
O. faveolata, Mountainous star coral
O. franksi, Boulder star coral

i. Family Montastraeidae
Montastraea cavernosa, Great star coral

j. Family Oculinidae
Oculina diffusa, Ivory bush coral
O. varicosa

k. Family Pocilloporidae
Madracis decactis, Ten-ray star coral
M. auretenra, Yellow pencil

l. Family Poritidae
Porites astreoides, Mustard hill coral
P. branneri, Blue crust coral
P. divaricata, Small finger coral
P. porites, Finger coral

m. Family Rhizangiidae
Astrangia solitaria, Dwarf cup coral

n. Family Siderastreidae
Siderastrea radians, Lesser starlet
S. siderea, Massive starletII.

2. Order Antipatharia (black corals)
   - a. Family Antipathidae
     - *Antipathes atlantica*
     - *A. caribbeana*
     - *A. columnaris*
     - *A. furcata*
     - *A. gracilis*
     - *A. hirta*
     - *A. pennacea*
     - *A. rigida*
     - *A. salix*
     - *A. tanacetum*
     - *Stichopathes luetkeni*
     - *Stichopathes* spp., Wire coral
   - b. Family Aphanipathidae
     - *Aphanipathes abietina*
     - *A. filix*
     - *A. humilis*
     - *A. thyoides*
   - c. Family Schizopathidae
     - *Bathypathes patula*
     - *Parantipathes tetrasticha*
   - d. Family Leiopathidae
     - *Leiopathes glaberrima*

II. Phylum Echinodermata (echinoderms)

A1. Class Echinoidea (sea urchins)

Subclass Euechinoidea

1. Order Cassiduloida
   - a. Family Cassidulidae
     - *Cassidulus caribaearum*

2. Order Echinolampadoida
   - a. Family Echinolampadidae
     - *Conolampas sigsbei*
     - *Echinolampas depressa*

3. Order Spatangoida
   - a. Family Brissidae
     - *Brissopsis atlantica*
   - b. Family Paleopneustina
     - *Heterobrissus hystrix*
   - c. Family Prenasteridae
     - *Agassizia excentrica*

4. Order Diadematoida
   - a. Family Diadematidae
     - *Diadema antillarum,* Long-spined urchin

5. Order Echinothurioida
   - a. Family Echinothuriidae
     - *Araeosoma belli*
     - *A. fenestratum*

6. Order Pedinoida
   - a. Family Pedinidae
     - *Caenopedina cubensis*

7. Order Arbacioida
   - a. Family Arbaciidae
     - *Arbacia punctulata*

8. Order Salenioida
   - a. Family Saleniidae
     - *Salenocidaris profundi*
     - *S. varispina*

9. Order Camarodonta
   - a. Family Echinometridae
     - *Echinometra lucunter*
     - *E. viridis*
   - b. Family Toxopneustidae
     - *Lytechinus callipeplus*
     - *L. euerces*
     - *L. variegatus*
     - *Tripneustes ventricosus,* Sea egg

10. Order Echinoneoida
    - a. Family Echinoneidae
      - *Echinoneus cyclostomus*

A2. Class Echinoidea (sea urchins)

Subclass Perischoechinoidea

1. Order Cidaroida
   - a. Family Cidaridae
     - *Cidaris rugosa*
     - *Eucidaris tribuloides,* Pencil urchin
     - *Stylocidaris lineata*

Tretocidaris bartletti

B. Class Holothuroidea (sea cucumbers)

1. Order Apodida
   a. Synaptidae
      Euapta lappa

2. Order Dendrochirotida
   a. Family Cucumariidae
      Aslia pygmaea
   b. Family Sclerodactylidae
      Pseudothyone belli, Hidden sea cucumber

3. Order Elasipodida
   a. Family Elpidiidae
      Scotoplanes globosa, sea pig
   b. Family Pelagothuriidae
      Enypniastes eximia

4. Order Holothuriida
   a. Family Holothuriidae
      Actinopyga agassizii
      Holothuria spp.
      Holothuria arenicola
      H. floridana, Florida sea cucumber
      H. glaberrima
      H. grisea
      H. mexicana, Donkey dung sea cucumber
      H. impatiens
      H. parvula
      H. surinamensis
      H. thomasi, Tiger tail sea cucumber

5. Order Synallactida
   a. Family Stichopodidae
      Astichopus multifidus, Furry sea cucumber
      Isostichopus badionotus, Three-rowed sea cucumber
      Eostichopus arnesoni, Conical sea cucumber

Appendix F. 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 environmental assessment, should briefly discuss the reasons for their elimination (40 CFR 1502.14(a)).

In Action 2 (Stocks Managed under the Puerto Rico Fishery Management Plan [FMP]), the Council rejected a complete alternative as well as a component of two alternatives:

1) As mentioned in the Action 2 discussion, Criterion E was originally considered under **Preferred Alternative 2** (and **Alternative 3**, but this alternative was ultimately also considered but rejected as discussed below) as the final criterion for selecting stocks for inclusion in the Puerto Rico FMP. This criterion would exclude from management species with a level of landings considered to be *de minimis*[82]. 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**, 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[83] 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 socio-economic 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

[82]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.
[83] Threshold of landings yet to be determined below which the fishery for stock or stock complex was considered to be *de minimis.*

landings. At the same meeting, the Council added a new Criterion E that would allow the Council to manage any species not identified through the stepwise process in **Alternative 2** that it determines are in need of conservation and management.

2) In Action 2 (Stocks Managed under the St. Puerto Rico FMP), the Council rejected **Alternative 3** as explained below.

Rejected:
Alternative 3 would 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 to determine if a species should be managed under the Puerto Rico FMP. The criteria under consideration were the same listed for **Preferred Alternative 2**. Briefly, the criteria included (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. Before applying the criteria, the Council would determine the order of consideration. 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.

Rationale:
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.

Appendix G. Process and Rationale for the Acceptable Biological Catch (ABC) Control Rule in Action 4, Preferred Alternative 3

G.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.

The overfishing limit (OFL) 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, though based on long-term landings, accounts for the potential variability in annual landings. To calculate SYL, the control rule allows a scalar to be applied to the landings during the reference period, which accounts for variability around the long-term landings. Thus, SYL is similar to an OFL. In addition, in the absence of better information, it can be considered to be a minimum estimate of MSY. In fact, the SYL was developed 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. For this reason, the SYL forms the basis for the SSC's ABC recommendation where ABC = buffer * SYL, where the buffer must be ≤ 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 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.

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. Until these data deficiencies are addressed, a Tier 4 approach to management represents the best scientific information available.

G.2. 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 under the control rule in Step 1. *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 G.1) and 12 susceptibility attributes (Table G.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 G.1 and G.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 G.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

Productivity Attributes	High (3)	Moderate (2)	Low (1)
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 G.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]

Susceptibility Attributes	Low (1)	Moderate (2)	High (3)
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 G.2). The methods used to establish the landings reference period and to quantify the scalar, for each stock, are described in turn below.

<u>Reference Period Landings</u>: 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. The SSC did not consider these zeros "true" zeros, reflecting no landings, and thus concluded that these 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 G.3 (commercial) and Table G.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 G.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; Snapper 1, 3, 4, 5, and 6; Grouper 1, 2, 3, 4, and 6; Parrotfish; Angelfish; Surgeonfish Grunts;Wrasses; Triggerfish; Corals, Sea urchins, and Sea cucumbers
2000 – 2011, excluding 2005	Snapper 2 and Grouper 5
1988 – 2016, excluding 2005	Dolphinfish; Tripletail; Jacks 1, 2, 3; and Rays 1, 2, 3
1999 – 2016, excluding 2005	Tunas and Mackerels
2010 – 2016	Wahoo
1988 – 2004	Barracuda

Table G.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 1, 2, 3; Tripletail; Rays 1, 2, 3

<u>75^{th} Percentile</u>: The 75^{th} 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 75^{th} 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 75^{th} percentile falls between two values. In that event, the value of the 75^{th} 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 G.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.

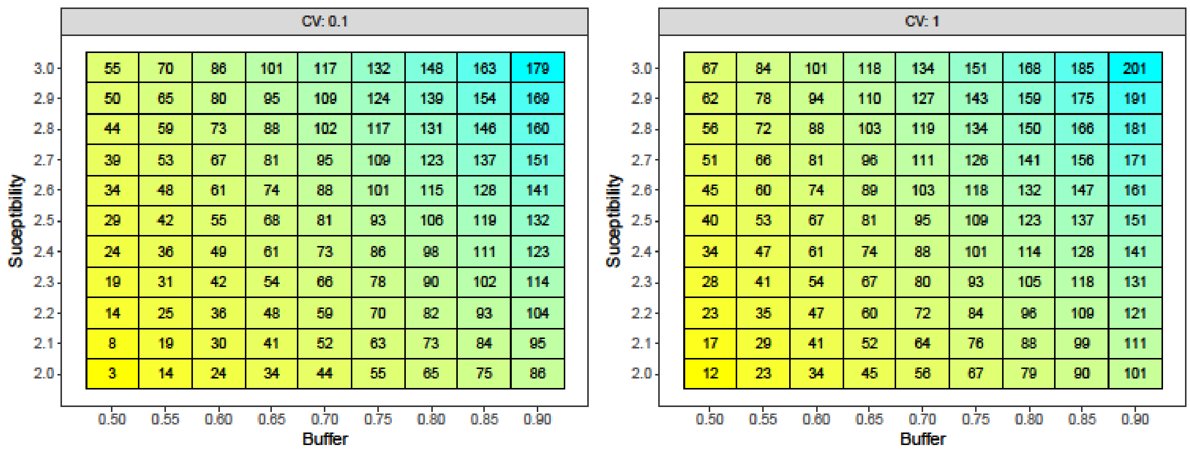

Figure G.1. Percent change in the ABC relative to the mean landings used in the equation, when the CV = 0.1 (left) and when the CV = 1.0 (right). The y-axis values represent the susceptibility score used in the scalar equation to calculate SYL and the x-axis values represent the buffer used in the equation 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 G.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.

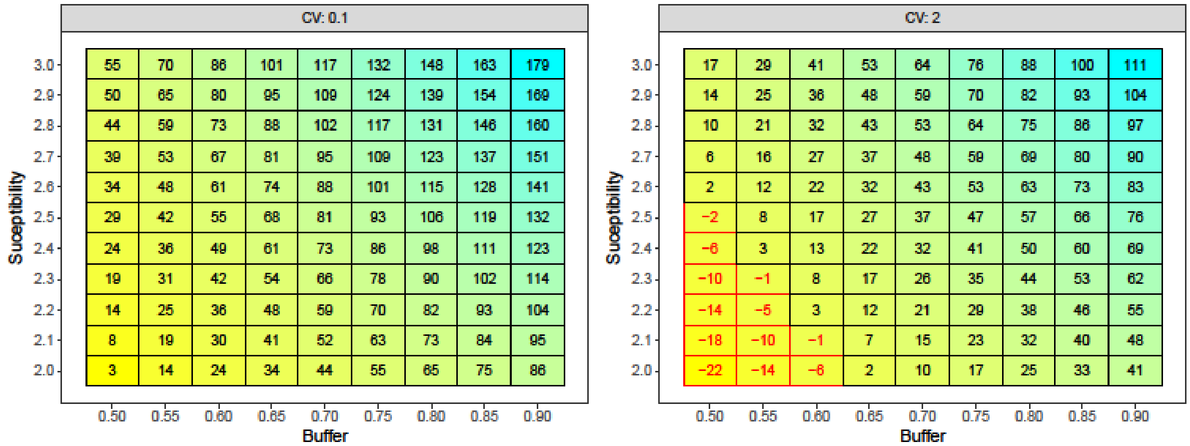

Figure G.2. Percent change in the ABC relative to the mean landings used in the equation, when the CV = 1.0 (left) and when the CV = 2.0 (right). The y-axis values represent the susceptibility score used in the scalar equation to calculate SYL and the x-axis values represent the buffer used in the equation to calculate ABC from SYL.

However, this relationship no longer holds when the CV > 1.0 (Figure G.2). As in Figure G.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 G.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, 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 75th percentile by the scalar. For our simple example of a stock with low susceptibility to the fishery:

75th 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 75th percentile) would be used in the calculation. Tables G.5 and G.6 below summarize the SYLs for stocks/stock complexes/indicator stocks in the Puerto Rico FMP per sector.

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 G.2), focusing on how these deficiencies affected data quality. 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 ≤ 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.

Tables G.5 and G.6 below summarize the ABCs for stocks/stock complexes/indicator stocks in the Puerto Rico FMP per sector.

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-alternative 3b** equates F_{MS} to the fishing mortality rate at a 40% SPR and **Sub-alternative 3c** sets that rate at a 30% SPR.

Preferred Alternative 3, Step 3:

Step 3 would specify the OY and ACL for each stock/complex. 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. Under **Preferred Alternative 2**, the Council would use sector information to establish SDC and reference points that apply to the stock or stock complex as a whole, but would set ACLs by sector. Thus, the tables below include the commercial contribution to SYL and ABC, but the SYL and ABC are set for the stock or stock complex. Sector ACLs are set by applying the buffer to the sector contribution to ABC. The OY is a measure of the optimum yield of the stock or stock complex, so it would be set equal to the total ACL.

The description of each of the sub-alternatives in 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 G.7 and G.8 below shows the values that would result from each of the sub-alternatives proposed under **Preferred Alternative 3**.

G.3. Calculated Outcomes from the Acceptable Biological Catch Control Rule

The following tables represent the calculated values for SYL, ABC, and ACL for each stock/stock complex/indicator stock for each of Puerto Rico's commercial and recreational sectors. Please see Sections 5.13, 5.14, and 5.16 for stock specific SYLs, ABCs, and ACLs.

Table G.5. Contribution to the SYL and ABC from the commercial sector for each stock/stock complex selected for management in the Puerto Rico FMP[84], including information on reference period used and mean commercial landings during the reference period.

Stock/Stock Complex	Commercial Reference Period[85]	Tier[86]	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

[84] 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).
[85] 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.
[86] 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[85]	Tier[86]	Mean Commercial Landings (lbs)	Commercial Contribution to SYL	Commercial Contribution to ABC
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
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 G.6. 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[87]	Mean Recreational Landings (lbs)	Recreational Contribution to SYL	Recreational Contribution to ABC
Snapper 1	2000 – 2011	4a	79,421	235,669	117,834

[87] 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	Recreational Reference Period	Tier[87]	Mean Recreational Landings (lbs)	Recreational Contribution to SYL	Recreational Contribution to ABC
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

Table G.7. SYLs and ABCs calculated following the ABC CR 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

Stock/Stock Complex	SYL	ABC
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 tunny, blackfin tuna)	254,937	123,435
Mackerel (cero mackerel, king mackerel)	761,268	380,634
Wahoo	498,207	249,104
Rays 1 (giant manta ray)	1,657	0
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

** Where SYL is a non-zero number, but the ABC is zero, the SSC recommended that the ABC be set at zero by deviating from the control rule for the reasons discussed at the SSC meetings in which the ABC was developed.

Table G.8. 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/stock 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

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 1	446,325	**424,009**	401,693	379,376	334,744
Snapper 2	270,775	**257,236**	243,698	230,159	203,081
Snapper 3	257,238	**244,376**	231,514	218,652	192,929
Snapper 4	122,562	**116,434**	110,306	104,178	91,922
Snapper 5	332,427	**315,806**	299,184	282,563	249,320
Snapper 6	125	**119**	113	106	94
Grouper 3	25,147	**23,890**	22,632	21,375	18,860
Grouper 4	2,623	**2,492**	2,361	2,230	1,967
Grouper 5	16,134	**15,327**	14,521	13,714	12,101
Grouper 6	128,136	**121,729**	115,322	108,916	96,102
Parrotfish 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 1	73,831	**70,139**	66,448	62,756	55,373
Wrasses 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 1	48	**46**	43	41	36
Jacks 2	1,108	**1,053**	997	942	831
Jacks 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 G.9. 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/stock 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 1	117,834	**111,942**	106,051	100,159	88,376
Snapper 2	26,288	**24,974**	23,659	22,345	19,716
Snapper 3	22,740	**21,603**	20,466	19,329	17,055

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 4	80,658	**76,625**	72,592	68,559	60,494
Snapper 5	25,251	**23,988**	22,726	21,463	18,938
Snapper 6	6,787	**6,448**	6,108	5,769	5,090
Grouper 3	20,668	**19,635**	18,601	17,568	15,501
Grouper 4	6,176	**5,867**	5,558	5,250	4,632
Grouper 5	4,448	**4,226**	4,003	3,781	3,336
Grouper 6	36,309	**34,494**	32,678	30,863	27,232
Parrotfish 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 1	8,698	**8,263**	7,828	7,393	6,524
Wrasses 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 1	44,099	**41,894**	39,689	37,484	33,074
Jacks 2	6,020	**5,719**	5,418	5,117	4,515
Jacks 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

Table G.10. The total ACLs for each stock and stock complex (commercial + recreational, as applicable) in the Puerto Rico FMP, based on Preferred Alternative 3, Sub-alternatives 3d-3h. All total ACLs under Sub-alternative 3i would be equal to zero, and were not included in the table. Additionally, stocks/stock complexes with an ABC set equal to zero by the SSC were not included in the table. Values in bold represent the total ACL (=OY) resulting from the preferred sub-alternative selected by the Council.

Stock/Complex	Sub-alt 3d OY=ACL =ABC	Sub- alt 3e OY=ACL =ABC*0.95	Sub- alt 3f OY=ACL =ABC*0.90	Sub- alt 3g OY=ACL =ABC*0.85	Sub- alt 3h OY=ACL =ABC*0.75
Spiny Lobster	554,981	**527,232**	499,483	471,734	416,236
Snapper 1	564,159	**535,951**	507,744	479,535	423,120
Snapper 2	297,063	**282,210**	267,357	252,504	222,797
Snapper 3	279,978	**265,979**	251,980	237,981	209,984
Snapper 4	203,220	**193,059**	182,898	172,737	152,416

Stock/Complex	Sub-alt 3d OY=ACL =ABC	Sub- alt 3e OY=ACL =ABC*0.95	Sub- alt 3f OY=ACL =ABC*0.90	Sub- alt 3g OY=ACL =ABC*0.85	Sub- alt 3h OY=ACL =ABC*0.75
Snapper 5	357,678	**339,794**	321,910	304,026	268,258
Snapper 6	6,912	**6,567**	6,221	5,875	5,184
Grouper 3	45,815	**43,524**	41,233	38,943	34,361
Grouper 4	8,799	**8,359**	7,919	7,480	6,599
Grouper 5	20,582	**19,553**	18,524	17,495	15,437
Grouper 6	164,445	**156,222**	148,000	139,779	123,334
Parrotfish 2	193,913	184,217	174,522	**164,826**	145,435
Surgeonfish	1,185	1,125	1,067	**1,007**	889
Triggerfish	95,318	**90,552**	85,787	81,020	71,489
Wrasses 1	82,529	**78,402**	74,276	70,149	61,897
Wrasses 2	26,841	**25,499**	24,157	22,815	20,131
Angelfish	3,673	3,489	3,306	**3,122**	2,755
Barracuda	177,040	**168,188**	159,336	150,484	132,780
Tripletail	41,342	**39,275**	37,208	35,140	31,007
Grunts	189,878	**180,384**	170,890	161,396	142,408
Jacks 1	44,147	**41,940**	39,732	37,525	33,110
Jacks 2	7,128	**6,771**	6,415	6,059	5,346
Jacks 3	9,479	**9,005**	8,531	8,057	7,110
Dolphinfish	1,837,943	**1,746,046**	1,654,149	1,562,252	1,378,458
Tuna	123,435	**117,263**	111,092	104,920	92,576
Mackerel	380,634	**361,602**	342,571	323,539	285,475
Wahoo	249,104	**236,649**	224,194	211,739	186,828

Appendix H. Fisheries Data Requirements

H.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 (50 CFR § 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) (50 CFR § 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 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 Chapter 5.

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 H.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 H.3 (Data Sources) discusses where current data comes from and how it is being collected to address management data needs.

H.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 H.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' Science and Technology Office is no longer conducting MRIP sampling in Puerto Rico. The Science and Technology Office, in cooperation with regional partners, is working to identify administrative body/group/agency solutions 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 H.3.

- 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 H.3).

- Recreational Data: The Marine Recreational Information Program (MRIP), formerly known as the Marine Recreational Fisheries Statistics Survey or MRFSS (see Table H.3.1), 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 H.3.

- 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 H.3.2.

  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 achieve "representative fraction of the populations"
9) Enhance data mining and recovery – scour and capture 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)

H.3 Data Sources

H.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.

H.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.

H.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 3.7.2 (Fishermen 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 sampling in Puerto Rico has continued since 2000 (SEDAR 2009) but was suspended since late 2017 due to impacts from Hurricane María. Table H.2 below lists the differences between the MRFSS and MRIP.

Table H.2. 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.

Subject/Theme	MRFSS	MRIP
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 H.3 provides a summary of data collected from each intercept.

Table H.3. 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

H.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).

H.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[88] 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.

H.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.

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.

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[88] 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.

As mentioned in Section H.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 H.4 lists NOAA Inititiatives that collect fishery-independent data, particularly in Puerto Rico. Table H.5 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 H.4. List of NOAA initiatives that collect fishery-independent data in the U.S. Caribbean, particularly in Puerto Rico.

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 H.5. 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. 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-	Collaboration among Puerto Rico DNER, Puerto Rico Sea

Fishery-Independent Sampling/Research Projects		
Survey	***Description***	***Entity in charge***
	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.	Grant, Council, U.S. Fish and Wildlife Service, USVI Department of Planning and Environmental Resources, 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.

H.3.2.1 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.

H.3.2.2 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

H.3.2.3 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).

H.3.2.4 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. 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 I. Information used to Identify and Describe Essential Fish Habitat (EFH) for Species New to Federal Management in the Puerto Rico Fishery Management Plan (FMP)

Through Action 6 of this integrated FMP/environmental assessment (EA), the Caribbean Fishery Management Council (Council) would describe and identify EFH for species new to federal management in the Puerto Rico exclusive economic zone (EEZ) according to functional relationships between all life stages of the new species and the marine and estuarine habitats of Puerto Rico. The species new to management under the Puerto Rico FMP (Action 2, Preferred Alternative 2) include coral-reef associated fish, pelagic fish, rays, and a number of benthic invertebrates (sea urchins, sea cucumbers, and corals).

Background

In 1983, the Council developed a Draft Environmental Impact Statement (DEIS) for the Caribbean Coastal Migratory Pelagic Fishery Management Plan (CCMP FMP) (CFMC 1983). The species considered under the CCMP FMP were: cero mackerel, king mackerel, great barracuda, dolphin, wahoo, almaco jack, bar jack, greater amberjack, horse-eye jack, yellow jack, blue runner, and rainbow runner. The Draft FMP was submitted in April 1983 at the 46th Council meeting but was withdrawn in December 1983 (48th CFMC meeting). The CCMP FMP was never formalized.

Coral reef-associated fish species (e.g., snappers, groupers) have been managed under the FMP for the Reef Fish of Puerto Rico and the U.S. Virgin Islands (USVI) (Reef Fish FMP) since 1985. The Reef Fish FMP included the jack species proposed for management in the CCMP FMP, but did not include the other pelagic species (cero mackerel, king mackerel, great barracuda, dolphin, or wahoo). Select corals, sea urchins, and sea cucumbers have been managed under the FMP for the Corals and Reef Associated Plants and Invertebrates of Puerto Rico and the USVI (Coral FMP) since 1995.

For the species that were managed under the Reef Fish and Coral FMPs, EFH was described and identified in the Final Environmental Impact Statement (FEIS) for the Generic EFH Amendment (CFMC 2004) and the Caribbean Sustainable Fisheries Act (SFA) Amendment (CFMC 2005). Those EFH designations would still be applicable to the previously managed species that were retained in the Puerto Rico FMP (see Action 2), but would not be applicable to the species new to management (Table I.1). The previous EFH designations were reviewed under the 2011 Five-Year EFH Review (CFMC 2011c) and are being reviewed under the on-going Five-Year EFH review. The 2011 EFH Five-Year review included information for some of the species proposed for management under the Puerto Rico FMP, such as cubera snapper and yellowmouth grouper. This appendix contains the information used in developing the EFH designations for the species new to management in the Puerto Rico FMP.

Table I.1. List of species new to federal management by designated functional group[89] under the Puerto Rico FMP that require EFH designations. The Puerto Rico FMP also includes all coral, sea urchin, and sea cucumber species that occur in the Puerto Rico EEZ, and EFH would be designated for those species new to management.

Scientific Name	Common Name	Functional Group
Lutjanus cyanopterus	Cubera snapper	Reef Fish
Mycteroperca intersticialis	Yellowmouth grouper	Reef Fish
Caranx hippos	Crevalle jack	Reef Fish
Elagatis bipinnulatus	Rainbow runner	Reef Fish
Alectis ciliaris	African pompano	Reef Fish
Balistes capriscus	Gray triggerfish	Reef Fish
Lobotes surinamensis	Tripletail	Pelagic
Coryphaena hippurus	Dolphin	Pelagic
Coryphaena equiselis	Pompano dolphin	Pelagic
Euthynnus alletteratus	Little tunny	Pelagic
Thunnus atlanticus	Blackfin tuna	Pelagic
Scomberomorus cavalla	King mackerel	Pelagic
Scomberomorus regalis	Cero mackerel	Pelagic
Acanthocybium solanderi	Wahoo	Pelagic
Sphyraena barracuda	Great barracuda	Pelagic
Manta birostris	Giant manta ray	Rays
Aetobatus narinari	Spotted eagle ray	Rays
Hypanus americanus	Southern stingray	Rays

This appendix is arranged in the following order: summary of species distribution (by functional group), 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 U.S. Caribbean and should be considered when site-specific areas of ciguatoxic fish are known.

[89] Functional groups were defined in Chapter 5.

Reef Fish

Under the U.S. Caribbean-wide FMPs, fishable habitat was defined to a depth of 100 fathoms. The deep-water snapper and grouper fishery, which includes the new species proposed for management under the Puerto Rico FMP, operates beyond that 100-fathom limit with reports for some species from areas that are surrounded by waters of 300 fathoms (549 meters [m] or 1,800 feet [ft]) or more.

Cubera snapper (Lutjanus cyanopterus)

Distribution

Cubera snapper are 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 to at least 85 m (Allen 1985, Lindeman et al. 2000). Cubera snapper appear 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

In general, snapper eggs 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 kilometers (km) offshore. The pelagic duration for snapper larvae lasts between 22 - 38 days. No specific information was found for cubera snapper eggs and larvae from Puerto Rico.

Cubera snapper 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, Puerto Rico, personal communication). They are found in depth ranges from very shallow in rocky shorelines of the north coast of Puerto Rico to mesophotic[90] 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 snapper from the deep reefs in Desecheo, Puerto Rico, specifically from the mesophotic reef tops (98 - 164 ft [30 - 50 m]) within the seasonally closed areas off the west coast of Puerto Rico (Bajo de Sico, Abrir La Sierra, and Tourmaline) and in the known but not protected spawning site of El Seco (Vieques, Puerto Rico). All cubera snapper reported from mesophotic reefs in Puerto Rico (survey depths of 98 - 164 ft [30 - 50 m]), were well above size at first reproduction, but no juveniles were

[90] Mesophotic coral reefs are found in tropical and subtropical regions at depths ranging from approximately 100 to 500 feet (30 – 152 meters).

observed. Although aggregations of cubera snapper were reported, no spawning behavior was observed at any of the sites surveyed.

Cubera snapper 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 snapper were most abundant and frequently observed at the bank and patch reefs at El Seco, with a large school of over 80 adult individuals reported (García-Sais et al. 2011). Cubera snapper were however absent from colonized pavements at depths of 98 - 164 ft (30 - 50 m). The suspected tiger grouper spawning site at El Seco included the presence of cubera snapper (>60 individuals) but no spawning was observed during the February - April 2011 surveys.

Abundance of large cubera snapper were estimated in the low to mid hundreds within mesophotic habitats at Abrir La Sierra 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. (2005, 2007, 2010, 2011, 2012, 2013) was 164 ft (50 m).

Spawning aggregations of cubera snapper have been reported at specific sites in Florida, Cuba, Mexico, USVI, and Belize, but not from Puerto Rico. Local knowledge and information provided by fishers interviewed by Ojeda-Serrano et al. (2007) identified potential spawning aggregations for cubera snapper, with spawning occuring between January and August. Spawning sites were reported off the south coast of Puerto Rico, east of Vieques, and off the north coast of Puerto Rico. None of these sites have been surveyed to confirm spawning aggregations of cubera snapper.

Biggs and Nemeth (2016) suggested that cubera snapper utilize an area of 1.4 to 1.5 km^2, centered at the shelf promontory and shelf edge in Grammanik Bank, a seasonally closed area in St. Thomas, USVI (CFMC 2004; 2005) used by a number of grouper (e.g., yellowfin grouper) and snappers as a spawning aggregation site. No actual spawning has been documented, but hydrated eggs found in fish from the area, which is indicative of imminent spawning. These multi-species aggregation sites are utilized by the different species at different times, with one displacing another. Cubera snapper aggregated monthly from May through November, with residence time peaking in August (peak when highest temperatures are recorded). 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 snapper. Benthic habitats at the mesophotic reefs of Grammanik Bank, where cubera snapper aggregate at depths of 98 - 197 ft (30 - 60 m), consist of a combination of *Montastrea/Orbicella* corals and hard bottom interspersed with gorgonians and sponges (Smith et al. 2008).

Prey-Predator Interactions
Randall (1967) reported fish as the main diet of cubera snapper. Prey included grunts, porcupinefish, and parrotfish, all demersal species, as well as more pelagic species such as herrings; indicating feeding occurs in the water column and on reef-associated habitats.

García Sais et al. (2007) suggested that the reef promontories at Bajo de Sico, including the reef top and reef wall, appeared to function as one large residential and foraging habitat for top reef demersal predators such as adult cubera snapper. Similarly, García Sais et al. (2011) suggested that the bank reef at El Seco functioned as the residential and/or foraging habitat for cubera snapper.

Ciguatera
Cubera snapper are said to be highly ciguatoxic. Citing the Department of Natural and Environmental Resources (DNER) Fishing Regulation 6768 (2004), the Puerto Rico Department of Health printed a pamphlet including cubera snapper as one of the most common fish causing ciguatera poisoning. In the USVI, cubera snapper is not considered to be ciguatoxic.

Yellowmouth Grouper (Mycteroperca intersticialis)
Distribution
Randall (1967, 1983) indicated that yellowmouth grouper were not very common in the West Indies. Yellowmouth grouper occur off Bermuda and the Bahamas, from North Carolina southward to the Florida Keys, throughout the Gulf of Mexico and Caribbean Sea, and southward to Brazil (Smith 1971). Yellowmouth grouper are found at depths 98 ft (30 m) or greater in the eastern Gulf of Mexico, but may be found at shallower depths in Bermuda and the Florida Keys (Bardach et al. 1958; Bullock and Smith 1991).

Habitat
In general, grouper eggs are 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.

Grouper 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 492 ft (150 m) (Heemstra and Randall 1993). Juveniles were present at Bajo de Sico (Schärer 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 Bajo de Sico (García Sais et al. 2007).

Yellowmouth grouper juveniles were reported at Bajo de Sico during the 2013-2014 surveys targeting Nassau grouper suggesting that Bajo de Sico could be considered a nursery area for yellowmouth grouper (Schärer and Nemeth 2015). Spawning aggregation sites such as El Seco in Vieques (García-Sais et al. 2011), Mona Island (Schärer et al. 2012), 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 U.S. Caribbean spawning sites (e.g., Schärer et al. 2012, Kadison et al. 2017).

Yellowmouth grouper were reported from the mesophotic reef at Bajo de Sico (Garcia-Sais et al. 2007) co-occurring with black and yellowfin groupers in survey areas between 98 - 164 ft (30 - 50 m) depth. The species was reported to occur to depths of 450 m (Grana Raffucci 2005a). Bajo de Sico is a residential site for yellowmouth groupers.

Fishers identified potential spawning aggregation sites for yellowmouth grouper when interviewed by Ojeda-Serrano et al. (2007). These sites were Grappler Bank, a few non-specific areas in southwest Puerto Rico but in an area surrounded by water deeper than 500 fathoms (3,281 ft / 1,000 m), and three sites very close to shore on the north coast (Ojeda-Serrano et al. 2007). Approximate coordinates for these spawning aggregation sites were presented in the report as well as the months when the aggregations take place (December-May). None of these sites have been confirmed as spawning aggregation sites.

Schärer et al. (2010) and Nemeth et al. (2007) 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. Bajo de Sico is a known spawning aggregation site for yellowmouth grouper.

The shallower part of Mona Island (98 ft [30 m]) on the southern part of the island, supports coral reefs and seagrass habitats. The islands of Mona and Monito are surrounded by waters deeper than 131 ft (40 m) to the north. Detailed descriptions of the habitats were prepared by

Schärer-Umpierre (2009) and Schärer et al. (2010) but no specific areas or habitat were identified for yellowmouth grouper, 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 from the protected spawning aggregation sites in western Puerto Rico where similar grouper species have been observed. The maximum depths at which yellowmouth grouper occur have not been established in these areas (García Sais et al. 2007, 2010, 2012, 2013).

Table I.2. Groupers reported as residents (R), present (P), aggregated (A) or in spawning condition (S) from the Bajo de Sico, Tourmaline, and Abrir la Sierra areas during each month of the year. Months with a dash (-) represent groupers for which information is unknown.

Area	Grouper Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	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	R	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	-	-	-	-	-	-	-	-	-	-

Prey-Predator Interactions

Randall (1967) reported that 100% of the stomach contents of yellowmouth grouper were fish, including chromis, atherinids and *Scarus croiisensi*. Garcia Sais et al. (2007) reported these species from Bajo de Sico, in areas where yellowmouth grouper were present and on reef promontories described as feeding grounds for yellowmouth grouper.

Ciguatera

Large groupers are said to be ciguatoxic, but this species is not listed separately in the literature as being ciguatoxic.

Gray Triggerfish (Balistes capriscus)

Distribution

Gray triggerfish are widespread throughout the Atlantic Ocean. In the western Atlantic, it occurs 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 occurs 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 - 361 ft (0 - 110 m).

Habitat

Information on eggs and larvae of the gray triggerfish specific to Puerto Rico is only known at the family level. The abundance of triggerfish larvae is greatest around 29 km offshore, and decreases further offshore (46 km) (Ramírez-Mella and García-Sais 2003).

Larvae and juveniles of gray triggerfish were among the most abundant groups sampled in the Gulf of Mexico associated with Sargassum mats (Wells and Rooker 2004). Juveniles settle 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 Interactions

The gray triggerfish feeds on benthic invertebrates (mollusks and crustaceans) but it is mostly reported by fishers in mid water. It is reported to eat sea urchins and sea cucumbers.

Juvenile gray triggerfish are prey of dolphinfish and tunas as well as other pelagic species feeding near Sargassum mats. Adults are preyed upon by groupers, sharks and humans.

Ciguatera

Gray triggerfish are listed as being implicated in Ciguatera in the Virgin Islands (Dammann 1969).

Crevalle Jack (Caranx hippos)

Distribution

Crevalle jacks are found on 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 2003).

Habitat

Crevalle jacks, like other species in the Carangidae family, are pelagic fish found in oceanic, estuarine and riverine environments, depending on 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. Juveniles are abundant in brackish estuaries with muddy bottoms, near sandy beaches and on seagrass beds, entering lagoons and lower courses of rivers. Crevalle jacks are diurnal predators, feeding of fish, shrimp and invertebrates (Böhlke and Chaplin 1993). Depth range is depth range 1 - 350 m.

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-Fernández et al. (2008) suggest that crevalle jack reproduce mainly from April-November, with a period of increased activity between May to July in Puerto Rico. Randall (1967) observed crevalle jack in clear waters only as solitary large adults stating that the species was more characteristic of turbid inshore waters and regions of low salinity. Stomach contents for this species in the USVI were empty (Randall 1967).

Life History

Maximum length is 124 cm TL and the maximum published weight is 32.0 kg (Frose and Pauly).

Reproduction and Spawning

Eggs are pelagic (Froese and Pauly).

Ciguatera

There have been some reports of ciguatera poisoning from this species (Halstead et al. 1990). Olsen et al. (1984) did not include crevalle jack in their review of ciguatera in the Eastern Caribbean.

African pompano (Alectis ciliaris)

Distribution

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

African pompano are found near shore in shallow areas and are described as neritic and oceanic; from near surface to beyond 328 ft (100 m). They are associated with both the pelagic and the reef habitats.

Prey-Predator Interactions

Randall (1967) reported empty stomachs of this species from the samples taken in the USVI.

Ciguatera

Olsen et al. (1984) did not list African pompano as a ciguatera risk fish.

Rainbow Runner (Elagatis bipinnulata)

Distribution

The rainbow runner is circumtropical in distribution, occurring throughout the warm temperate and tropical oceans. In the western Atlantic it occurs from New England to the northern coast of South America including, the Gulf of Mexico and the Caribbean (FAO 1986).

Habitat

Adult and young rainbow runner 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. Rainbow runner are usually absent at depths less than 121 ft (37 m), occur occasionally at depths greater than 194 ft (59 m), and are common over reefs found at depths 328 - 427 ft (100 - 130 m). Usually rainbow runner are found in small schools, but in certain locations at specific times of the year large schools can be 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 runner 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, rainbow runner are plentiful. However, in most areas, including the U.S. Caribbean, rainbow runner are infrequently seen (Randall 1968). Rainbow runner feed on invertebrates, mainly on larger crustaceans of the zooplankton, and small fishes (Frose and Pauly).

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.

Reproduction and Spawning

Eggs are pelagic (Frose and Pauly).

Prey-Predator Interactions

Rainbow runner were described by Hiatt and Strasburg (1960) as an inshore pelagic species, and its food as "probably pelagic fish although it certainly will take swimming crustaceans or squid" (in Randall 1967).

Ciguatera

Rainbow runner was not included in the list of ciguatera-causing fish in Puerto Rico (Escalona de Motta et al., 1986).

Pelagic species

None of the pelagics species proposed for management under the Puerto Rico FMP are defined as highly migratory species (HMS) under the Magnuson-Stevens Act, and thus are not managed under the Consolidated Atlantic HMS FMP. Dolphin, pompano dolphin, and wahoo are managed under the FMP for the Dolphin and Wahoo Fishery of the Atlantic (SAFMC 2003), but that management does not extend to the U.S. Caribbean.

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 U.S. Caribbean but throughout a larger area of distribution.

Dolphin (Coryphaena hippurus)

Distribution

The dolphin is an oceanic pelagic fish found worldwide in tropical and subtropical waters (Figure I.1). 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 are oceanic but also approach 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 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 decreased significantly. Other changes in the habitat of dolphin include the massive presence of Sargasso in the Caribbean (Franks et al. 2010). Dammann (1969) reported that dolphin were caught in the U.S. Virgin Islands at the edge of the 100 fathom (182 m) shelf and sometimes inshore. Dammann (personal communication in CFMC 1983) also reported that dolphin have been caught in green water on top of the shelf very close (*i.e.*, 100 yards [91 m]) to shore. The commercial and recreational landings clearly indicate the seasonality of the dolphin 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

Habitat of the dolphin 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 can feed and shelter during various life stages. The dolphin is well known for its propensity to station itself near non-motile 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 USVI 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.

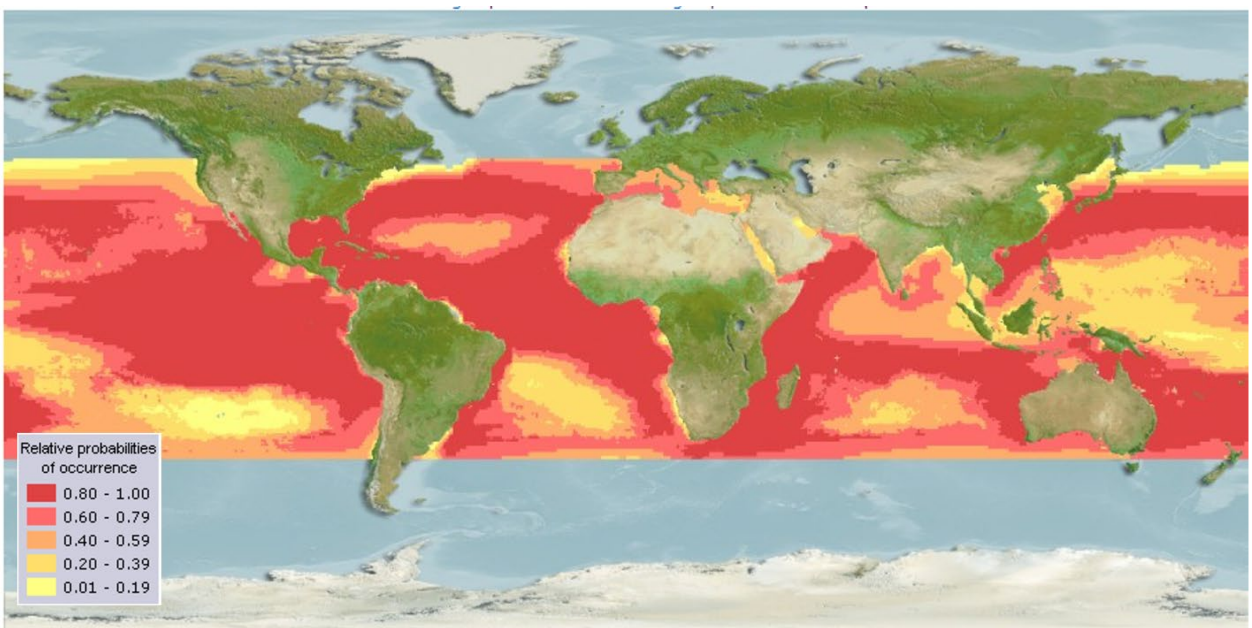

Figure I.1. Distribution map for dolphin (*Coryphaena hippurus*).
Source: www.aquamaps.org, version of Aug. 2016. Web. Accessed 25 Sep. 2019.

Pompano dolphin (Coryphaena equiselis)

Distribution

Pompano dolphin have 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). 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.

Juvenile and adult fish occur in the same areas. Ripe pompano dolphin have been collected in the Atlantic at in 8.1 in (205 mm) standard length (SL) (Gibbs and Collette 1959).

The migratory circuits of the dolphin fish include a northern cycle – extending from the east coast of the U.S. to north of Puerto Rico and the USVI and a southern circuit extending from south –southeast Puerto Rico to the south (Figure I.2). The peak season in Puerto Rico is reported to occur in February-March (SAFMC 1999) but having two seasons that are different for the North and South coasts.

There are no reports of actual spawning by dolphinfish in Puerto Rico but ripe ovaries have been reported. 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).

Prey-Predator Interactions

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 such as triggerfish and filefishes, surgeonfish, goatfish, jacks, surface-associated species of flying fish, and ballyhoo, with additional differences in species-specific prey items during each season. The orange spotted filefish, was the most common fish found in the dolphin fish stomachs, which indicates that dolphin fish move throughout the water column since this prey species tends to stay near the bottom near reef structures. Other prey species include bigeyes that are 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*) (De Sylva; personal communication in CFMC 1983).

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. 2000 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. 2000 argued, based on stomach contents studied by Oxenford and Hunte (1999), that food is an important factor in determining the aggregation of dolphinfish. 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) argued that Sargassum, as it extends into international waters, is an ecosystem that should be considered critical marine habitat. Pelagic top predators such as dolphinfish have been shown to be food-dependent on floating algae such as Sargassum (Manooch 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.

Ciguatera

There are no reports of ciguatera poisoning by dolphinfish in the U.S. Caribbean. However, it has been implicated in ciguatera poisoning in the Florida-Caribbean region (Stinn et al. 2000).

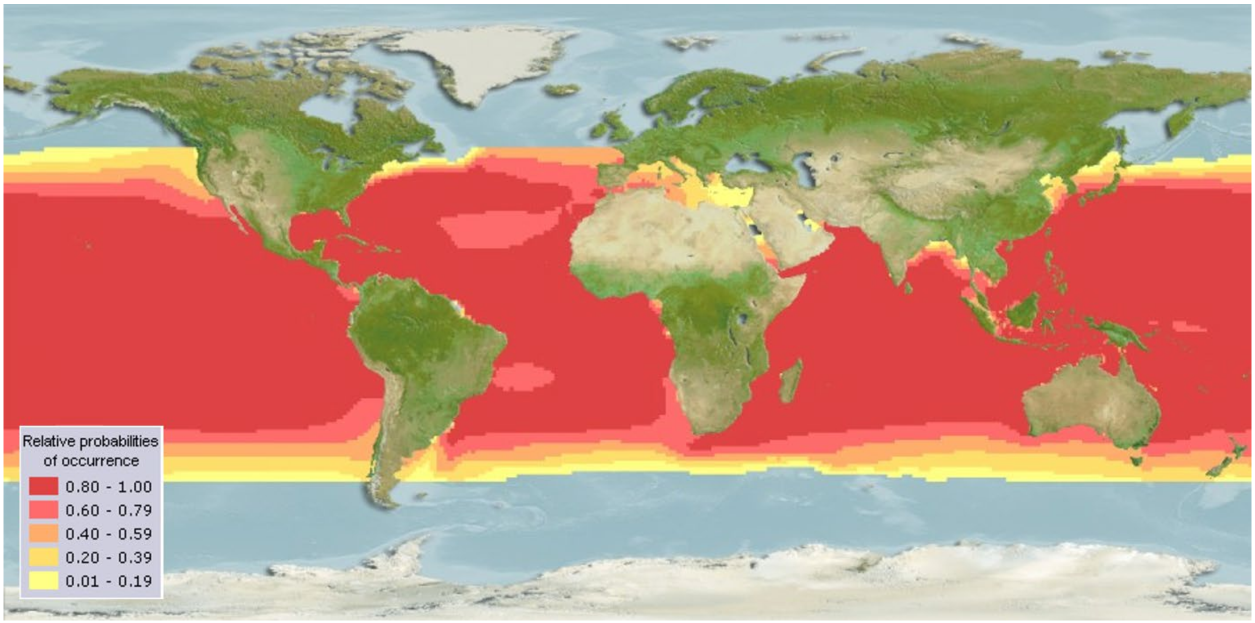

Figure I.2. Distribution map for pompano dolphin (*Coryphaena equiselis*).
Source: www.aquamaps.org, version of Aug. 2016. Web. Accessed 25 Sep. 2019.

Little Tunny (Euthynnus alletteratus)

Distribution

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 (Figure I.3). 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 (De Sylva and Rathjen 1961 and Marchal 1963).

Habitat

Cruise collection data compiled by De Sylva 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 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 (37 m) and the 54 fathom (100 m) line. 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 1.9 miles (3 km) along 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 were present in the plankton in spring and summer. Spawning appears to occur near the surface usually in water deeper than 148 ft (45 m) (Marchal 1963; De Sylva and Rathjen 1961).

Prey-Predator Interactions

The round herring (*Etrumeus sardina*) was the most important food species of the little tunny 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 tunny 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 little tunny is characteristic of the green inshore water over continental or insular shelves. They swim 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 U.S. Virgin Islands little tunny stomach contents contained mostly fish (57%: Jenkinsia sp., goatfish, etc.), squids (37%), and polychaetes (6%).

Ciguatera

This species was considered an infrequent poisoner in the USVI (Olsen et al. 1986).

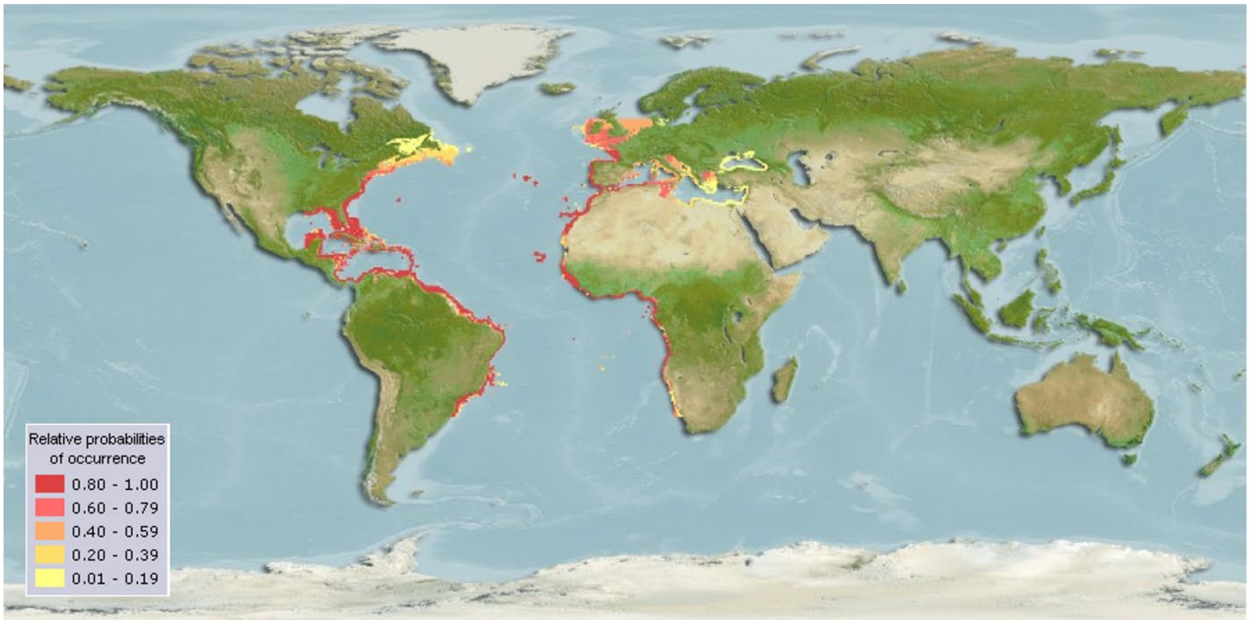

Figure I.3. Distribution map for little tunny (*Euthynnus alletteratus*).
Source: www.aquamaps.org, version of Aug. 2016. Web. Accessed 25 Sep. 2019.

Blackfin tuna (Thunus atlanticus)
Blackfin tuna are found in the western Atlantic Ocean 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. 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
The blackfin tuna is the only tuna species restricted to the western Atlantic (Figure I.4). The blackfin tuna does migrate to higher latitudes when waters warm in summer, but to a lesser extent than the other tuna species. It is usually restricted to the shelf areas and is not often found in waters less than 90 fathoms (165 m). 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, blackfin tuna typically follow an east to west route along the edge of the drop off during migrations along Puerto Rico and the Virgin Islands.

Prey-Predator Interactions
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 fishes such as herring and

sardine. Juvenile blackfin tuna have a diet made up primarily of plankton. Surgeonfish larvae have been observed in the stomachs of blackfin tuna (Reeson 1975).

Several shark species are believed to be major predators of blackfin tuna. Blackfin tuna juveniles of 9.8 inches (in) (250 mm) were found to be the bulk of blue marlin stomach contents in September during a sampling in Puerto Rico (Erdman 1978).

Ciguatera
There are no references implicating blackfin tuna in ciguatera poisoning.

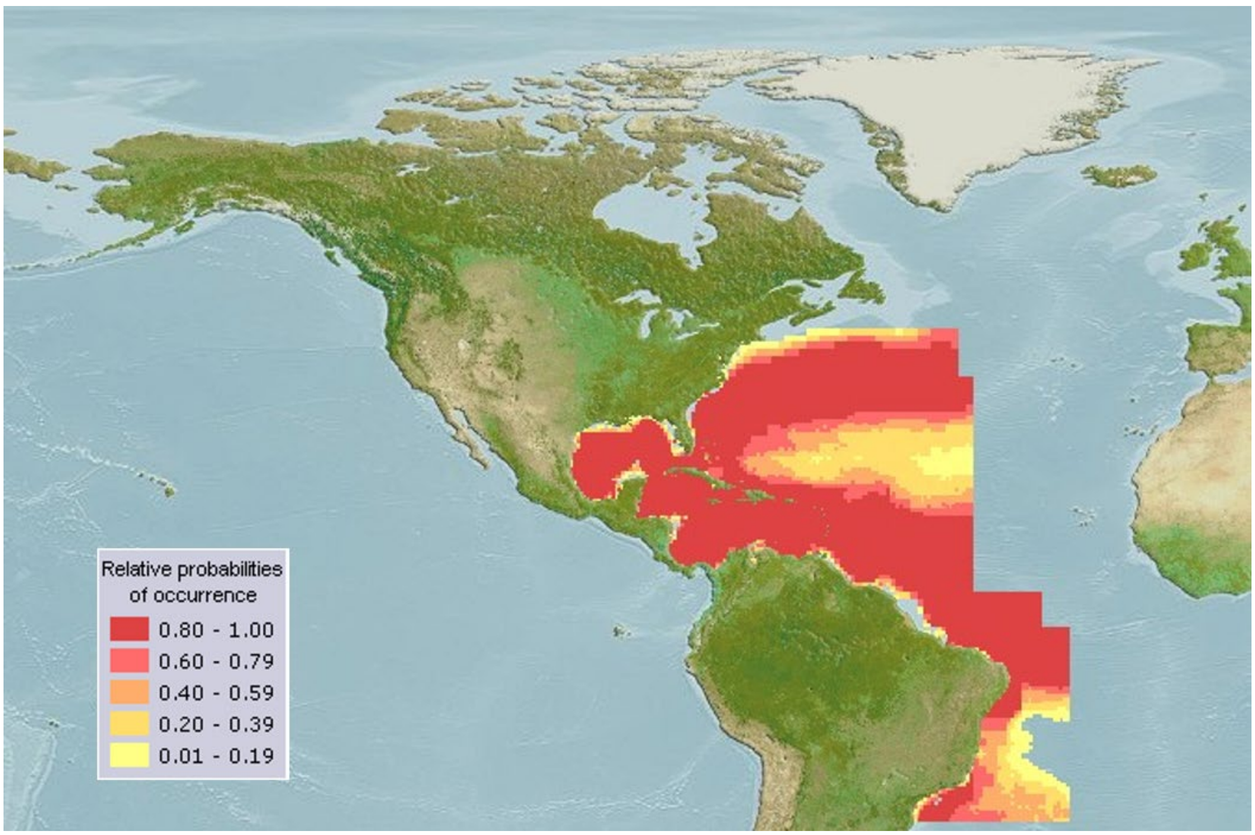

Figure I.4. Distribution map for blackfin tuna (*Thunus atlanticus*).
Source: www.aquamaps.org, version of Aug. 2016. Web. Accessed 25 Sep. 2019.

King mackerel (Scoberomorus cavalla)
Distribution
King mackerel inhabit the tropical western Atlantic with a north-south extension between Brazil and the Northeast USA (Figure I.5). 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 and Sutherland 1978) 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 Florida Keys and into the Gulf of Mexico, appearing in the northern Gulf in June. They apparently remain in the northern Gulf of Mexico until October, migrating as far west as Port Aransas, Texas. These fish reappear off Ft. Pierce, Florida at about the same time each year (Williams and Sutherland 1978). Two tagged returns from Mexico indicate some interaction with Mexican stocks.

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 U.S. 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 (D. Olsen, USVI Department of Planning and Natural Resources; personal communication). The migration pattern for king mackerel and several of the other pelagic species needs to be defined.

Habitat

Larvae are encountered in surface waters of 26.3° to 31°C and 26.9 to 35 ppt. King mackerel feed primarily on fishes with smaller quantities of penaeid shrimps and squids. Large schools have been found to migrate over considerable distances along the Atlantic U.S. coast, water temperature permitting (Froese and Pauly 2019).

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 240 ft (73 m) 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 m) 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 (in Jacobsen and Browder 2006).

Prey-Predator Interactions

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; personal communication in 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 king mackerel may be observed as a solitary fish or in small groups, swimming in mid-water, but often nearer the bottom than the surface. The stomachs of 22 fish from the USVI contained mostly fish (92%) including yellowtail snapper, jacks, and squid (8%).

Ciguatera

Stinn et al. (2000) reported that king mackerel is among the fish most frequently implicated in ciguatera throughout the wider Caribbean. Olsen et al. (1984) rank it as a frequent poisoner in the St. Thomas, USVI area. There appears to be a ciguatoxic fish hotspot south of St. Thomas, USVI (Stinn et al. 2000).

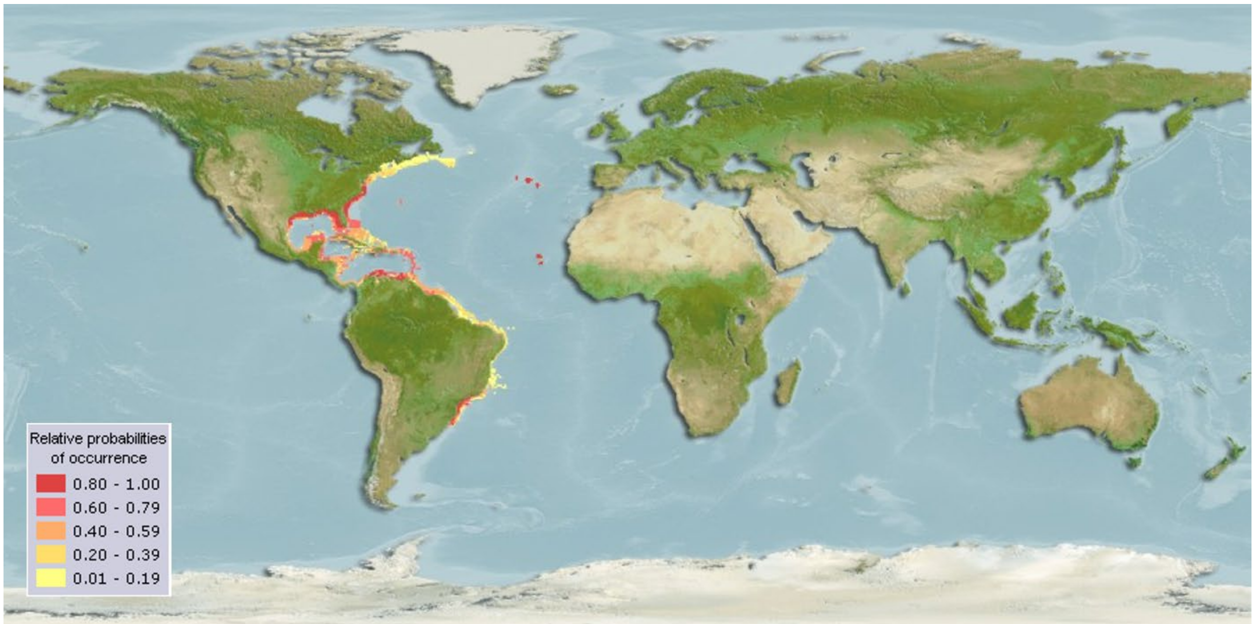

Figure I.5. Distribution map for king mackerel (*Scoberomorus cavalla*).
Source: www.aquamaps.org, version of Aug. 2016. Web. Accessed 25 Sep. 2019.

Cero mackerel (Scoberomorus regalis)

Distribution

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 (Figure I.6). This species is probably the most common of the scombrids in the local U.S. Caribbean waters.

Cero mackerel are 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 mackerel 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

The species is considered a coastal pelagic species (FAO 1978). 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).

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 Interactions

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 1978).

Randall (1967) reported the cero mackerel 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.

Ciguatera

The cero mackerel is considered highly ciguatoxic in the U.S. 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 et al. 1977).

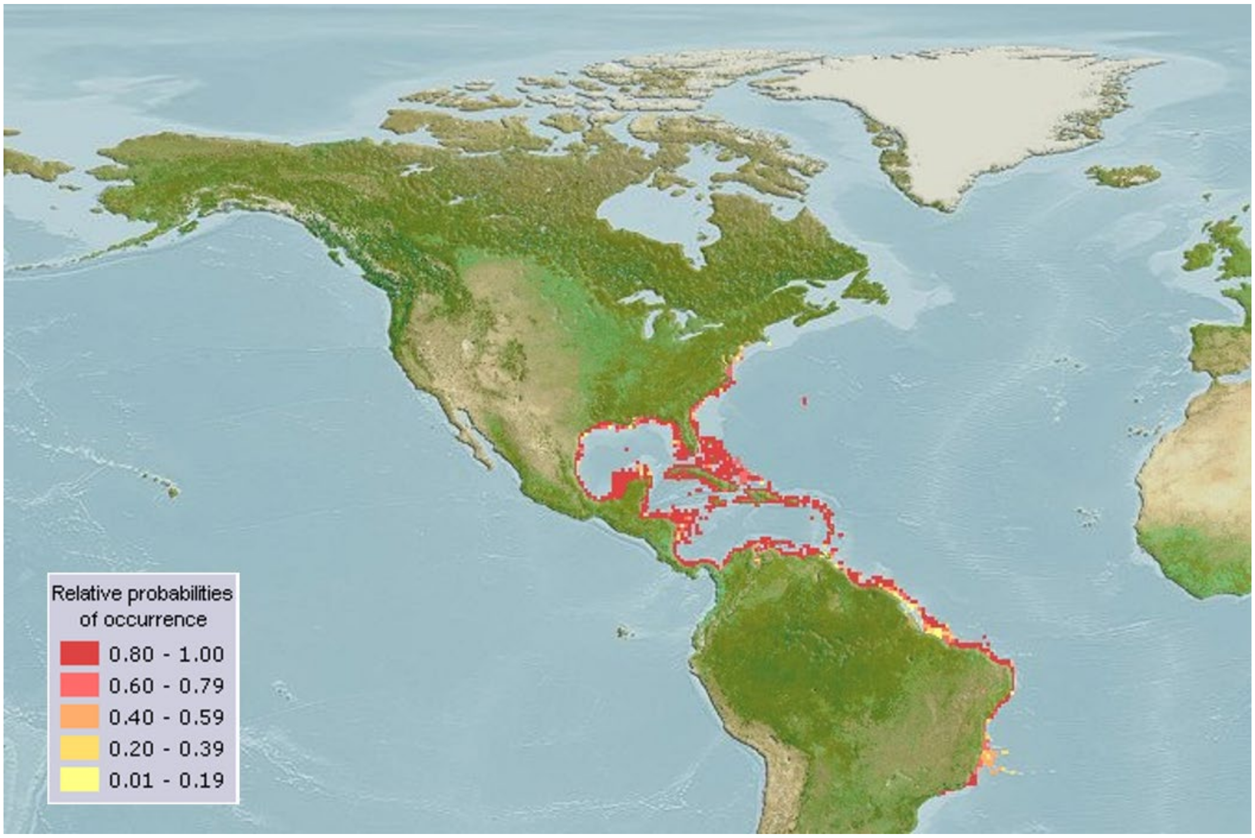

Figure I.6. Distribution map for cero mackerel (*Scoberomorus regalis*).
Source: www.aquamaps.org, version of Aug. 2016. Web. Accessed 25 Sep. 2019.

Wahoo (Acanthocybium solandri)

<u>Distribution</u>

Wahoo are oceanic pelagic fish found worldwide in tropical and subtropical waters of the Atlantic, Indian and Pacific oceans and the Caribbean and Mediterranean Seas (Figure I.7). 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).

Wahoo have 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 and Yoshita 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 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 (Wahoo Research Project [WRP] 2007).

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 USVI 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. The species is landed in the U.S. Virgin Islands year-round although it is less abundant in June through August (Dammann 1969).

Theisen et al. (2008) determined that wahoo constitute a "single globally distributed population" a finding attributed to extensive dispersal at all life stages.

Habitat

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).

Larval and post larval wahoo are usually collected in water at depths greater than 328 ft (100 m). The species is a very powerful fast swimmer and, like the dolphin, is also frequently found in the open ocean (Hogarth 1976 and Iversen and Yoshita 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).

The pelagic zone is 'typical habitat' for the adults of the wahoo (in Jacobsen and Browder 2006). It appears to be migratory in the Florida Straits and Gulf Stream but is caught with regularity in the U.S. Virgin Islands. Wahoo have been reported to travel in small schools, but this trait is probably restricted to young fish. 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.

Although wahoo are 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.

In Puerto Rico, wahoo are also harvested with dolphin (target species) but Figuerola-Fernández 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-Fernández 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.

<u>Prey-Predator Interactions</u>
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.

<u>Ciguatera</u>
Wahoo has not been implicated in ciguatera poisoning (Olsen et al. 1984, Escalona de Motta et al. 1986).

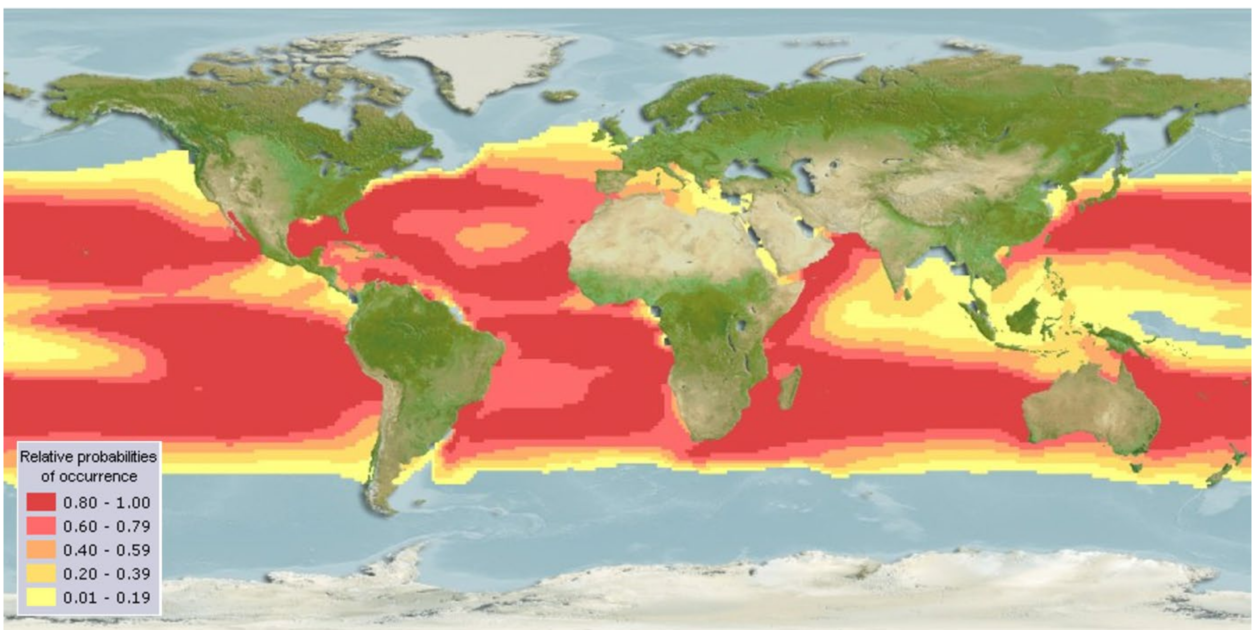

Figure I.7. Distribution map for wahoo (*Acanthocybium solandri*).
Source: www.aquamaps.org, version of Aug. 2016. Web. Accessed 25 Sep. 2019.

Great Barracuda (Sphyraena barracuda)

<u>Distribution</u>

Great barracuda are 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 (De Sylva 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. 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 herrings, sardines and silverside fishes. Barracudas are also associated with reef fish habitats evidenced by the presence of moray eels and other coral reef associated reef fish in stomach contents (Randall 1967).

<u>Habitat</u>

Eggs of barracuda are pelagic and contain an oil globule indicative of flotation in the water column. Ramírez-Mella and García-Sais (2003) reported larvae of barracudas 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.

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 seven 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 1978). 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 (De Sylva 1970). Barracudas are said to aggregate to spawn (Sadovy and Cornish 2000). 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 328 ft (100 m). The reported preferred habitat is high profile-bottom such as reefs and wrecks in waters that are 68 °F or warmer (Florida Museum of Natural History [FLMNH] 2007; Manooch 1984). 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 (Fisher 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-Fernández et al. (2008) reported a 6-month main spawning season (March-August) for great barracuda around Puerto Rico, but there is a potential for reproductive activity year-round (Erdman 1978). It is believed that spawning takes place in deeper, offshore waters (FLMNH 2007).

<u>Prey-Predator Interactions</u>
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 (De Sylva 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 1978). 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 that fed upon tagged reef fishes before they could reach the shelter of the reef after release from a boat. Fish such as surgeonfish *(Acanthurus bahianus*, *A. coeruleus*), goatfish (*Mulloidichthys martinicus, Pseudopeneus maculatus)*, and parrotfish (Sparisoma spp.) were taken from the stomachs of two such marauding barracudas (Randall 1967).

Ciguatera
Human mortalities have been reported from the ingestion of barracuda, as this species is a frequent carrier of ciguatera. Barracuda are almost universally feared throughout both Puerto Rico and the U.S. Virgin Islands with very few regions eating fish larger than two to three 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 (De Sylva 1963; Tosteson 2004).

Tripletail (Lobotes surinamensis)
Distribution
The distribution of tripletail includes tropical and subtropical waters of all oceans: Western Atlantic (New England and Bermuda southward to Argentina [Carpenter 2003]); and Falkland Islands (Carpenter and Robertson 2015); 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 (Carpenter and Johnson 2016). 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 (Carpenter 2001).

Habitat
Ditty and Shaw (1994) 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 RV Nancy Foster Cruise Reports from the U.S. Caribbean. Larvae are usually found offshore and in surface waters (Ditty and Shaw 1994). Finding larvae offshore would suggest spawning takes place offshore but this information has not been documented (Ditty and Shaw 1994).

In Puerto Rico the tripletail is mostly associated with fish aggregating devices (FADs) (Wessley Merten, founder and president of the Beyond Our Shores Foundation; personal communication, https://dolphintagging.com/).

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 in Puerto Rico or the U.S. Virgin Islands during their life history is unknown.

Prey-Predator Interactions
Tripletail feed on nekton, shrimp and crabs (Franks et al. 2003) and small fish. Although not commonly eaten in Puerto Rico, tripletail are taken and kept when fishing for pelagics near FADs.

Life History

Maximum reported length of 110 cm TL and maximum reported weight of 19.2 kg.

Ciguatera
There is no information on tripletail and ciguatera.

Rays

Giant Manta Ray (Manta birostris)
Distribution
Giant manta rays are found worldwide in tropical, subtropical, and temperate bodies of water and are commonly found offshore, in oceanic waters, and near productive coastlines (Figure I.8). 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 Yucatán 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. 2011b; 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 Yucatán peninsula, Graham et al. (2012) calculated a maximum distance travelled of 715 mi (1,151 km) (based on cumulative straight-line distance between locations), further confirming that the species is capable of fairly long-distance migrations.

Habitat

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. 2011b). 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. 2011b). 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.)".

Prey-Predator Interactions

The giant manta feeds mainly on zooplankton, small fishes may be taken while plowing through the water column.

Ciguatera

There is no information on mantas and ciguatera.

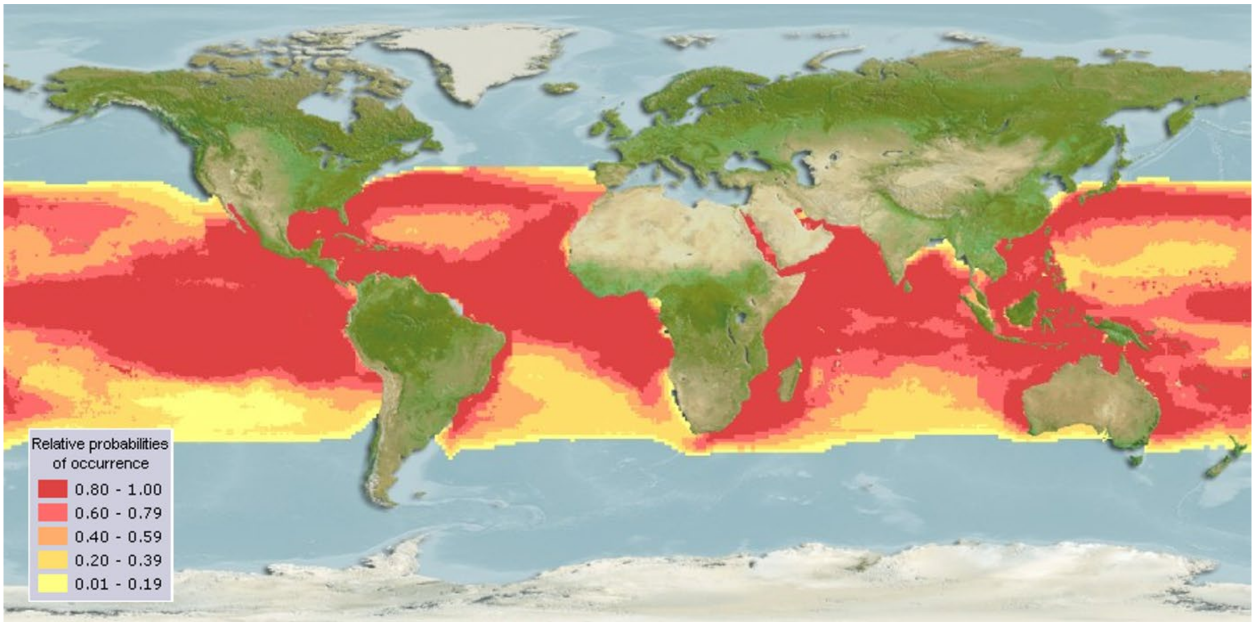

Figure I.8. Distribution map for giant manta ray (*Manta birostris*).
Source: www.aquamaps.org, version of Aug. 2016. Web. Accessed 25 Sep. 2019.

Spotted Eagle Ray (Aetobatus narinari)

Distribution

The spotted eagle ray is a large ray with a widespread distribution across the Indo-Pacific and eastern and western Atlantic in tropical and warm-temperate waters (Figure I.9). Recorded over the continental shelf from the surface to 197 ft (60 m) depth in coastal and open ocean environments. Sometimes, the species enters lagoons and estuaries and is often associated with coral-reef ecosystems. 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

The spotted eagle ray is usually in motion, swimming gracefully over sand, grass, and mud flats and reefs (Randall 1967).

Prey-Predator Interactions

The eagle ray feed mainly on gastropods like queen conch and bivalves (Randall 1964).

Ciguatera
The spotted eagle ray does not appear among the species listed to be implicated in ciguatera (Olsen et al. 1984).

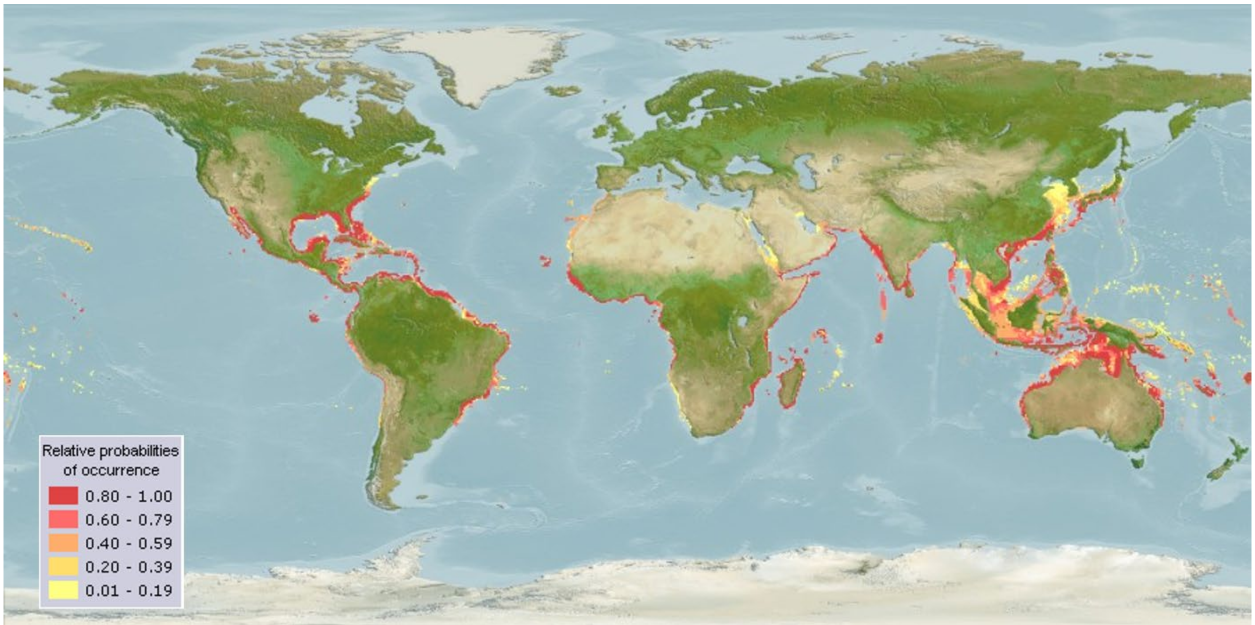

Figure I.9. Distribution map for spotted eagle ray (*Aetobatus narinari*).
Source: www.aquamaps.org, version of Aug. 2016. Web. Accessed 25 Sep. 2019.

Southern stingray (Hypanus americanus)
Distribution
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 (Figure I.10).

Habitat
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 northern part of its range and can endure temperatures above 86° F (30° C). Temperature induced seasonal migrations have been observed throughout its range.

Prey-Predator Interactions

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 stingrays in the USVI were fish (e.g. juvenile surgeonfish), worms, and crabs.

A number of shark species, such as the white, tiger and bull sharks are the major predators on the stingray.

Ciguatera

Stingrays, commonly known as chuchos in Puerto Rico, along with any other rays, are used in the preparation of popovers (empanadillas). They have a very low risk of being implicated in ciguatera (Olsen et al. 1984).

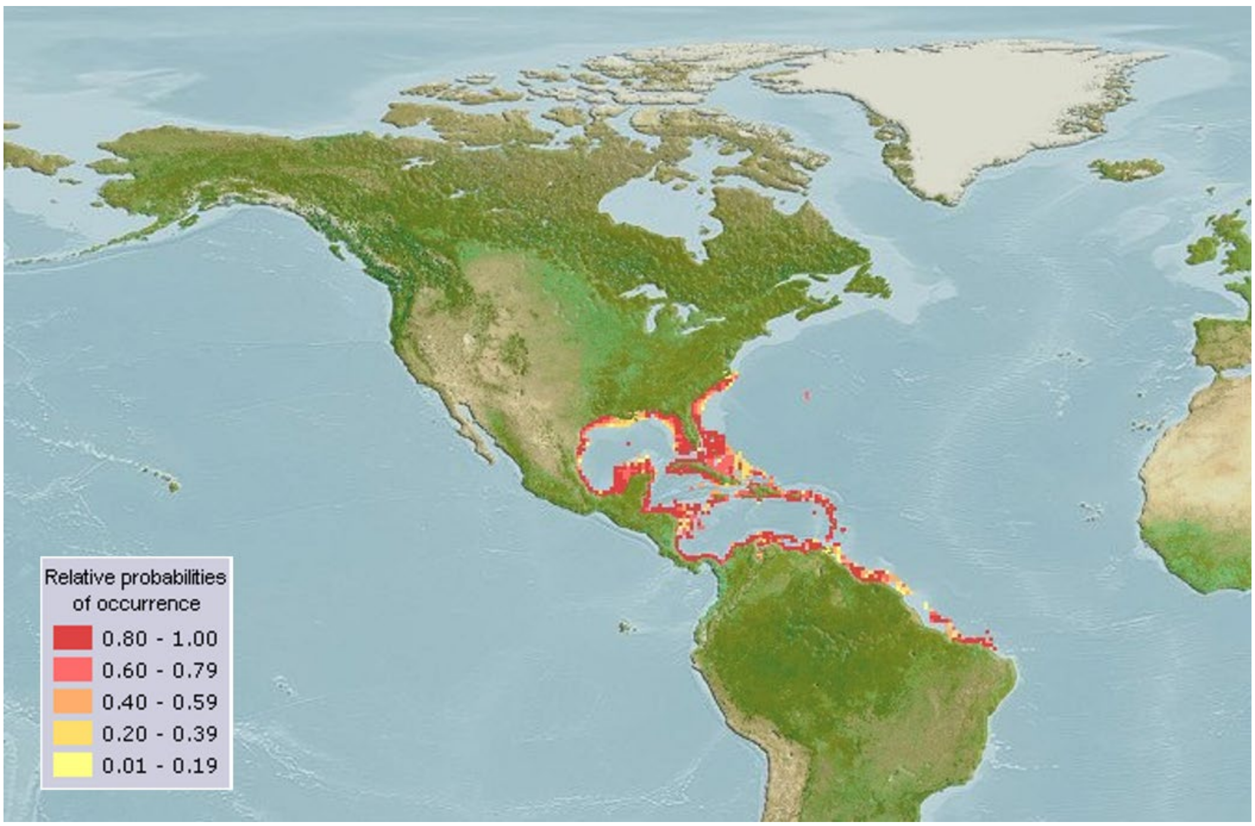

Figure I.10. Distribution map for southern stingray (*Hypanus americanus*).
Source: www.aquamaps.org, version of Aug. 2016. Web. Accessed 25 Sep. 2019.

Coral Reef Resources

Sea Urchins – Class Echinoidea

Sea urchins belong to the Phylum Echinodermata, along with sea cucumbers, starfish, brittle stars, and crinoids. Sea urchins (class Echinoidea) are typically round and spiny, with tests (bodies) generally 1-4 in (3-10 cm). About 950 species are found in all oceans and depth zones along the seabed from intertidal depths down to 16,400 ft (5,000 m). Sea urchins generally move slowly, crawling with their tube feet, or pushing themselves with their spines. Urchins are adapted to live on rocks and other types of hard bottom (Barnes 1974) and are capable of living under rocky layers and excavating depressions on rocky surfaces. Urchins can also burrow in sand and crevices during high wave action and can survive on rocky shores as well as the deep ocean floor.

Roughly 76 species of Echinoids occur in the wider Caribbean region, with only 14 species reported in the U.S. Caribbean (Alvarado 2011). Three of the five most common sea urchins in the U.S. Caribbean (*Echinometra lucunter, E. viridis,* and *Diadema antillarum*) are associated with hardground substrates while the other two (Tripneustes ventricosus and Lytechinus variegatus) are associated with seagrass beds.

Sea urchins feed primarily on algae, but also eat slow-moving or sessile organisms and carrion. Predators of sea urchins include sea otters, starfish, triggerfish, and humans. Aside from grazing on reef algae, urchins can raze 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 and some juvenile fishes and shrimp and known to utilize the long spines of this urchin species as shelter.

Sea urchins eject sperm and eggs into the water column with fertilization occurring in the sea water. Depending on the species, fertilized eggs may be retained among the urchins spines in a brooding-like behavior. Sea urchins have planktonic larvae that might take months to develop. Once the adult skeleton is being formed, larvae sink to the bottom. Metamorphosis can be as short as 1 hour. D. antillarum are known to aggregate and spawn throughout the year in the Caribbean.

Sea urchins are common in shallow and deep-waters around Puerto Rico. The deep-water surveys recently conducted in the U.S. Caribbean EEZ show what appear to be trails of these organisms.

Sea Cucumbers – Class Holothuroidea

Sea cucumbers belong to the Phylum Echinodermata, along with sea urchins. Sea cucumbers (Class Holothuroidea) have a soft, cylindrical body that usually measures between 4 and 12 in (10 and 30 cm) long, with some species measuring up to 10 ft (3 m). Sea cucumbers are found world-wide on rocky bottoms, sandy bottoms, mud-like bottoms, from shallow waters down to depths of 5.5 miles (8.9 km). Sea cucumbers form large herds that move across the bottom of the ocean. The body of some deep-water sea cucumbers made of tough gelatinous tissue that allows animals able to control their buoyancy, making it possible for them to actively swim. The swimming sea cucumber, Enypniastes eximia, was recently recorded during NOAA's Ocean Exploration and Research, Exploring Deep-sea Habitats off Puerto Rico and the U.S. Virgin Islands.

There are about 1,700 species of sea cucumbers, with roughly 63 species in the wider Caribbean region, about half of which are reported in the U.S. Caribbean (Alvarado 2011).

Sea cucumbers serve an important role as they break down detritus and other organic matter, they helping to recycle nutrients in the marine ecosystem. Sea cucumbers crawl on the bottom feeding on detritus from the sediments or algae growing over the hard surfaces. Most are deposit or suspension feeders. The sediment passes through the sea cucumber's gut and is returned devoid of food particles to the habitat. Some cucumbers have a commensal relationship with a fish (pearl fish) that lives in the respiratory tree, using the sea cucumber as shelter, with no apparent damage to the sea cucumber. The body wall of sea cucumbers often contain a toxin, which makes them distasteful to predators.

Reproduction in the sea cucumbers includes hermaphroditic protrandy (changing from male to females) and brooding behavior. Fertilization is external, except in a deep-water species that appear to have internal fertilization. The young leave the mother well-formed or brooding takes place within the ovary. In most species however, fertilized eggs develop in the water column and embryos are planktonic (pelagic). The stages of metamorphosis of the larvae are all pelagic until a small cucumber is form and settlement to the benthos takes place.

Corals (For additional information on corals, see Appendix J)

The Council intends to manage all species of corals, whether described in this section or not. Corals (Phylum Cnidaria) included for management under the Puerto Rico FMP include species in (1) Class Hydrozoa: Subclass Hydroidolina - Order Anthoathecata - Family Milleporidae and Family Stylasteridae; (2) Class Anthozoa: Subclass Octocorallia (soft corals, gorgonians, sea pansies, sea pens) - Order Alcyonacea (soft corals), and Order Pennatulacea (sea pens); Subclass Hexacorallia - Order Scleractinia (stony corals), and Order Anthipatharia (black corals). A description of coral species previously managed under the U.S. Caribbean-wide Coral FMP can be found in the Caribbean SFA Amendment (CFMC 2005). Please see Section 3.3.1 of this document for an updated description of Endangered Species Act-listed corals and Appendix E for a list of coral species included in this FMP. Due to the large numbers of species included in the FMP, this summary is just a high-level overview of corals in the management area.

For most corals, it is believed that light requirement 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 decreases. 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).

Star corals (Montastrea spp.) are generally the most common species of coral on Atlantic reefs at moderate depths (Colin 1978). Massive boulders reaching several meters across can form in shallow water (1 - 20 m) and flattened heads or plate-like colonies in deeper water (below 20 m). Star corals often form massive mounds that are important structural elements of buttresses and other fore reef elements at moderate depth and the coral colonies become more flattened as water depth increases.

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.

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 molluscs 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).

Within a colony, 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).

Appendix J. Description of the Species Included in the Puerto Rico Fishery Management Plan (FMP)

This appendix summarizes the available information on the biology and life history for stocks/stock complexes (e.g., fish, spiny lobster, queen conch, corals, sea cucumbers, and sea urchins) 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 queen 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, Virgin Islands Department of Planning and Environmental Resources, 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.

Cardinal snapper, *Pristipomoides macrophtalmus*

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

Cardinal snapper are gonochronistic (i.e., sexes are distinct) and thought to spawn year round with peak spawning observed during March and December in Puerto Rico (Rosario et al. 2006).

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*

Please see Appendix I for information about this species

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. They 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, *Cephalopholis fulva*

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, *Cephalopholis 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

Black grouper occur in the western Atlantic, from Bermuda and Massachusetts, USA to southern Brazil, including the southern Gulf of Mexico and throughout the Caribbean (Heemstra and Randall 1993). Adults are found on rocky and coral reefs, from depths of 10-30 m, and juveniles occur in mangroves.

Life History

Attains at least 133 cm TL and weight of 65 kg, with one report of black grouper from Bermuda attaining a weight of 81 kg (Heemstra and Randall 1993).

Diet

Adults feed primarily on fishes and juveniles prey mainly on crustaceans.

Reproduction and Spawning

The spawning season for this species varies with the most common spawning season from December to April with peak spawning from January to March (Kobara, et al. 2017). Black grouper form transient spawning aggregations of tens to hundreds of fish over reef promontories at the shelf edge. Aggregations form on the full moon, with spawning typically commencing 10 to 12 days later. Courtship occurs in pairs to small groups up to five fish, with courtship activity peaking during or minutes after sunset. Black grouper are broadcast spawners with external fertilization. Evidence reported for protogynous hermaphrodism and sizes of ripe females from 50-100 cm and males from 96-166 cm (Heemstra and Randall 1993). Black grouper in spawning condition were observed on the Campeche Bank in July and August.

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, *Hyporthodus 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, *Hyporthodus 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*

Please see Appendix I for information about this species.

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*

Please see Appendix I for information about this species

Wrasses, Labridae

Three wrasses are managed in the Puerto Rico FMP as one single 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 radiatus*

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 bottom-feeding predators found in fresh, brackish, and marine waters around the world. 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. Please see Appendix I for information about these species.

Crevalle jack, *Caranx hippos*

Please see Appendix I for information about this species

African pompano, Alectis ciliaris

Please see Appendix I for information about this species.

Rainbow runner, *Elagatis bipinnulata*

Please see Appendix I for information about this species.

Great Barracuda, *Sphyraena barracuda*

Please see Appendix I for information about this species.

Tripletail, *Lobotes surinamensis*

Please see Appendix I for information about this species.

Dolphin, *Coryphaena hippurus*

Please see Appendix I for information about this species.

Pompano dolphin, *Coryphaena equiselis*

Please see Appendix I for information about this species.

Little tunny, *Euthynnus alletteratus*

Please see Appendix I for information about this species.

Blackfin tuna, *Tunnus atlanticus*

Please see Appendix I for information about this species.

King Mackerel, *Scomberomorus cavalla*

Please see Appendix I for information about this species.

Cero Mackerel, *Scomberomorus regalis*

Please see Appendix I for information about this species.

Wahoo, *Acanthocybium solandri*

Please see Appendix I for information about this species.

Giant manta ray, *Manta birostris*

Please see Appendix I for information about this species.

Spotted eagle ray, *Aetobatus narinari*

Please see Appendix I for information about this species.

Southern Stingray, *Hypanus americanus*

Please see Appendix I for information about this species.

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

See Appendix I

Sea Cucumbers

See Appendix I

Corals

The Council intends to manage all species of corals, whether described in this section or not. Corals included in the Puerto Rico FMP include the phylum Cnidaria (formerly Coelenterata) 1) Class Hydrozoa: Subclass Hydroidolina - Order Anthoathecata - Family Milleporidae and Family Stylasteridae; 2) Class Anthozoa: Subclass Octocorallia (soft corals, gorgonians, sea pansies, sea pens) - Order Alcyonacea (soft corals), and Order Pennatulacea (sea pens); Subclass Hexacorallia - Order Scleractinia (stony corals), and Order Anthipatharia (black corals).

Hydrocorals, Class Hydrozoa

Two families within the Class Hydrozoa, Order Anthoathecata are included for management in the Puerto Rico FMP: Milleporidae (fire corals) and Stylasteridae (lace corals).

Milleporidae species represented in the Puerto Rico FMP are the fire corals (*Millepora* spp.). 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).

Stylasteridae species are also colonial but do not contain zooxanthallae. They have been used frequently as ornamental pieces (Goenaga and Boulon 1992). The rose lace coral (*Stylaster 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

Anthozoans in the Puerto Rico FMP include black corals (Order Antipatharia), soft corals (Subclass Octocorallia, Order Alcyonacea), sea pansies, and sea pens (Subclass Octocorallia, Order Pennatulacea), as well as the true reef-building corals (Subclass Hexacorallia, Order Scleractinia). 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.

Soft corals, Order Alcyonacea

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

Due to the numerous scleractinian species included in the Puerto Rico FMP, 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 resources stock complex, *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).

Montastrea annularis (boulder star coral) and *Montastrea 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. *O. 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. annularis* 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).

Porites astreoides (mustard hill coral); *Porites branneri* (blue crust coral); *Porites divaricata* (small finger coral); and *Porites porites* (finger coral) are four poritidae species in the Puerto Rico FMP. *P. astreoides* 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. astreoides* 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. astreoides* 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. In Puerto Rico and the USVI, commercial harvesting is apparently uncommon but is known to occur (Goenaga and Boulon 1992). However, harvest of all managed corals is prohibited in the Puerto Rico FMP.

The ecology and life history of these organisms is, for the most part, unknown. Taxonomy, to a large extent, is also unknown. Two of the genera included in the coral reef resources stock complex are 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.

Appendix K. Summary of Endangered Species Act (ESA) Consultations on the Queen Conch, Coral, Reef Fish, and Spiny Lobster Fishery Management Plans (FMP)

The Puerto Rico FMP will subsume some of the activities currently managed under the FMP for the Reef Fish of Puerto Rico and the U.S. Virgin Islands (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). Activities under these FMPs may affect ESA listed species and designated critical habitat and ESA Section 7 consultations have been completed in the past. The following summarizes the consultation history for each FMP.

Queen Conch and Coral

Fishing authorized under the Queen Conch and Coral FMPs occurred mainly via hand harvest of queen conch and coral reef-associated organisms (harvest of corals was prohibited), and previous consultations determined that ESA-listed species in the action area were not likely to be adversely affected by either of these fisheries. Additionally, potential effects to the two listed *Acropora* species and designated critical habitat for *Acropora* were determined to be extremely unlikely to occur and discountable.

Reef Fish

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 (*Acropora*), 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 (humpback, fin, sei, and sperm) or Northwest Atlantic distinct population segment (DPS) of loggerhead sea turtle, or the critical habitat for green, hawksbill or leatherback sea turtles.

Spiny Lobster

On December 12, 2011, NMFS completed its most recent biological opinion evaluating the effects of the continued authorization of the U.S. Caribbean spiny lobster fishery, managed under the Spiny Lobster FMP, on ESA-listed species and designated critical habitat. In the opinion, NMFS concluded that the spiny lobster fishery's continued authorization is not likely to destroy or adversely modify Acropora critical habitat in the U.S. Caribbean, or to jeopardize the continued existence of staghorn coral, or green, hawksbill, or leatherback sea turtles. NMFS also concluded that the continued authorization of the U.S. Caribbean spiny lobster fishery is not likely to adversely affect ESA listed whales (humpback, fin, sei, and sperm), loggerhead sea turtles, elkhorn coral, or critical habitat for 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 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. 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.

In addition, 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).

NMFS has expanded the scope of the reinitiated consultation to include the above-listed species. Since reinitiating consultation, NMFS has prepared various memoranda documenting its determination that allowing the fisheries managed under the Reef Fish and Spiny Lobster FMP to continue operating during the reinitiation period would not violate Section 7(a)(2) or Section 7(d) of the ESA. Most recently, in an October 31, 2018 memorandum, NMFS updatedthose ESA Section 7(a)(2) and Section 7(d) determinations. That memorandum addressed all listed species for which one or more reinitiation triggers for these FMPs have been met (see above). This memorandum analyzed theeffects of the continued operation of these 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 (rough cactus coral, pillar coral, lobed star coral, mountainous star coral, and boulder star coral) to ensure that those findings still apply. Based on the analyses, NMFS determined that allowing fishing managed under the Reef Fish and Spiny Lobster FMPs to continue during the reinitiation period, which extended through December 2019, would not violate Section 7(a)(2) of the ESA with respect to any of the above-references species or violate 7(d) of the ESA.

Appendix L. Bycatch Practicability Analysis

Introduction

Fishery Management Councils are 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 fishery management plans (FMP) 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. National Marine Fisheries Service (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 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 U.S. Caribbean exclusive economic zone

(EEZ). Trammel nets, which were banned from the EEZ in 2005 (CFMC 2005), were reported to produce little bycatch.

Anecdotal information suggested 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 Caribbean SFA Amendment BPA (CFMC 2005), based on the laws that existed at that time, 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); and
- 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,

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 socio-economic 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 Caribbean Fishery Management Council (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, Southeast Fisheries Science Center (SEFSC), Southeast Regional Office (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 Annual Catch Limit (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 accountability measures (AM), 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 above to gauge 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. In general, 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 EA included in this document also redefine and/or establish management refence points, and redefine or establish ACLs. However, those findings differ because the 2010/2011 BPA pertained to a shift from no ACL-based management to ACL-based management. Here, it is instead a change in the magnitude of an already established ACL. In this latter case, if the ACL for a stock or stock complex established in this FMP is lower than the previously established ACL for that stock or stock complex, bycatch would be expected to increase in proportion to the more conservative catch allowance. In contrast, if the newly established ACL is higher than the previously established ACL, bycatch would be expected to decrease in proportion to the more liberal catch allowance. For stocks new to federal management, the reduction in bycatch would be expected to be similar to the findings of the 2010/2011 BPA because of the similar shift in management (from no ACL-based management to ACL-based management).

B. Ecological effects due to changes in the bycatch of a stock (effects on other species in the ecosystem): the 2010/2011 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. Similar to the discussion in (A) above, species caught in concert with stocks that are new to federal management would experience a reduction in bycatch proportional to the more conservative catch allowances (newly established ACLs). Bycatch of species that are caught in concert with federally managed stocks for which the ACLs were revised under the Puerto Rico FMP would be expected to increase as ACLs were reduced, and decrease as ACLs were increased.

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 4.1.3, 4.1.4, 4.2.3., 4.2.4, 4.3.3, 4.3.4, 4.4.3, 4.4.4, 4.5.3, 4.5.4, 4.6.3, 4.6.4, 4.7.3, and 4.7.4.

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 4.1.4, 4.2.4, 4.3.4, 4.4.4, 4.5.4, 4.6.4, and 4.7.4.

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. Under both the historic region-based management approach and the island-based management approach, 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 3.3.1) would be potentially affected by activities authorized under the Puerto Rico FMP.

Protected species and critical habitat 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., corals, coral critical habitat).

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 and since those opinions provided take estimates for actions throughout the U.S. Caribbean), 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, and 3 hawksbill sea turtles would be non-lethally taken over three year periods. Take of *Acropora* (staghorn and elkhorn, combined) coral was calculated for three one-year periods at 0.0041 square miles per year. 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 one three-year period at 93 square feet.

Recently listed species (*i.e.*, rough cactus coral, pillar coral, lobed star coral, mountainous coral, boulder star coral, the Central and Southwest Atlantic DPS of scalloped hammerhead shark, Nassau grouper, oceanic whitetip shark, giant manta ray, and the North Atlantic and South Atlantic DPS of green sea turtles) 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 K) 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 *Acropora* corals in the Puerto Rico management area. Similarly, NMFS' effects analyses for Nassau grouper, the Central and Southwest Atlantic DPS of scalloped hammerhead shark, giant manta ray, oceanic whitetip shark, lobed star, mountainous star, boulder star, rough cactus, and pillar coral, and the North Atlantic and South Atlantic DPS of green sea turtle 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 possible 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.

Finally, the relative abundance, size structure, and age structure of other species in reef communities could be expected to change in response to changes in 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 informations becomes available.